A MULTI-METHOD EXPLORATION OF THE
MATHEMATICS TEACHING EFFICACY AND EPISTEMOLOGICAL BELIEFS
OF ELEMENTARY PRESERVICE AND NOVICE TEACHERS

DISSERTATION

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ABSTRACT

This study examined pre-service and novice elementary teachers’ mathematics teaching efficacy, mathematics epistemological beliefs, and the relationship between the two constructs. Both quantitative and qualitative methodologies were employed. The quantitative research participants were 60 preservice elementary teachers enrolled in a Master of Education initial certification program at a large state university in the Midwest. Data were collected at three points in the program to determine the influence of a mathematics methods course and the student teaching experience. Self-report survey measures included teacher efficacy (TES), mathematics self-efficacy, a mathematics performance test, mathematics teaching efficacy (MTEBI) and mathematics epistemological beliefs (DSBQ). In a multiple regression analysis, teacher efficacy predicted mathematics teaching efficacy, however, mathematics self-efficacy and mathematics performance did not. Changes over time were also considered through a repeated measures MANOVA. Mathematics epistemological beliefs did not change during the study. Teacher efficacy and mathematics teaching efficacy increased significantly over the period of time that the pre-service teachers were enrolled in a mathematics methods course. However, mathematics teacher efficacy did not change and teacher efficacy significantly decreased during student teaching. Mathematics self-
efficacy increased from the beginning to the end of the study. Finally, Pearson correlation analyses of the relationship of mathematics epistemological beliefs to mathematics self-efficacy ($r = .277; p < .05$) and mathematics teaching efficacy ($r = .666; p < .01$) were significant. However, a repeated measures MANOVA revealed that mathematics epistemological beliefs did not influence changes in mathematics self-efficacy or mathematics teaching efficacy.

This study also qualitatively explored three novice teachers’ mathematics epistemological beliefs, their analyses of the contextual and task factors that impact mathematics teaching efficacy, and the influence their epistemological beliefs had on mathematics teaching efficacy. Thematic coding and analyses were conducted with the interviews and classroom observation data to create teacher profiles. The dimensions of epistemological beliefs (Schommer, SEQ, 1990) were used as a framework to analyze each teacher’s epistemological beliefs about mathematics. The qualitative portion of this research sought to clarify Tschannen-Moran, Woolfolk Hoy and Hoy’s (1998) integrated model of teacher efficacy by probing the factors that impact teachers’ cognitive processing and analysis of the teaching task and context. For analysis of the teaching context, the teachers’ school and classroom environment, student behavior and student mathematics performance were taken into account. To examine the teacher’s analysis of the teaching task, efficacy for student engagement, classroom management, and instructional strategies were considered. The influence of teachers’ epistemological beliefs on mathematics teaching efficacy was also explored.
Factors that influenced the teachers’ analysis of the mathematics teaching context included availability of a mentor teacher, a mandated curriculum guide, students’ family backgrounds, mainstreamed special needs students, and students’ lack of number sense. Several factors that are not addressed on the TSES appeared to impact analysis of the mathematics teaching task: teachers’ relationships with students, teachers’ mathematics content knowledge, management of instructional time, and ability to teach to a wide range of student mathematics understanding. Teachers’ epistemological beliefs influenced their definitions of the mathematics teaching task and what it meant for them to teach mathematics successfully in their context, thereby impacting mathematics teaching efficacy. Implications and recommendations include: theoretical conception and measurement of subject specific teacher efficacy need to include teachers’ self-efficacy for understanding and using content knowledge. Teaching context must in some concrete way be included in the theoretical understanding and measurement of teacher efficacy. It is also recommended that qualitative teacher efficacy and epistemological findings be used to inform future development of quantitative measures of these constructs.
Dedicated
to my parents,
Chuck and Peg Esterly.
Thank you for your sacrificial love.
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CHAPTER 1

INTRODUCTION

Bandura (1997) defined self-efficacy as “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (p. 2). Bandura (1997) suggested that self-efficacy beliefs influence motivation, affect, and actions more than what is objectively true. Self-efficacy beliefs influence choice of activity, task perseverance, level of effort expended, and ultimately, degree of success achieved.

Similarly, teacher efficacy, or teacher’s judgments of their abilities “to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated” (Tschannen-Moran & Wolfolk Hoy, 2001, p. 783), affects the effort teachers invest in teaching, the goals they set, their persistence in difficult teaching circumstances, and their resilience in the face of setbacks. Bandura’s theory of self-efficacy (1977) suggests that teacher efficacy may be most malleable early in learning. Therefore preservice training and the initial years of teaching could be critical to the long-term development of teacher efficacy. Disagreement over the conceptualization of the construct, however, has contributed to a lack of clarity in measuring teacher efficacy during the past quarter century. In response to Tschannen-
Moran, Woolfolk Hoy and Hoy’s (1998) appeal for studies to test and refine their proposed integrated model of teacher efficacy, this study seeks to explore what influences teachers’ analysis of the mathematics teaching context and task.

Epistemology is a branch of philosophy that studies the nature and justification of knowledge. The line of epistemological belief research most concerned with the classroom setting conceptualizes personal epistemological beliefs as systems with multiple, more or less independent dimensions of beliefs (Schommer, 1990). These dimensions (e.g., structure of knowledge) have been demonstrated to influence academic classroom learning and performance. This study explores teachers’ epistemological beliefs and examines the relationship between teachers’ mathematics epistemological beliefs and their self-efficacy to teach mathematics.

Teacher Efficacy

Research on teacher efficacy has been driven by the construct’s powerful predictive and relational impact on both student and teacher outcomes. As Woolfolk and Hoy (1990) noted, “Researchers have found few consistent relationships between characteristics of teachers and the behavior of learning of students. Teachers’ sense of efficacy...is an exception to this general rule” (p. 81). Numerous studies have found a positive relationship between teacher efficacy and student achievement (e.g., Armor et al., 1976; Ashton, Webb, & Doda, 1983) and student motivation (e.g., Midgley, Feldlaufer, & Eccles, 1989). Moreover, teacher efficacy influences how teachers persist and interact with struggling students (Gibson & Dembo, 1984), how teachers plan and
organize their instruction (Allinder, 1995), and how teachers manage their classrooms (Woolfolk, Rosoff, & Hoy, 1990).

Although several researchers have attempted to develop unique teacher efficacy instruments (e.g., Ashton Vignettes, the majority of teacher efficacy studies have measured the construct quantitatively, primarily using some version of Gibson and Dembo’s (1984) Teacher Efficacy Scale (TES). Further, when researchers have wanted to consider context-specific teacher efficacy, they have usually simply adapted the TES to the setting. For example, the items of the TES were used as a foundation for the Science Teaching Efficacy Beliefs Instrument, which in turn, was adapted to develop the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI). However, as these subject specific instruments were developed, pedagogical knowledge and pedagogical content knowledge were addressed, but teachers’ beliefs about their content knowledge were not considered. This is pertinent because Hebert, Lee, and Williamson (1998) found that the number one reason that teachers rated themselves high on teacher efficacy was their confidence in their knowledge.

In fact, throughout the theoretical development of teacher efficacy, researchers have debated the appropriate definition and measurement of the construct. The argument has its roots in conflicting understandings of the two theoretical strands from which the construct has developed: Rotter’s locus of control and Bandura’s social cognitive theory. In response to the conceptual confusion surrounding teacher efficacy (which is discussed in greater detail in Chapter 2), Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) proposed an integrated model of teacher efficacy.
Tschannen-Moran and Woolfolk Hoy (2001) explain that as teachers analyze the teaching task and its context, they weigh the relative importance of factors that make teaching difficult or act as constraints against an assessment of the resources available that facilitate learning. Their model elucidates teacher efficacy as a context and task specific construct. Teachers obviously do not feel equally efficacious about every teaching situation. Thus, Tschannen-Moran, Woolfolk Hoy and Hoy (1998) claim that “greater specification is needed to understand what information is drawn from the teaching task, the context, and the assessment of personal teaching competence to form self efficacy” (p. 239). Moreover, the researchers acknowledge that studies using quantitative measures contribute to our comprehension with “snapshots” of the efficacy beliefs of large numbers of teachers at a particular point in time, yet they emphasize that qualitative investigations are needed to refine our understanding of the process of developing efficacy. Thus, the present study uses both quantitative and qualitative methodology to clarify and deepen our understanding of what influences elementary teachers’ cognitive processing of their mathematics teaching task and context, and their assessment of their teaching competence.

Epistemological Beliefs

Since the 1970s the study of epistemological beliefs has focused on the empirical investigation of personal epistemological development and how individuals’ beliefs influence their processes of thinking and reasoning, especially in academic settings (Hofer & Pintrich, 1997). Among those who have developed models representing beliefs about knowledge, Schommer (1990, 1992) is known for her empirical research on the
link between epistemological beliefs and academic classroom learning and performance (Hofer & Pintrich, 1997). Schommer (1990) challenged the prevalent unidimensional conception of epistemological beliefs, and proposed that personal epistemology is a belief system comprised of at least five more or less independent dimensions: the structure, certainty, and source of knowledge, and the control and speed of knowledge acquisition. Moreover, she was the first to develop a quantitative instrument to measure epistemological beliefs, the Schommer Epistemological Questionnaire (SEQ).

To explore domain specificity of epistemological beliefs Buehl, Alexander and Murphy (2002) developed the Domain Specific Belief Questionnaire (DSBQ). The instrument focuses on mathematics, a more well-structured area of study, and history, a more ill-structured domain (VanSledright & Frankes, 1998). The findings of their study revealed undergraduate students believe more effort is required to acquire knowledge in mathematics than in history and mathematics knowledge is more integrated with the knowledge in other areas than is history knowledge. The results suggested that academic epistemological beliefs are largely domain specific.

The development of quantitative measures of epistemological beliefs have afforded means to statistically relate beliefs about knowledge to other learning outcomes. Studies have demonstrated that epistemological beliefs are related to student comprehension (Schommer, 1990), academic performance (Schommer, 1993), and how students integrate and acquire new knowledge (Kardash & Scholes, 1996; Rukavina & Daneman, 1996). The mathematics beliefs literature reveals that teachers’ beliefs about mathematics play a significant role in shaping their patterns of instructional behavior.
Brownlee, Purdie, and Boulton-Lewis (2001) appear to be among the few who have explored how pre-service teachers’ personal epistemological beliefs change during teacher education. Yet the personal epistemological belief literature has primarily focused on the epistemological beliefs of students. Personal epistemological beliefs of teachers have only begun to be examined.

Moreover, despite Schutz, Pintrich and Young’s (1993) call for combining cognitive and motivational components to develop a more integrated model of learning, there continues to be a dearth of research on the relationship between epistemological and efficacy beliefs. However, Hofer (1999) considered the relations between college students’ beliefs about knowledge and their motivation, learning strategies and academic performance in a Calculus course. She found a significant positive correlation between mathematics epistemological beliefs and mathematics self-efficacy. However, again, there appears to be limited studies relating epistemological beliefs with teacher efficacy beliefs.

Although Fives (2003) points out that a number of studies consider the extent to which teachers’ knowledge is related to their efficacy beliefs, only one, which examined how holding certain inaccurate conceptions of science might cause low science teaching efficacy (Schoon & Boone, 1998), begins to describe how personal epistemological beliefs influence teacher efficacy. The other studies look at teacher knowledge as defined as education level (e.g., Hoy & Woolfolk, 1993) or courses taken (e.g., Enochs, Scharmann, & Riggs, 1995). Fives’ (2003) own study investigates the relationship between pedagogical content knowledge beliefs and teacher efficacy. Gregoire’s (2003)
study on belief change involves both epistemological and efficacy beliefs, however, both constructs are considered in relation to teacher practice and not in relation to one another.

Relatively early in the development of teacher efficacy, Ashton and Webb (1986) stated that teacher efficacy beliefs “can be expected to have different relationships to different subject matter, depending on teachers’ beliefs about the subject being taught” (p. 139). As teachers analyze the tasks involved in teaching mathematics (e.g., appropriately selecting and implementing mathematics instructional methodologies), it seems apparent that one factor that may influence this process is their epistemological beliefs about mathematics. It is proposed that the beliefs that teachers hold about how mathematics is known help to shape the task and to create the context in which they teach mathematics, thereby impacting mathematics teaching efficacy. Thus, further research is necessary to explore the relationship between teachers’ epistemological beliefs about content knowledge and their teacher efficacy beliefs.

Statement of the Problem

In the current teacher education community some researchers (Huinker & Madison, 1995; Smith, 1996) argue that the change in beliefs about the nature of mathematics and how it is most effectively learned as conceived by the reform movement has impacted teachers’ self-efficacy to teach mathematics. Much of what has supported teachers’ already low efficacy in mathematics teaching – neat, orderly algorithms and control of instruction through lecture – is being eliminated (or at least minimized) in the reform process. Teachers are being challenged to lay down what has given them security in a domain that has typically been one of the lowest in terms of efficacy (Smith, 1996).
As Putnam et al. (1992) explain,

The reform movement is asking teachers to view mathematics in ways they have never experienced as learners (or teachers). This entails changing teachers’ beliefs about what it means to understand math, what problem solving is, and who should make sense of mathematics (p. 223).

In their work with preservice teachers, Huinker and Madison (1995) found that those who had been most successful in a traditional mathematics paradigm (i.e. were always “good” at mathematics), often greatly struggled with teaching in a constructivist paradigm. There is a significant difference between teaching mathematics as telling a set of procedures versus involving and guiding students in the process of making sense of mathematical ideas. As teacher education programs promote more conceptual approaches to learning and teaching mathematics, they need to simultaneously address issues that affect mathematics teaching efficacy (Smith, 1996).

Empirical studies of the relationship between teachers’ beliefs about the nature of mathematics and how it is known – their epistemological beliefs – and their efficacy to teach mathematics are extremely limited. Exploration is required to gain an understanding on how these two constructs are specifically related. Furthermore, there is need to qualitatively investigate Tschannen-Moran, Woolfolk Hoy and Hoy’s (1998) cyclical model to gain a clearer understanding of the cognitive processing involved in the analysis of the teaching task and context. Although the relationships between teachers’ cognitive and motivational beliefs are complex, it is conceivable that teachers’ epistemological beliefs influence their definition of the teaching task, thereby impacting their teaching efficacy. The possibility of this dynamic solicits in-depth examination.
Purpose of the Study

The overarching goal of this study was to explore preservice and novice teachers’ epistemological beliefs about mathematics and their efficacy to teach mathematics, and to consider the relationship between the two constructs. To achieve this goal, the first purpose of this study was to examine the relationship between elementary preservice teachers’ mathematics teaching efficacy and epistemological beliefs about mathematics, and to determine whether these beliefs change over time. More specifically, the results of a self-report survey instrument of individuals’ mathematics self-efficacy and the corresponding mathematics performance test on the same problems were first used to determine the extent to which they are able to predict mathematics teaching efficacy. Additionally, the extent to which mathematics teaching efficacy, mathematics self-efficacy, and epistemological beliefs about mathematics change over two academic quarters in a teacher certification program was examined. Moreover, this study considered how preservice teachers’ mathematics epistemological beliefs may influence changes in their efficacy to do and teach mathematics. These relationships are investigated using quantitative methods.

The second main purpose of this study was to more deeply explore three novice teachers’ mathematics epistemological beliefs, their analyses of the contextual and task factors that influence mathematics teaching efficacy, and the influence epistemological beliefs have on mathematics teaching efficacy. Qualitative methodologies including interviews and classroom observations were employed to attain a richer understanding of
these constructs and their relationships. Teachers’ espoused mathematics epistemological and efficacy beliefs were obtained through interviews, whereas their enacted epistemological and efficacy beliefs were observed and deduced from actual classroom instructional practice. The qualitative portion of this research seeks to clarify Tschannen-Moran et al.’s (1998) integrated model of teacher efficacy by probing the factors that impact teachers’ cognitive processing and analysis of the teaching task and context. The influence of teachers’ epistemological beliefs on their definition of the teaching task is specifically addressed.

Research Questions

The goal of this study was to explore teachers’ epistemological beliefs about mathematics and their efficacy to teach mathematics, as well as to consider the relationship between the two constructs. To attain this purpose, a combination of quantitative and qualitative methodologies were utilized to obtain a more complete understanding of the beliefs and experiences of teachers. In the quantitative portion of this study with preservice elementary education students, the following research questions were investigated:

1) To what extent do teacher efficacy, mathematics self-efficacy and mathematics knowledge predict mathematics teaching efficacy?

2) How do elementary preservice teachers’ overall teacher efficacy, mathematics teaching efficacy, mathematics self-efficacy, and epistemological beliefs about mathematics change over two quarters of pre-service training?
3) How do mathematics epistemological beliefs influence the changes in mathematics self-efficacy and mathematics teaching efficacy during preservice training?

In the subsequent qualitative portion of this study the following questions guided the interviews and classroom observations of novice teachers:

4) What are the mathematics epistemological beliefs of the three novice elementary teachers in this study?

5) What aspects of the teaching context and task influence three novice elementary teachers’ efficacy judgments for teaching mathematics?

6) How do the mathematics epistemological beliefs of the three novice elementary teachers in this study influence their analysis of the mathematics teaching context and task as theorized in the integrated model of teacher efficacy?

Definition of Terms

Mathematics Epistemological Beliefs: Epistemology is a branch of philosophy that studies the nature and justification of knowledge. Epistemological beliefs are beliefs about the nature of how something is known. Thus, mathematics epistemological beliefs are beliefs about how mathematics is known.

Dimensions of Epistemological Beliefs: Because “beliefs about the nature of knowledge are far too complex to be captured in a single dimension, a more plausible conception is that personal epistemology is a belief system that is composed of several more or less independent dimensions” (Schommer, 1990, p. 498). Schommer has proposed that there
are at least five aspects or dimensions of epistemological beliefs: the structure, certainty, and source of knowledge, and the control and speed of knowledge acquisition. For example, in terms of the structure of mathematics knowledge, a person can believe that mathematics knowledge is a set of disconnected and isolated facts, or that it is comprised of connected, rich relationships in a web of interrelated concepts.

**Teacher Efficacy:** Teacher Efficacy has been defined as a teacher’s judgment of her or his capabilities to bring about desired outcomes of student engagement and learning, even among those students who may be difficult or unmotivated (Armor et al., 1976). More recently, Tschannen-Moran et al., (1998) have conceptualized teacher efficacy in an integrated cyclical model that combines analysis of a teaching context and task with assessment of personal teaching competence. The conceptual development of the construct of teacher efficacy is discussed in detail in Chapter 2. Yet it is important to point out that teacher efficacy is not another way of saying teacher effectiveness. Teachers’ perceptions of efficacy are judgments about capabilities to act, whereas teacher effectiveness is an assessment of the success of an instance of teaching.

In the teacher efficacy literature, researchers referring to the same construct have used several different terms. In this study, the terms teacher efficacy, teacher sense of efficacy, and teacher self-efficacy are used interchangeably. In the subject-specific teacher efficacy literature, the construct is referred to as mathematics teaching efficacy or science teaching efficacy. The current study follows this precedent.

**Mathematics Teaching Efficacy:** Teacher efficacy beliefs are dependent upon the specific teaching situation, and teachers’ overall level of efficacy may not accurately
reflect their beliefs about their ability to teach in a particular domain, such as mathematics. Therefore, a specific measure of mathematics teaching efficacy would more accurately predict mathematics teaching behavior and thus be more beneficial to the change process necessary to improve mathematics students’ achievement (Riggs & Enoch, 1990). Thus, as a subset of teacher efficacy, mathematics teaching efficacy is a measure of the efficacy to teach mathematics.

**Preservice Teacher:** [Also called prospective teachers.] In this study these terms refer to individuals who were enrolled in a Master of Education teacher certification program in order to attain initial licensure to become kindergarten through eighth-grade teachers.

**Self-Efficacy:** According to social cognitive theory, the central mechanism of personal agency is perceived self-efficacy - the “belief in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p.3).

**Limitations**

The quantitative portion of the present study involved preservice teacher education students of the Master of Education initial teaching certification program at a large state university in the Midwest. The qualitative portion involved follow-up interviews with several novice teachers who were prior participants in the quantitative portion. Thus the results may not be generalizable to other pre-service and novice teachers, such as those enrolled in or who have graduated from an undergraduate teaching certification program. Additionally, the nature of the data collection relies on voluntary participation and self-report techniques. The preservice and novice teachers willing to
participate in this research may be specialized in some way, and their responses may demonstrate aspects of social desirability or self-promotion.

Although participants were encouraged to respond honestly and ensured of confidentiality, responses are likely influenced by the preservice teachers’ awareness gained in their constructivist mathematics methods courses. They may have responded with the “appropriate” response to an epistemological statement, but did not truly espouse that belief. This highlights the advantage of qualitative exploration of teachers’ epistemological beliefs as enacted in their mathematic teaching. Yet the qualitative researcher must not naively forget that teachers can also show you what they think you want to see.

One of the limitations involved in the study of teacher efficacy has been the persistent lack of clarity in the definition and measurement of the construct. When teacher efficacy is explored qualitatively, there is an even greater challenge to assure that what is being observed and analyzed is truly an example of teacher efficacy beliefs. Initially, rather than asking direct teacher efficacy interview questions, I attempted to access teacher efficacy beliefs statements within the context of a more natural discussion of their teaching experiences. Teachers’ beliefs about their abilities to teach mathematics were often stated in the present tense. I acknowledge that it was sometimes necessary to use these statements to extrapolate the teachers’ beliefs about future performance. I later used the questions of the TSES (Tschannen-Moran & Woolfolk Hoy, 2001) in a follow-up interview with the final participant. Use of more direct teacher efficacy questions resulted in clearer teacher efficacy belief statements.
The timing of the quantitative portion of this study highlights the importance of a research schedule. At the first data collection, the teachers in this study had recently completed their first mathematics methods course, which emphasized conceptual understandings of mathematics. Had the initial data collection occurred prior to this methods course, a more accurate measure of the students’ mathematics teaching efficacy and epistemological beliefs would have been obtained. Furthermore, had this study begun at the beginning of the M.Ed. program, the effects of mathematics methods courses could have been more clearly ascertained.

Another concern is that because the mathematics methods course was only 10 weeks long and met only once a week, it is possible that the limited time may have prevented significant changes in the measured factors. Finally, the preservice teachers in this study were in field placements for most of the year, gradually increasing their time in the schools. Although teacher efficacy tends to increase with mastery experience, it is possible that the most dramatic changes in teacher efficacy may have occurred during the students’ first field experience prior to the beginning of this study. Further, some teacher efficacy studies have explored the influence of student teaching experiences on prospective teachers who had relatively little prior field experience. That was not the case for participants in this study. Thus, there may not be a significant change in teacher efficacy and mathematics teaching efficacy between the second and third data collection points.
Significance of the Study

The study of prospective teachers’ sense of efficacy is especially important because research indicates that teacher efficacy not only influences teacher performance, but also affects students’ self-efficacy, achievement, and attitudes toward school and specific subject matter (Tschannen-Moran et al., 1998). In fact, teacher efficacy is one of the few characteristics of teachers that have been studied that consistently relates to student achievement (Ashton & Webb, 1986).

This study extends the current research on mathematics teaching efficacy and investigates its relationship with epistemological beliefs about mathematics. The relationship between prospective teachers’ overall teacher efficacy and mathematics teaching efficacy are also empirically established. Furthermore, it is evident that mathematics teaching efficacy alone will not result in effective mathematics teaching – teachers cannot teach mathematics if they do not have adequate knowledge, skills and understanding about the nature of mathematics. This study is the first to explore the relationship between mathematics self-efficacy and mathematics teaching efficacy. Moreover, the longitudinal nature of this study helps to identify any changes in these constructs over time and emphasizes the need to monitor and help develop preservice teachers’ mathematics teaching efficacy and beliefs about mathematics in teacher education programs.

Future research is necessary to identify specific methods of increasing teacher mathematics efficacy and mathematics teaching efficacy, and thereby improve student mathematics achievement. Researchers (Tschannen-Moran et al., 1998) have called for
interpretative case studies and qualitative investigations designed to refine our understanding of the processes of developing efficacy. Additionally, further research is necessary to determine how teachers’ epistemological beliefs about mathematics may influence their definition of the teaching task, thereby influencing their self-efficacy to teach mathematics. This study seeks to fill these gaps in the literature.
CHAPTER 2

REVIEW OF RELEVANT LITERATURE

Overview of the Chapter

Within the field of educational psychology, researchers have recognized that both motivational and cognitive factors powerfully impact teacher practice and student academic outcomes. The bodies of literature on teacher efficacy and teacher knowledge and beliefs have each revealed the influence of teachers’ beliefs on their classroom behavior. However, relatively few studies have been conducted that integrate both teacher efficacy and teacher knowledge and beliefs. As the current study seeks to fill a gap in the literature, the purpose of this review is to develop a theoretical framework that serves as a foundation for understanding the context in which the current study is situated, to further reveal the need for this research, and to provide a basis for methodology decisions.

The review considers two main areas of relevant literature: teacher efficacy studies and epistemological belief studies. Because this present research focuses on mathematics teaching efficacy and epistemological beliefs, the self efficacy for mathematics and beliefs about mathematics literature are also included to gain a more
complete understanding of the two constructs. Further, as the current study attempts to provide greater insight into teacher efficacy and epistemological beliefs through incorporating both quantitative and qualitative methods, one focus of this review to identify the unique findings of previous research that has employed each approach.

Teacher Efficacy

Over the past quarter century researchers have sought to theoretically clarify and effectively measure the concept of teacher efficacy. Although literally hundreds of studies have explored teacher efficacy, this review focuses on the quantitative research that has had substantial impact on the measurement and definition of teacher efficacy, as well as on qualitative studies that provide insight into the cognitive processing involved in teachers’ evaluations of their efficacy. Statistical analyses of larger samples provide the benefits of investigating quantified levels of respondents’ current sense of efficacy for teaching, changes in teachers’ sense of efficacy over time, as well as instrument validation. However, a review of studies that analyze interviews, observations and other qualitative data will provide depth of description and detail to better understand the underlying meanings and processes involved in teacher efficacy.

In the quantitative measurement section, the definition of teacher efficacy is first considered through a historical overview of the development of quantitative measures of efficacy. Then quantitative subject-specific studies of teacher efficacy are examined, followed by a review of research on the impact of methods courses and field experiences on prospective teachers’ efficacy. The quantitative measurement section concludes with a discussion of Tschannen-Moran et al.’s (1998) integrated model of
teacher efficacy and how the Teacher Sense of Efficacy Survey (TSES), the instrument developed to evaluate the theoretical model, is designed to more effectively measure the construct.

In the second major section, the advantages of qualitative measurement of teacher efficacy are first considered. Then the qualitative methods of data collection and analysis utilized in the reviewed studies are identified. I next present a chronological overview of qualitative studies of teacher efficacy along with their purpose, methods, and a particular focus on how the studies’ findings contribute to a more complete conception of the components in the cyclical model of teachers’ sense of efficacy as theorized by Tschannen-Moran et al. (1998). For each qualitative study, the sources of efficacy, as well as the analysis of the teaching task, analysis of the teaching context, and assessment of personal teaching competence involved in the development of teachers’ sense of efficacy are considered. The section concludes with a summary of how the qualitative findings inform the cognitive processing portion of the cyclical model of teachers’ sense of efficacy.

Quantitative Measurement of Teacher Efficacy

Rand Study. In the mid-1970s the RAND Corporation published the findings of their study on the factors impacting the reading achievement of students in the Los Angeles Unified School District. In addition to student background characteristics, Armor et al. (1976) ascertained that teacher attributes accounted for a significant portion of the variation in the reading scores of minority students. Teacher attributes were comprised of background characteristics (e.g., ethnicity) and predispositions or attitudes toward
teaching, which the authors defined as “the extent to which the teacher believes he or she has the capacity to produce an effect on the learning of students” (Armor et al., 1976, p. 23).

This construct, which the researchers called teacher efficacy, was measured with two questions that were based in Rotter’s locus of control theory. The first question, which reflected external locus, was “When it comes right down to it, a teacher really can’t do much – most of a student’s motivation and performance depends on is or her home environment.” The second question, which reflected internal locus, was “If I try really hard, I can get through to even the most difficult or unmotivated students” (Armor et al., 1976, p. 73). Thus, teachers with a high teacher efficacy believed they could “control” or influence student motivation and academic performance.

Other Rotter-based studies. Although the RAND study opened a valuable new frontier of research, the researchers’ unfortunate choice of the term teacher efficacy when the items actually reflected Rotter’s concept of locus of control, has led to much of the theoretical confusion surrounding the construct’s development (Cybulski, 2003). For several years following the RAND study, researchers continued to use Rotter’s locus of control theory as a foundation to pursue a deeper understanding of a construct that so powerfully influenced student achievement. Three studies in particular stand out for their original approaches to measuring teacher beliefs about control over the results of teaching.

The first was Guskey’s (1981) Responsibility for Student Achievement instrument which yielded a measure of how much teachers assumed responsibility for
student outcomes in general, as well as for their successes and failures. Overall, Guskey found that teachers assumed more responsibility for successes than for failures, expressing a greater confidence in their ability to influence positive outcomes than to prevent negative ones. That same year, Rose and Medway (1981) developed the Teacher Locus of Control (TLC) measure which asked teachers to attribute responsibility for student successes or failures either internally to the teacher or externally to the student. They found that the TLC was a better predictor of teacher behaviors than Rotter’s (Internal-External) I-E Scale, perhaps because it more specifically reflected a teaching context.

For instance, the TLC predicted teachers’ willingness to implement new instructional strategies, where as Rotter’s scale did not. A year later, Ashton, Olejnik, Crocker, and McAuliffe (1982) developed the forced-choice formatted Webb Scale to reduce the problem of social desirability bias. For each of the seven items, teachers had to decide if they agreed most strongly with the first or second statement. They found that teachers who scored higher on the Webb efficacy scale evidenced fewer negative (angry or impatient) interactions in their teaching. However none of these three measures was adopted to any great extent in subsequent teacher efficacy research.

*Bandura-based efficacy measures.* Over the past 20 years, teacher efficacy has been primarily studied in the context of Bandura’s (1977, 1997) social cognitive theory. The instruments that have been most prominent in the theoretical discussion of effective methods of measuring teacher efficacy as conceived with in the framework of social cognitive theory include the Ashton Vignettes (1982), Gibson and Dembo’s Teacher
Efficacy Scale (1984), Riggs and Enoch’s Science Teaching Efficacy Beliefs Instrument (1990), Bandura’s Teacher self-efficacy scale (1997), and most recently, the Tschannen-Moran and Woolfolk Hoy Teacher Sense of Efficacy Scale (2001). Each of these studies, along with pertinent subsequent research on each will be reviewed chronologically, with the exception of Riggs and Enoch (1990) which will be reviewed under the heading of Specificity of Teaching Efficacy.

**Ashton Vignettes.** Ashton and colleagues (1982) used the Ashton Vignettes instruments, each consisting of 25 teaching problem situations to investigate teachers’ sense of self-efficacy. One version required self-referenced responses (extremely ineffective to extremely effective) while the second required norm-referenced responses (much less effective than most teachers to much more effective than other teachers). The researchers assumed that teacher efficacy was context specific, using items such as: “Your school district has adopted a self-paced instructional program for remedial students in your area. How effective would you be in keeping a group of remedial students on task and engaged in meaningful learning while using these materials?” The 65 teachers surveyed appeared to evaluate their effectiveness in terms of their performance in comparison to the performance of other teachers, suggesting that teacher efficacy was a norm-referenced construct. The norm-referenced vignettes were significantly correlated with the Rand items, but the self-referenced vignettes were not. This instrument was not widely adopted in teacher efficacy research.

**Gibson and Dembo Teacher Efficacy Scale.** Gibson and Dembo (1984) were among the first to reconceptualize the construct using a second theoretical strand:
Bandura’s (1977, 1997) construct of self-efficacy, or “beliefs in one’s capabilities to organize and execute the courses of action required to produce given attainments” (p. 3). Gibson and Dembo (1984) attempted to expand the measurement of efficacy and clarify its meaning with the development of the Teacher Efficacy Scale (TES), a 30-item Likert-scale formatted, self-report instrument. They surveyed 208 elementary teachers, and the factor analysis yielded a two factor structure. Gibson and Dembo interpreted the two factors to reflect the two expectancies of Bandura’s social cognitive theory: self-efficacy and outcome expectancies. Factor 1 (which accounted for 18.2% of the total variance) was termed “personal teaching efficacy” (PTE) and reflected teachers’ belief that they had the skills and abilities to bring about student learning. All of the items loading on this factor are related to Bandura’s self-efficacy dimension. The authors commented that this factor corresponded to the original Rand item: “If I really try hard, I can get through to even the most difficult or unmotivated students.”

Factor 2 (which accounted for 10.6% of total variance) was simply termed “teaching efficacy” (TE), reflecting the belief that “any teacher’s ability to bring about change is significantly limited by factors external to the teacher, such as home environment, family background, and parental influences” (Gibson & Dembo, 1984, p. 574). The authors argued that this factor was related to Bandura’s outcome expectancy dimension and that it corresponded to the second Rand item: “When it comes right down to it, a teacher really can’t do much because most of a student’s motivation and performance depends on his or her home environment” (p. 574).
In addition to developing their Teacher Efficacy Scale, Gibson and Dembo (1984) also sought to explore whether “high and low efficacy teachers exhibited differential patterns of teacher behaviors in the classroom related to academic focus, feedback, and persistence in failure” (p. 571). In classroom observations of eight teachers the researchers utilized a teacher-use-of time instrument, measures of teacher praise and criticism frequency differences in response to students’ correct and incorrect answers, and the ratio of feedback interactions in which a teacher either repeated the question, provided a clue, or asked a new question following a student’s incorrect response.

Gibson and Dembo (1984) did indeed find significant differences in classroom behavior between low and high efficacy teachers. In terms of instructional strategies, low efficacy teachers spent almost one half of their observed time in small group instruction, whereas high efficacy teachers only spent about a quarter of their time using small groups. However, high efficacy teachers spent more time monitoring and checking seat work. While teachers spent a relatively small portion (2%) of their time in intellectual games, no observations of this occurred in high efficacy teachers’ classrooms. However, the researchers noted that teachers’ allocated time and organization did not necessarily reflect students’ academically engaged time or academic focus.

In terms of student engagement, Gibson and Dembo observed that when students gave an incorrect response to low efficacy teachers’ questions, 4% of these interactions resulted in teacher feedback in the form of criticism; there were no observations of criticism in high efficacy teachers. Low efficacy teachers demonstrated a greater lack of persistence in that they were more likely to respond to incorrect responses by giving the
answer, asking another student, or allowing another student to call out before a student gave the correct response. In contrast, high efficacy teachers were more effective in leading students to correct responses through their questioning.

Additionally, low efficacy teachers were observed to appear flustered by any interruption of their routine while they were engaged with small groups, whereas the high efficacy teachers seemed to utilize this format with greater ease and flexibility. Gibson and Dembo’s data suggested that high efficacy teachers may achieve higher student engagement rates by employing whole class instruction and may be better able than low efficacy teachers to keep other students engaged while instructing small groups. Although they recognized the need for study of larger samples of teachers, Gibson and Dembo (1984) concluded that “those teachers who in general expect students to learn and who have confidence in their ability to teach may communicate higher expectations by providing less criticism to students and persisting with students until they respond correctly rather on going on to another student or question” (p. 579).

The development of the Gibson and Dembo Teacher Efficacy Scale greatly benefited the study of teacher efficacy. However, researchers’ subsequent factor analyses of the TES revealed inconsistencies, with a few items loading on both factors. Several studies endeavored to theoretically clarify the construct of teacher efficacy as they performed factor analyses on Gibson and Dembo’s Teacher Efficacy Scale in the midst of their own research on correlates of the construct. Woolfolk and Hoy (1990) explored the structure of efficacy for prospective teachers and considered whether it was related to their orientations toward discipline, order, control, and motivation in schools. They
adapted the Teacher Efficacy Scale, using the 16 items that Gibson and Dembo had found 
to produce adequate reliability, four other of their items that involved teachers’ preservice 
preparation, along with the two RAND items.

They subjected the scale to two different factor analytic procedures, first 
replicating the two factor solution Gibson and Dembo had used. Their results closely 
matched those of the prior study, with the factors Personal Teaching Efficacy and 
General Teaching Efficacy (instead of just Teaching Efficacy) accounting for 27% of the 
variance. However, Woolfolk and Hoy (1990) challenged Gibson and Dembo’s 
interpretation of the second factor they associated with Bandura’s outcome expectancy. 
The researchers explained that the question of whether teachers can overcome the effects 
of students’ adverse background influences is not an outcome expectation, but rather an 
efficacy expectation because it involves the potential to perform. Woolfolk and Hoy also 
considered a three factor solution, further dividing personal efficacy into the two related 
aspects of responsibility for positive student outcomes and responsibility for negative 
student outcomes. However, using the three aspects of efficacy did not add to the more 
parsimonious two factor solution.

Moreover, the researchers found that relationships between efficacy and other 
teacher variables need to be carefully specified. Specifically, they discovered that 
preservice teachers with high teaching efficacy were more humanistic in their pupil 
control ideology than those with low teaching efficacy. However, Woolfolk and Hoy 
(1990) clarify that the relationship existed only among those preservice teachers who also 
had high personal efficacy, believing they have the ability to make a difference in student
achievement. The authors argue that when multidimensional measures of efficacy are used, researchers must look beyond composite scores to identify samples of high and low efficacy teachers.

Hoy and Woolfolk (1993) later developed a 10 item adaptation of the Gibson and Dembo TES to examine the relationships among general and personal teaching efficacy and aspects of a healthy school climate. They shortened the Teacher Efficacy Scale to include five personal and five general teaching efficacy items from the Woolfolk and Hoy (1990) version that had the highest factor loadings in the earlier research. In this study they determined that two aspects of school organization, principal influence and academic emphasis, predicted personal teaching efficacy.

In their 1990 study, Woolfolk Hoy and Hoy called attention to the fact that most of the TE items of the TES stated negative attitudes, whereas all of the PE items stated positive attitudes. They suggest that “it is possible that the items cluster into TE and PE factors in part because of these differences in response directions” (p. 89). Guskey and Passaro (1994) responded to Woolfolk Hoy and Hoy’s call for further research to explore this concern. Guskey and Passaro observed that not only were the items of the TES that loaded on the personal efficacy factor all positive, they also all used the referent “I” and had an internal locus (i.e., “I can”). Those items that loaded on the teaching efficacy factor mainly were not only all negative, but also used the referent “teachers” and had an external locus (i.e., “teachers cannot”). Thus, the researchers reasoned that the interpretation of these two factors might confound type of efficacy with referent, sign, and locus.
Guskey and Passaro (1994) altered the items of an adapted version of the TES (similar to that used by Woolfolk and Hoy, 1990) to represent the missing combinations of “I cannot” and “Teachers can.” Their factor analysis confirmed two independent efficacy dimensions. However, they challenged previous researchers’ interpretations of the two factors as personal and teaching efficacy. Their results indicated an internal versus external distinction, similar to locus of control measures of causal attribution. Guskey and Passaro argued that the internal factor represented perceptions of personal influence, power, and impact in teaching situations while the external factor related to perceptions of the influence, power and impact of elements that lie outside the classroom and might be beyond the direct control of individual teachers.

However, Soodak and Poddell (1996) questioned Guskey and Passaro’s interpretations, arguing that their use of “can” and “cannot” as the basis for distinguishing between internal and external items was not explained, nor was it intuitively obvious. Moreover Guskey and Passaro imposed a two-factor solution on their participants’ responses, thereby precluding detection of other possible dimensions. Thus, Soodak and Poddell’s goal was to investigate the existence of additional dimensions of teacher efficacy that were consistent with Bandura’s original conceptualization of self-efficacy, as well as determine whether teachers’ beliefs about the role of outside influences included elements other than the student’s home environment.

Soodak and Poddell (1996) used an adapted version of the Gibson and Dembo TES including 15 items of the original measure, along with items addressing students’ behavior and emotionality. They identified three uncorrelated factors which they labeled
Personal Efficacy, Outcome Efficacy, and Teaching Efficacy. Soodak and Poddell interpret PE to pertain to a teacher’s belief that he or she possesses teaching skills, while OE refers to the belief that desirable student outcomes will result from his or her implementation of these skills. They stated that although both factors pertain to teachers’ beliefs in their own effectiveness, PE and OE concern distinct cognitions about efficacy and therefore may differentially influence teachers’ instructional decisions. “This distinction suggests that efforts to enhance teacher efficacy must take into account whether low teacher efficacy is due to teachers’ lack of confidence in their skills or a sense of futility regarding the impact of their work” (p. 410). The authors explain that the third factor, TE, has been viewed as the belief that teaching can overcome the effects of outside influences. Soodak and Poddell clarified TE to involve outside influences in addition to the home, including heredity and television violence.

Deemer and Minke (1999) further addressed structural issues of the TES when they claimed that Guskey and Passaro (1994) did not adequately deal with the issue raised by Woolfolk and Hoy (1990) of positive versus negative orientation in item wording on interpretation of the measure. Thus they altered each item of the Gibson and Dembo TES so that a positive and negative version of each item was available and all items were worded in the first person “I.” Two versions of the revised measure were created with approximately equal numbers of original, as well as revised positive, and negative items on each. Deemer and Minke examined three potential factor structures.
using principal axis factoring. They found that when wording confounds were eliminated, the TES appeared unidimensional. However, the researchers did not conclude that teacher efficacy is a unidimensional construct.

Rather, consistent with Bandura (1997) and Pajares’s (1997) work, they propose that teacher efficacy may be more differentiated than the TES adequately captures. Deemer and Minke (1999) emphasize that teachers’ sense of efficacy may vary across the various tasks of teaching, and so they conclude that global instruments such as Gibson and Dembo’s (1986) TES “decontextualize efficacy judgments and lack close relationships to specific teaching tasks, thus limiting their predictive capabilities” (p. 7). They echoed Pajares (1997) and Bandura’s (1997) proposals as they suggested that “in order to reveal the true dimensionality of the efficacy construct, future studies should devise measures that are more specific to teaching duties” (p. 9).

Concerns with the Gibson and Dembo TES. Although the Gibson and Dembo (1984) Teacher Efficacy Scale has greatly benefited the study of teacher efficacy for many years, research has demonstrated a number of concerns with the instrument’s ability to adequately represent the construct. Researchers have revealed grammatical issues, including referent (I vs. teachers), sign (positive or negative), and locus (internal vs. internal). Also, both the number and identity of the dimensions of the construct as measured by the TES have been disputed. Although many studies revealed two dimensions, adjustments for grammatical concerns resulted in apparent unidimensionality.
Furthermore, a debate has persisted over the identity of the second factor – is it outcome expectancy or a generalized teaching efficacy? Bandura (1997) has argued that a person's estimate of the likely consequences of performing a particular task at the expected level of competence (outcome expectancy) is not the same construct as self-efficacy - a person's belief that they have the ability to orchestrate the necessary actions to perform a given task. Further, Tschannen-Moran and Woolfolk Hoy (2001) argued that,

Bandura pointed out that outcome expectancy adds little to the explanation of motivation because the outcome a person expects stems from that person’s assessment of his or her own capabilities and expected level of performance, not from what it would be possible for others to accomplish under similar circumstances. (p. 792)

Even so, researchers (Gibson & Dembo, 1984; Soodak & Poddell, 1996) have reasoned that a combination of teachers’ efficacy expectancies and outcome expectancies would more accurately reflect the cognitive processing behind their instructional decisions and classroom behavior.

Another concern about the TES is found in the nature of the conditions that are considered in measuring the second factor, no matter whether it is interpreted as outcome expectancies or general teaching efficacy. Tschannen-Moran et al., (1998) maintained that what they have labeled the GTE scale does not have items that reflect the positive influences of environmental factors such as quality curricular resources and a supportive
administration and school culture. Thus because this scale focuses only on the external constraints that impede teaching, it captures only a partial analysis of the teaching task as constituted.

Further, Gibson and Dembo reported that two substantial factors emerged from their factor analysis. However, Henson (2001) points out that Factor I accounted for 18.2% of the matrix of association variance and Factor II accounted for only 10.6% of the variance. Henson (2001) argues that this variance accounted for is minimal at best and indicates poor factorial validity.

Finally, many researchers (e.g., Bandura, 1997; Pajares, 1997) have identified the level of specificity as another concern with the measurement of teacher efficacy. Teacher efficacy has been defined as context and subject-matter specific. It is evident that teachers often feel more competent in certain subject areas and in working with particular populations of students (Tschannen-Moran & Hoy, 2001). However, as Deemer and Minke (1999) expressed, Gibson and Dembo’s (1986) TES appears to be too global to effectively measure specific teaching tasks and contexts.

Subject-Specific Teaching Efficacy. Regarding optimal level of specificity, as early as 1986 Ashton and Webb reported a subject domain distinction that served to clarify the teacher efficacy construct. Ashton and Webb’s (1986) study [reviewed in depth under qualitative studies] involving basic skills mathematics teachers is the earliest identified research that addresses mathematics teaching efficacy. Consistent with Bandura’s conception of self-efficacy as being situation-specific, Ashton and Webb
found that teacher efficacy beliefs “can be expected to have different relationships to different subject matter, depending on teachers’ beliefs about the subject being taught and the students in the classroom” (1986, p. 139).

Basic skills high school mathematic teachers were selected because of the authors’ belief that sense of efficacy would be most likely to have an impact on teacher behavior in courses with low achieving students. Ashton and Webb used the Webb efficacy measure, Ashton Vignettes and the two RAND items to measure teacher efficacy. Although these efficacy instruments’ items were not stated in a specific mathematics context, the mathematics teachers assumed the mathematics domain. A significant relationship between the teachers’ general (math) teaching efficacy and their students’ mathematics performance scores was found. This impact on student mathematics achievement illustrates the importance of studying prospective teachers’ mathematics teaching efficacy.

Midgley, Feldlaufer, and Eccles (1988, 1989) explored the difference in teacher efficacy between teachers in elementary and junior high schools. They chose to study mathematics teachers in order to examine the effects of student tracking, which becomes much more frequent, especially in mathematics, after the transition to junior high. They created a scale to measure personal teaching efficacy comprised of five items, including items drawn from the RAND study and Ashton and Webb (1986). The researchers found that junior high teachers trusted students less, were more controlling in their attitudes toward children and had lower personal teaching efficacy than the elementary teachers of the same students. Their findings also support Bandura’s (1997) claim that self-efficacy
is not a general trait, but rather a situation-specific belief. Midgley, Feldlaufer, and Eccles suggest that the difference in mathematics personal teaching efficacy beliefs is due to the fact that junior high schools are typically larger and less personal, and teachers must instruct more students with whom they spend a relatively small portion of the school day compared to elementary teachers.

Thus, teacher efficacy beliefs are dependent upon the specific teaching situation, and teachers’ overall level of efficacy may not accurately reflect their beliefs about their ability to teach in a particular domain, such as mathematics. Therefore, a specific measure of mathematics teaching efficacy would more accurately predict mathematics teaching behavior and thus be more beneficial to the change process necessary to improve mathematics students’ achievement (Riggs & Enoch, 1990). This is especially pertinent to studies of elementary teachers who teach a variety of subjects.

With this reasoning, Riggs and Enoch (1990) used the Gibson and Dembo (1984) TES as a template to design the Science Teaching Efficacy Beliefs Instrument (STEBI), which would later be used to create a mathematics teaching efficacy instrument. Developed prior to the arguments over the identity of the second factor, the 25-item STEBI measure was comprised of what the authors designate at the personal science teaching efficacy (PSTE) belief scale and the science teaching outcome expectancy (STOE) scale. Riggs (1995) administered the STEBI to 75 elementary teachers to study the effects of a year-long training designed to develop teachers’ abilities to teach activity-based science. Initially, teachers with low PSTE were identified to spend less time teaching science and developing science concepts, display higher use of text-based
science teaching, utilized activity-based instruction less frequently, and were generally less effective at teaching science (as evaluated by observers). Low PSTE teachers also made fewer positive changes in their beliefs on how children learn and how teachers are to teach science during the year-long Science Education and Equity project. Teachers with low STOE also tended to use text-based approaches and incorporated less cooperative teaching. They also always reported their own science teaching effectiveness as average, whereas high STOE teachers’ self-rating varied.

In contrast, teachers with high PSTE demonstrated leadership in their schools, had used activity-based science program prior to participation in the project, and actively involved students in science learning. After participation in the training program, significant increases in PSTE were observed in those who initially had low PSTE. However, no significant increases in STOE were observed; teachers low in STOE continued to believe that teachers are limited by external factors in their capacity to influence student performance. Riggs (1995) suggested that teachers need to first develop their own ability to teach science before they can focus on potential student outcomes.

_Influence of methods courses and field experiences on subject-specific teaching efficacy._ Enochs et al. (1995) recognized the concerns that Woolfolk and Hoy (1990) raised about Gibson and Dembo’s definition of outcome expectancy. Enochs et al. explained that two of the outcome expectancy items on the TES were not incorporated in the STEBI, and they agree that outcome expectancy items should instead reflect teachers’ belief in students’ ability to learn, given effective teaching. The researchers also argue
that several personal teaching efficacy items on the TES are combinations of both self-efficacy and subsequent contingencies between performance and outcomes. Thus the STEBI-B for preservice teachers was revised to include 23 items.

Enochs et al. (1995) administered the STEBI-B to 73 preservice elementary teachers and consistent with prior research found that those with higher science teaching self-efficacy scores also had more humanistic orientations toward control or management in the classroom. They also determined that the higher teachers’ science teaching efficacy, the more they believed that activity-based instruction was the most appropriate approach. Surprisingly, they found that the more college science classes the prospective teachers had completed, the less they would choose to teach their students science if given the option. The authors speculate that these preservice teachers’ exposure to more lecture-based college science courses had a negative impact on science teaching interest. Fives (2003) offers another explanation that both the advanced level of the courses and the way they were delivered may have inhibited preservice teachers’ beliefs in their ability to reconstruct the material for elementary school children.

Wilson (1996) used the STEBI-B for pre-, mid- and post- evaluations of the effects on efficacy of the field experiences of 18 elementary preservice teachers in science, mathematics and technology. She found a large increase in science teaching efficacy after six months of field experience. Wilson also conducted interviews with the students and concluded that in order to increase preservice teacher efficacy, field
experiences must be clearly defined, logically sequenced with a pattern of slow introduction into the clinical sites, and planned for and practiced before implementation.

Additionally, she found that field experiences that permitted preservice teachers to participate in cooperative teams had a positive influence on their science, mathematics and technology teaching efficacy.

In a similar field experience study, Vinson (1995) replaced the word “science” on the STEBI-B with “math,” “social studies,” and “language arts” to obtain teaching efficacy data in all four subject areas. Surveys were administered pre- and post-clinical experience to 58 pre-student-teaching novices who served in six different schools. The significant increase in personal teaching efficacy was attributed to the field experiences providing authentic school experience and opportunity to work directly with students (mastery experience). General teaching efficacy did not change significantly. However, compared with social studies and language arts, the general mathematics teaching efficacy scores were the lowest.

Vinson (1995) sought to further understand the factors affecting the variance in pre-student-teaching novice’s sense of [math, science, language arts, and social studies teaching] efficacy. She asked a series of eight interview questions to identify what and who influences teacher efficacy. One pertinent finding was that her participants selected mathematics as the hardest subject to teach to students who were the most difficult to teach. This view was based in the prospective teachers’ own difficult experiences with mathematics and beliefs that mathematics is less interesting than other subjects.
Furthermore, the participants attributed mathematics success to more inborn abilities – not effort or effective teaching. Vinson concluded that as a situation-specific construct, teacher efficacy is influenced by a variety of factors including subject taught, student characteristics, school settings, grade level, and the availability of a colleague/cohort support system.

Huinker and Madison (1995, 1997) assessed the influence of a conceptually-oriented mathematics methods course on preservice teachers’ mathematics teaching efficacy beliefs and the extent to which changes in these beliefs correspond to changes in pedagogical conceptions of mathematics. In addition to extensive qualitative research, Huinker and Madison administered the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI), which is a modified version of the STEBI. The MTEBI, which underwent factorial validation by Enochs, Smith, and Huinker in 2000, is comprised of what the authors once again identify as a personal mathematics teaching efficacy subscale and the outcome expectancy subscale. The MTEBI was administered to 62 preservice elementary teachers at the beginning and then again at the end of the mathematics methods course. They observed significant increases in both mathematics teaching self-efficacy (MTSE) and mathematics teaching outcome expectancy (MTOE). Further analysis of their qualitative research on two students with mathematics minors revealed that individual increases in mathematics teaching efficacy were related to whether the preservice teachers were able to transition from a traditional to a constructivist paradigm of teaching mathematics - a transition that is a prerequisite for teachers being able to implement the new mathematics teaching standards.
Huinker and Madison (1997) acknowledge that the students studied were simultaneously obtaining clinical experience and thus it is unlikely that the mathematics methods courses alone were responsible for the increases in efficacy. Field placement observations revealed that the preservice teachers obtained vicarious experiences during their fieldwork as they observed classroom teachers and their peer partners. The preservice teachers’ fieldwork also provided opportunity to perform and thus see the impact of their own teaching (mastery experience). These findings on the positive influence of mathematics methods courses and field experiences are consistent with those of Woolfolk Hoy (2000).

Woolfolk Hoy (2000) used instruments that were not subject-specific: the Gibson and Dembo short form which she separated into the personal teaching efficacy scale (PTE) and the general teaching efficacy scale (GTE), the Bandura Teacher Self-Efficacy Scale, and a program-specific measure named the OSU Teaching Confidence Scale. She found that measures of teacher efficacy all increased between the beginning of a one year teacher education program and the end of the prospective teachers’ student teaching experience. However, from the end of the student teaching to the end of the first year of teaching, decreases in the Bandura, GTE, and PTE scales were significant. Hoy and Woolfolk (1990) had previously found increases in personal efficacy and decreases in general teaching efficacy during student teaching. Even so, the prospective teachers in the earlier study entered their student teaching with relatively little prior classroom experience, while those in the 2000 study were in a year-long internship. Woolfolk reasons the decrease in efficacy during the first year for the 2000 study teachers was due
to the loss of the support provided by their internship because level of support during the first year of teaching correlated with increases in efficacy.

Wingfield, Nath, Freeman, and Cohen (2000) studied the effect of field-based preservice experiences on elementary mathematics teaching self-efficacy beliefs. They used a modified version of the STEBI to survey 141 preservice teachers. From pre-field-based experience to post-experience the increases in what the authors call the self-efficacy scale were significant, but the slight increases in the outcome scale were not significant. Wingfield et al. (2000) explained that consistent with Gibson and Dembo’s (1984) definitions, the outcome efficacy can be referred to as the belief in how well students can actually be taught, given the students’ family, school, and academic ability limitations, where as personal self-efficacy is a belief in one’s ability as a teacher to bring about positive student change and motivation. Thus, Wingfield et al. contend that the prospective teachers in their study had a strong belief of being able to teach mathematics, however did not believe they were able to make a significant effect on the eventual outcome for students because of outside influences.

Bandura’s Teacher Self-Efficacy Scale. In the midst of the arguments over the dimensions of teacher efficacy and how to best measure it, the father of the social cognitive theory, Bandura (1997), developed his own Teacher Self-Efficacy Scale. Highlighting that teachers’ sense of efficacy is not necessarily uniform across subjects or the various tasks they are required to perform, Bandura sought to capture a more complete depiction of teachers’ sense of efficacy as he created the 30 item instrument comprised of seven subscales. The subscales measure efficacy to influence decision
making, efficacy to influence school resources, instructional efficacy, disciplinary
efficacy, efficacy to enlist parental involvement, efficacy to enlist community
involvement, and efficacy to create a positive school climate. However, reliability and
validity information for Bandura’s Teacher Self-Efficacy Scale have not been available.

*An Integrated Model of Teacher Efficacy.* In response to the concerns with the
way teacher efficacy was previously conceptualized as measured with the Gibson and
Dembo TES, Tschannen-Moran et al. (1998) proposed an integrated cyclical model of
teacher efficacy (see Figure 1). In the cyclical model, the four sources of information
about efficacy as described by Bandura (1986, 1997), mastery experience, physiological
arousal, vicarious experiences, and verbal persuasion, are cognitively processed. In this
process the teacher must analyze his or her teaching context as well as the teaching task.
Teachers obviously do not feel equally efficacious about all teaching situations.

As teachers consider the teaching task and context, they also assess their current
personal teaching competencies to accomplish that task. Tschannen-Moran, Woolfolk
Hoy and Hoy (1998) explain that “in analyzing the teaching task and its context, the
relative importance of factors that make teaching difficult or act as constraints is weighed
against an assessment of the resources available that facilitate learning” (p. 228). The
researchers consider this dimension of their model to be related to, but not the same as
general teaching efficacy (GTE). Furthermore, they reason that “in assessing self-
perceptions of teaching competence, the teacher judges personal capabilities such as
skills, knowledge, strategies, or personality traits balanced against personal weaknesses
or liabilities in this particular teaching context” (p. 228). This component of the model is
similar to personal teaching efficacy (PTE). Tschannen-Moran et al. (1998) propose that the interaction of the analysis of the teaching task and its context along with the assessment of personal teaching competence results in judgments about self-efficacy for the teaching task at hand. The consequences of the teacher efficacy, including goals, effort and persistence, impacts the teacher’s performance, which in turn, results in new sources of efficacy information. This theoretical model will serve as the framework for the qualitative analysis of the present study. The model is explored in greater detail in the qualitative section.

Figure 2.1. Theoretical model of teacher efficacy. Source: Tschannen-Moran et al., 1998, p. 228.
In 2001 Tschannen-Moran and Woolfolk Hoy published a new measure of teacher efficacy to evaluate their theoretical model. The instrument resolves measurement concerns with the TES that included grammar, lack of positive environmental factors, as well as task and context specificity. The researchers began with the Bandura scale, and with the assistance of graduate students who were experienced teachers, they developed 52 items that reflected significant tasks of teaching. Tschannen-Moran and Woolfolk Hoy subjected the resulting instrument, originally named the Ohio State teacher efficacy scale (OSTES), to validity and reliability testing in three separate studies. The final version had both a long form with 24 items and a short form with 12 items. Later renamed the Teacher Sense of Efficacy Scale (TSES), factor analyses revealed three factors accounting for 58 percent of the variance. The three factors reflected primary tasks of classroom teachers and were labeled: Efficacy in Student Engagement, Efficacy in Instructional Practices, and Efficacy in Classroom Management.

In comparison to the Gibson and Dembo TES (1984) which has been the most popular teacher efficacy instrument used to date, the TSES captures a wider range and greater specificity of teaching tasks. These include assessments of teaching in support of student thinking, effectiveness with capable students, creativity in teaching, and the flexible application of alternative assessment and teaching strategies (Tschannen-Moran & Woolfolk Hoy, 2001). This instrument has great promise to more clearly identify specific aspects of teacher efficacy and thereby more effectively measure the construct.
Unfortunately, during the time of the quantitative data collection of the present study, the TSES was still under development. However, the instrument is used as a framework for evaluating the teacher efficacy data collected in the qualitative portion of this study.

Qualitative Measurement of Teacher Efficacy

The vast majority of studies on teachers’ sense of efficacy have been quantitatively-oriented, using self-report Likert-scaled measurement instruments and statistical analysis to explore the evolving construct. However, researchers (e.g., Hebert et al., 1998; Tschannen-Moran et al., 1998; Milner & Woolfolk Hoy, 2003) have repeatedly asserted there is a great need for interpretive case studies and qualitative investigations to expand and refine our understanding of the process by which teachers’ sense of efficacy is developed. Therefore, studies that have qualitatively investigated teachers’ sense of efficacy are explored here to gain a clearer perspective on what has already been discovered about the various aspects or components involved in the construct’s development.

First, the benefits of qualitative study of teachers’ sense of efficacy is considered. A historical overview of the qualitative studies’ influence on our current understanding of teachers’ sense of efficacy is provided. The qualitative methods of data collection and analysis that have been implemented thus far are identified. Finally, findings of qualitative investigations are examined to gain insight into the cognitive processing involved in teachers’ evaluation of their perceived teaching efficacy.

The analysis of the teaching task, analysis of the teaching context, and assessment of personal teaching competence, as proposed in Tschannen-Moran et al.’s (1998)
cyclical model, will be used as themes through which the factors impacting teachers’ sense of efficacy are considered. Furthermore, I will identify additional issues and characteristics influencing the cognitive processing involved in teachers’ sense of efficacy that are revealed in the literature, but may not be specifically addressed in the cyclical model.

Benefits of the qualitative study of teachers’ sense of efficacy. Burke-Spero and Woolfolk Hoy (2003) explain that although quantitative instruments can assess respondents’ current sense of efficacy for teaching or increases over time, they are unable to identify the sources of efficacy or the paths that lead to the changes. Furthermore, without specifying the context and content of teaching in quantitative measures, it is impossible to determine what basis teachers use to respond to efficacy questions. Thus, they and others (e.g., Ashton & Webb, 1986; Ginns & Watters, 1996) have sought to extend understanding of perceived efficacy by providing a richer portrayal of the underlying meanings in participants’ responses and allowing sources and cognitive processing of efficacy to emerge from qualitative data. Qualitative researchers contend that their methods provide thicker descriptions and more detail which can “unpack the emotional elements of personal teaching efficacy and begin to address how these elements mediate teachers’ behaviors and practices” (Burke-Spero & Woolfolk Hoy, 2003, p. 31). In the present study, qualitative methods of gathering and analyzing teacher efficacy data are employed to explore the details of three elementary teachers’ cognitive processing as theorized in Tschannen-Moran and Woolfolk Hoy’s cyclical model. The
purpose is to obtain a rich portrayal of how they analyze the task and their context of teaching mathematics and how they assess their competence for teaching mathematics.

Qualitative data collection and analysis. A variety of qualitative methods have been implemented to access “the voices of teachers, their perspectives, explanations for efficacy beliefs and the factors they perceive to impact their own sense of teaching effectiveness” (Hebert et al., 1998, p. 216). The most common method of qualitative data collection in teaching efficacy studies is the use of semi- or un-structured interviews. However, open-ended questionnaires, teaching vignettes requesting teacher response, participant observations, researcher/participant video analyses and document and artifact analyses have also been conducted in both case studies of specific teachers and exploratory studies of the factors impacting teachers’ sense of efficacy.

In terms of overall approach to analysis, De Laat and Watters (1995) explain that the case study provides the opportunity to review, revise or refute theory in the light of revelations from teachers’ explanations and interpretations. Furthermore, Ramey-Gassert, Shroyer, and Staver (1996) argue that qualitative exploratory studies are the most effective approach when the purpose of a study is to investigate phenomena that are not well understood in order to identify or discover important variables so as to generate hypotheses for further research. This is the case in research on the factors influencing teachers’ sense of efficacy.

Surprisingly, only a few qualitative studies on teachers’ sense of efficacy explain the actual process of data analysis employed. However, several studies do refer to using
the software analysis program, NUD*IST (e.g., De Laat & Watters, 1995). Ramey-Gassert et al. (1996) used a constant-comparison method whereby the researcher is continually comparing new information with other collected data to support or refute established and emerging speculations, along with clustering, or the technique of identification of recurrent themes and patterns in the data. The authors developed conclusions and interpretations as trends and patterns became more defined.

Czerniak and Schriver (1994) and Burke-Spero and Woolfolk Hoy (2003) have the most explicit descriptions of their analyses methods. Czerniak and Schriver (1994) used a phenomenological approach through which they attempted to delineate all “meaning units” through the text, code the units that were relevant to their research objectives, and cluster identified themes to form descriptive conclusions. They provide a detailed explanation of the six steps they followed to avoid bias and portray an accurate interpretation of their participants’ views. They were unique in their use of video analysis and the software Textbase Alpha. Burke-Spero and Woolfolk Hoy (2003) created chronological narratives from the interview transcriptions of five preservice teachers. The data was coded using NUD*IST to identify relationships, themes, and patterns with in each case and across cases using narrative analysis and analysis of narrative. Moreover, an analysis of frequency report data was conducted.

Qualitative studies of teacher efficacy. Each of the reviewed qualitative studies will be presented chronologically along with their purpose, methods, and a particular focus on how the study’s findings contribute to a more complete understanding of the components in the cyclical model of teachers’ sense of efficacy as theorized by
Tschannen-Moran et al. (1998). Specifically, the sources of efficacy, as well as the analysis of the teaching task, analysis of the teaching context, and assessment of personal teaching competence involved in the development of teachers’ sense of efficacy that are addressed in each study will be discussed. The section concludes with a summary table of all the reviewed qualitative studies and a synopsis of how the qualitative findings inform the cyclical model of teachers’ sense of efficacy.

Ashton and Webb (1986) conducted an extensive ecological analysis of teacher efficacy. In addition to self-report questionnaires, they used observations, informal interviews and document analyses to ethnographically explore:

the nature of teachers’ efficacy attitudes, (2) factors that facilitate and inhibit development of a sense of efficacy, (3) teacher behaviors associated with teachers’ sense of efficacy, and (4) the relationship between teachers’ sense of efficacy and student achievement (p. 25).

Their ecological analysis involved an exploration of the educational environment that impacts teacher efficacy. They conceptualized the environment to include the microsystem of the teacher’s immediate setting, the mesosystem of the interrelations among the teachers’ major settings, the exosystem of the formal and informal social structures that influence the teachers’ setting, and the macrosystem of the predominant cultural beliefs and ideologies that impact teacher thought and behavior. In regards to the microsystem of the teacher’s immediate setting they considered student characteristics such as socioeconomic class, race, and classroom conduct, which impact teachers’ expectations about student ability. Characteristics of the microsystem that influence
teachers’ efficacy also include teacher characteristics such as sex, ideology, and role orientations, as well as class size and activity structure (small vs. large group instruction).

As Ashton and Webb (1986) investigated the mesosystem they expected school size, norms and demographic characteristics, collegial relations, principal-teacher relationships, decision making structures, and teachers’ relationships with their students’ families to impact efficacy. In terms of the many formal and informal social structures external to the school environment, or the exosystem, the researchers expected the nature of the school district (location, size, socioeconomic composition, role of teacher organizations, etc.) and legislative and judicial mandates to impact teacher efficacy. And finally, the basic cultural beliefs of the macrosystem such as conceptions of the learner, ability, effort and intelligence along with conceptions of the role of education were also predicted to influence teacher efficacy. These system conceptions can provide clarity to the components of the cyclical model of teachers’ sense of efficacy in which assessments of what it will take to be successful in a given context are made. These aspects of the micro- and macrosystems impact analysis of the teaching task while those of the meso- and exosystem influence analysis of the teaching context.

Ashton and Webb (1986) wanted to ground their understanding of teachers’ sense of efficacy in the experiences and perceptions of teachers, so they chose an ethnographic approach to their research. They initially conducted 10 hours of participant observations in the classrooms of four middle and junior high school teachers who had high Rand efficacy scores and four teachers with low scores. Then these eight teachers’ perceptions of educational objectives, teacher role, classroom difficulties, and relationship with
students, peers and administrators, with an emphasis on teaching low-achieving, low-socioeconomic-status students were explored through open-ended interview questions. The next phase of research was the systematic observation of 48 high school teachers using three pre-existing observation instruments. Then, 23 of these teachers agreed to be interviewed with open-ended questions similar to those used in the interviews with middle school teachers.

Although they warn against oversimplifying the complex interplay of factors, Ashton and Webb’s (1986) discussion of their findings from interviews on “teacher efficacy attitudes” centered on four topics: teaching low-achieving students, the student-teacher relationship, classroom management strategies, and instructional strategies. These topics are similar to the teaching tasks as defined by Tschannen-Moran et al. (1998).

Ashton and Webb (1986) found that low efficacy teachers attributed classroom problems to the shortcomings of students, not to their own failings as teachers. They did not share responsibility for their students’ lack of achievement, but rather conveyed it was due to lack of ability to learn, insufficient motivation, character deficiencies (bad classroom behavior) or poor home environments. In contrast high efficacy teachers took pride in their ability to reach the very students their colleagues defined as unteachable. Low efficacy teachers also tended to be distrustful of students who threatened their sense of professional competence.

Concerning instructional strategies, low efficacy teachers tended to sort and stratify their classes according to ability and give preferential treatment to some students while neglecting others. They exhibited an inability to spark student interest in academic
work and an unwillingness to push students and to closely monitor their academic progress. Sometimes they simply stopped trying to teach low achieving students. However, high efficacy teachers communicated and reinforced high expectations for behavior and academic performance. They kept their students on task and displayed a “with-it-ness,” aware of what was going on in their classroom (Kounin, 1970). They had a willingness to teach all students and a determination not to accept student failure.

Ashton and Webb (1986) also investigated the teaching context as to whether school structure impacted teachers’ sense of efficacy. They discovered that teachers working within a middle school structure and philosophy had a higher sense of efficacy than teachers in a junior high structure. Moreover, the middle-school teachers had greater satisfaction with teaching and higher expectations for students’ academic success, although they also had more difficulties in their relationships with colleagues.

Anderson, Greene and Loewen (1988) examined the relationships among teachers’ and students’ sense of efficacy, thinking skills, and student achievement. Sixty-five (grade three and grade six Canadian) teachers’ sense of efficacy was first assessed by a version of the TES, and then twelve highest and twelve lowest scoring teachers were selected for interviewing. The semi-structured interviews were designed to address teachers’ perceptions of their efficacy and the factors that enhance or detract from their efficacy. They were conducted at the beginning and end of the year-long study. The researches identified four categories of factors that impacted teacher efficacy. Student factors included students’ personality, motivation, ability and backgrounds. Teacher factors involved relationship with students and personality. School factors impacting
teacher efficacy consisted of leadership support, quality of staff, interruptions, availability of supplies, number of students in a classroom, and policies that teachers are not able to control. Home and community factors included lack of parental support, poor home environment, “broken homes,” and the general attitude in society toward learning. The teacher efficacy of grade three teachers was significantly correlated with student achievement, however, this was not the case for grade six. The participating teachers indicated that by grade six, the teachers’ perceptions of ability to influence students was declining. The authors also point out that teachers’ sense of efficacy appeared to depend a great deal on context. Where there were dramatic changes in teacher efficacy, “unique contextual situations were easily identified” (p. 163).

The primary purpose of Czerniak and Schriver’s (1994) study was to substantiate the construct of science teacher self-efficacy with qualitative data. In the process they also conducted a validation of the science teacher self-efficacy Likert instrument that Czerniak had published in 1989. The survey was a 30-item modified version of the TES, adapted for measuring science teaching efficacy. The researchers surveyed 30 preservice teachers before, in the middle, and following the quarter of their teaching experience. Their scores were compared with qualitative data collected through open-ended, journal-like questionnaires that the preservice teachers completed after teaching each of five science lessons. Czerniak and Schriver also compared the efficacy scores with teaching strategies chosen and the reasons for choosing those strategies to determine if teachers’ levels of efficacy were related to their pedagogical strategies. The researchers identified
low and high efficacy teachers as those who respectively scored in the bottom and top 20% of the 30 teachers on the modified TES.

Czerniak and Schriver also interviewed their participants as they jointly viewed videotapes of their teaching episodes to gather more information about the preservice teachers’ teaching behaviors. The researchers used a phenomenological approach of analysis through which they attempted to delineate all “meaning units” in the journals and transcriptions, code the units that were relevant to their objective of comparing efficacy to instructional strategies and justification of those strategies, and cluster identified themes to form descriptive conclusions.

They found that both high and low efficacy teachers used a wide variety of teaching strategies including discussion, experiments, games, hands-on activities, demonstrations, literature, simulations, lecture, writing and student projects. The main difference between the type of strategy used was that high efficacy teachers used learning centers, observation activities, simulations, and small group discussions, while low efficacy teachers did not use these strategies at all. Low efficacy teachers’ strategies included reading from the textbook, but none of the high efficacy used this strategy. Low efficacy teachers also used demonstrations, lecture, and student projects much more frequently than high efficacy teachers, while the latter more often integrated science with other subjects.

When asked about reasons for choosing the types of instructional strategies to use, high efficacy teachers’ responses indicated a concern for student learning, and they
tended to back up their rational with an educational theory. They explained that the strategies would provide a hands-on or concrete referent, provide visual clues, promote retention, and aid in conceptual understanding. Few low efficacy teachers referred to educational theory as reasons for their selected strategies and were usually more concerned about student behavior.

High efficacy teachers chose strategies that promoted student autonomy, and thinking and higher-level problem solving skills. In contrast, teachers with low efficacy appeared more concerned with choosing an interesting approach that was interesting and fun; few were concerned with students’ autonomy of learning in the lesson. Moreover, high efficacy teachers tended to use current goals of science education such as critical thinking, decision making and using hands-on activities in planning of instruction more than the low efficacy teachers.

In considering the strengths of their lessons, high efficacy teachers focused on providing students opportunities to make choices and independently discover the concepts being taught. When these teachers mentioned classroom management, it was concerned with keeping students on task so they could learn the concept. In contrast, the low efficacy teachers believed their teaching strengths laid in their ability to maintain step-by-step control and arrive at correct answers. In terms of weaknesses in their lessons, they most often cited lack of a smooth functioning class and their inability to control student behavior. However, high efficacy teachers were concerned with being better able to help their students learn. They identified not providing enough individual
attention and lack of time to effectively communicate the lesson as the main weaknesses. They not appear concerned with control or noise, and they were four more times likely as the low efficacy teachers to state that there were no weaknesses in their lesson. Yet when they did provide weaknesses, they described them in greater detail than low efficacy teachers.

In their evaluations of lesson success or failure, high efficacy teachers were more likely to place the credit or blame on themselves. They connected classroom management problems with their own lack of skill or poor planning, directions, transitions, or questioning techniques. On the other hand, low efficacy teachers rarely mentioned personal mistakes or lack of content knowledge; they more often placed the blame for classroom management problems on the students. High and low efficacy teachers also assessed lesson success in different ways. High efficacy teachers cited children’s interest, evidence of learning, on-task behavior, and participation. Low efficacy teachers more frequently examined concrete examples of the students’ actual work, products, or correct answers as measures of success; their evaluations of success were also dependent on the comments of their cooperating teachers or the students.

Czerniak and Schriver (1994) summarized that high efficacy teachers hold beliefs about science teaching that are congruent with current science education goals, and they more frequently use the types of instructional strategies promoted in science education. This qualitative study helped to “determine the accuracy and potential of self-efficacy measures for studying behaviors in science education by examining preservice teachers’
beliefs or reasoning for choosing certain instructional strategies and their perceptions of success and failure” (p. 86). The researchers conclude that this type of qualitative research provides educators insights into the types of behaviors associated with differing levels of efficacy in preservice teachers. Czerniak and Schriver’s analysis suggests that self-efficacy is a viable construct for examining preservice teacher beliefs and behaviors in science education. It is interesting to note that the authors did report the contexts in which the preservice teachers were completing their teaching experiences to discern any differences between levels of efficacy.

Huinker and Madison (1995) examined teacher beliefs and their developing conceptions of mathematic teaching as preservice teachers progressed through a mathematics methods course. They considered to what extent changes in mathematics teaching efficacy corresponded to changes in their pedagogical conceptions of mathematics. In addition to administering the MTEBI pre- and post-mathematics methods course, they conducted extensive qualitative research that included three semi-structured interviews with two participants, observations in their methods courses and field placements, and collection of artifacts, such as course assignments, assessments, and journal entries.

The first interview focused on the participants’ experiences prior to the methods classes, accessing the sources of their efficacy. They were asked to discuss their reasons for becoming elementary teachers, for selecting a mathematics minor, to recall memories of learning mathematics in elementary middle and high school, and college, and to self
assess their mathematical content knowledge in relation to their future role as elementary teachers. The second interview focused on changes that occurred during the semester in terms of the subjects understanding of mathematics content and of how to teach mathematics – issues related to the analyses of the teaching task. The third interview focused on the fieldwork component of the course – successes and frustrations in teaching mathematics to elementary schools students and on reflections regarding overall preparation to become teachers of mathematics – all sources of efficacy.

As the preservice teachers’ conceptions of mathematics teaching and learning - their analysis of the task - were challenged in the mathematics methods course, they had to rethink their own “successful” experiences in mathematics (sources of efficacy) and learn to teach in a new way. The researchers concluded that individual increases in mathematics teaching efficacy were indeed related to whether the preservice teachers were able to transition from a traditional to a constructivist paradigm and thereby redefine the task of teaching mathematics.

De Laat and Watters (1995) examined antecedent factors (sources) that are associated with various levels of science teaching self-efficacy. They interviewed 10 primary teachers (five who scored high and five who scored low) on the personal science teaching self-efficacy scale (PSTE) of the STEBI. The interviews consisted of five open-ended questions designed to probe each teacher’s science related background, ascertain beliefs about teaching science, explore current classroom science teaching practices, and identify the teacher’s primary concerns about the teaching of science in the school.
Teachers who had high assessments of their competence to teach mathematics all expressed personal interest in science and had opportunities to implement or explore science outside of school in family situations. Good teachers, role models and successful employment episodes played a positive part in their experiences of science.

The researchers also addressed analysis of the teaching task. None of the five teachers with the highest PSTE scores used the recommended state curriculum guide exclusively. All had a broad understanding of science and they described science as a meaningful way of teaching children to operate as problem solvers and logical thinkers. They viewed science teaching as a means of developing thinking skills in real life situations, used themes to integrate science teaching into other subject areas, and recognized the importance of hands on experience.

However, those with low efficacy analyzed the task very differently. Two of the lowest five scorers used the curriculum guide exclusively in a structured program. Most expressed a desire for prescriptive materials with step-by-step guidance and answers to problems. In general, the lower scorers on PSTE confined science within narrow dimensions and expressed a poor understanding of its potential to teach children how to develop the life-skills they will need to become scientifically literate citizens. Not surprisingly, their analysis of the science teaching task was limited in scope and none adopted a constructivist approach.

Vinson (1995) conducted a mixed methods study of changes in the levels of teaching efficacy as a function of the clinical experience in six public elementary schools. First, the STEBI was administered to 58 preservice teachers, substituting social studies,
language arts and mathematics in for science. Then six of the teachers were interviewed to explore how the teaching task factors of student characteristics and school subjects and the teaching context factors of school setting and grade level influence efficacy.

When questioned about student characteristics as they related to their sense of efficacy, all six of the novices expressed that some students – especially boys, those of lower socioeconomic groups and from a minority race, those less attentive or not willing to learn or try, special education students and those from homes with only one parent – were more difficult to teach than others. When asked about subject areas, mathematics was considered the most difficult to teach to students who were the most difficult to teach. The reasons for this view were based in the six preservice teachers’ belief that mathematics is more difficult to understand and less interesting than other subjects. However, the researchers concluded that subject area efficacy is context specific and depends on whether the preservice teacher was referring to particular categories of students or entire classes. Furthermore, the interviews revealed that these preservice teachers believed that mathematics achievement is more attributable to inborn tendencies as opposed to increased levels of effort or the application of effective teaching techniques.

In terms of teaching context, the six participants (whose ethnicity is not specified) described an excellent school setting as one having a predominantly Caucasian, middle or upper socioeconomic level population, where students have two parents who are actively involved in their education. Cooperation among the faculty members and a supportive principal were also identified as factors necessary for a context supportive of their
efficacy. In terms of a grade level that would support their efficacy, the participants expressed a conflict between older elementary students’ lack of respect for their teachers and younger students’ lack of maturity and independence.

Vinson also explored the sources of these preservice teachers’ self-efficacy. Family members who had been or were teachers themselves and university instructors were the most influential people. Their authentic practicum experience in public elementary schools, which provided opportunity to work directly with children (as opposed to the university setting and coursework) was the greatest support system for their sense of efficacy.

Ginns and Watters (1996) developed rich descriptions of two novice teachers’ beliefs about science and science teaching through semi-structured interviews that probed their school, university and personal science experiences. Interviews were conducted at the mid-point and the end of each teachers’ first year of teaching. The interview data were analyzed (methods were not specified) for evidence of sources that contributed to the development of science teaching self-efficacy and for links between self-efficacy and the nature and style of science implement by each novice teacher. The sources that emerged from the data which impacted science teaching efficacy included negative science related experiences in their own school careers, involvement with science on a personal level, the applied components of university courses, and positive interactions with children.

Ramey-Gassert, Shroyer, and Staver (1996) sought to clarify the construct of science teaching efficacy beliefs of elementary teachers through examining factors that
influence personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE). They used interviews, surveys, and in-depth questionnaires to access teachers’ science-related backgrounds, teacher preparation, professional development experiences, and other antecedent life experiences related to science. They purposefully selected 10 teachers to interview based on their STEBI scores, including participants who scored high on both the PSTE and STOE subscales, low on both subscales, midrange, and puzzling high/low and low/high scorers. They found that many themes in the data, such as teacher support and resources, were influential factors for both PSTE and STOE. They observed variations in overall patterns amongst the high, moderate, and low PSTE groups, while patterns in the data for STOE were not as clearly defined.

Ramey-Gassert et al. identified two primary categories of factors that influenced the development of PSTE that they termed internal and external factors. Internal factors were defined as factors that were within the teacher’s immediate or personal control. They included teacher characteristics such as interest in science and science teaching, desire for change or improvement, desire for personal or professional growth, desire for collegiality, and image of self or role definition. Internal factors were influenced by the teachers’ antecedent science-related experiences in school, nature, teacher preparation courses, inservice professional development and science teaching experiences. From these antecedent master experience sources teachers developed beliefs and attitudes toward science and science teaching that also impacted the internal factors. Internal factors can be seen as a combination of what is necessary for success in the teacher analysis of the teaching task and assessment of their personal teaching competence.
External factors were defined as those factors beyond the teacher’s direct or immediate control - primarily the student, parent/community, and school/workplace variables comprising the school environment. These factors included the availability of resources, peer/administrative support, and opportunities for decision making and professional growth, as well as perceptions of students’ academic abilities and achievements, and family/community support and resources for science teaching. External factors parallel those involved in teachers’ analysis of the teaching context.

A composite profile of teachers with high PSTE scores revealed an individual who was positive, independent, and professionally active with a hands-on/minds-on, process skills approach to teaching science and a low reliance on the textbook. In contrast, teachers with low PSTE were externally driven, had lower levels of hands-on science activities, and expressed negative prior science experiences, feelings of inadequacy, and a poor science background. Although insights about STOE were more limited than for PSTE, the primary insights about STOE concerned approaches to teaching science. Individuals with high STOE had strong backgrounds and interest in science and were student-oriented in their teaching, focusing on the question, how do students learn best?

Low STOE teachers’ interview data revealed patterns of having poor or nonexistent preparation for teaching science, and they were not seekers of professional development experiences. They experienced frustration and did not understand the time necessary for students to develop conceptual knowledge of science. They expressed that “the kids just don’t get it,” reinforcing their belief that “science was too hard for me, and
it’s too hard for them.” Their poor antecedent experiences and self-perceived lack of background and success in science translated into a high degree of empathy with students and an anxiety about teaching science effectively enough for students to fully understand science concepts.

Ramey-Gassert et al. concluded that PSTE is related to internal factors such as teachers’ attitudes toward science and resultant interest in science teaching – which directly impact the analysis of the teaching task, whereas STOE is more related to external factors such as school environment and student variables that are beyond their control (i.e., the teaching context). Furthermore, they identified no direct connection between PSTE and STOE. In other words, teachers’ belief that they can personally accomplish the task of effectively teaching science (PSTE) does not translate to the belief that they can affect change in others, enabling students to learn science (STOE). These findings confirm the conception of there being two distinct components involved in teachers’ analyses of what is necessary for successful teaching – the teaching task and the context.

Wilson (1996) focused on the effect of field experiences on the development of self-efficacy in elementary preservice teachers. In addition to administering the STEBI pre- and post-field experience, Wilson interviewed 23 pre-service teachers to determine what degree of self-efficacy the preservice teachers developed as a result of participating in the field experiences of an innovative program. She found that club activities in which the preservice teachers prepared two mathematical presentations along with the classroom team presentations were most beneficial sources because they spent time in the
classroom setting and thus developed confidence and practiced developing lesson plans and presenting the lessons. Their class interactions with students and opportunities to learn from mistakes provided mastery experience and increased self-efficacy.

Huinker and Madison (1997) also explored the impact that methods courses and field experiences had on personal efficacy beliefs and outcome expectancy beliefs in science and mathematics teaching. In this study they focused on one preservice elementary teacher, Annie, who had a dramatic increase in her mathematics teaching efficacy as scored quantitatively. Through semi-structured interviews and observations the researchers identified the specific sources that developed efficacy. In their methods courses, the preservice teachers had vicarious experiences of observing the performances of others as the professors modeled the kind of teaching they hoped to inspire. As Annie stated, “I want to teach math to make sense just like it did in this class.” As Bandura (1986) noted, “perceived self-efficacy can be readily changed by relevant modeling influences when people have had little prior experience on which to base evaluations of their personal competence.” Furthermore, verbal persuasion from professors, especially evident when discussing the teachers’ concerns related to their fieldwork impacted efficacy.

Preservice teachers also obtained vicarious experiences during their fieldwork as they observed classroom teachers and their peer partners. However, the most influential source of efficacy info – performance attainments - was obtained through preservice teachers’ fieldwork that provided opportunity to perform and thus see the impact of their own teaching. As they developed and taught lessons in elementary classrooms, they were
able to integrate their pedagogical and content knowledge and to gain firsthand experience of children enthusiastically learning math. The authors point out that even failures can raise efficacy beliefs if the poor performances are attributed to faulty strategies rather than inability and the individuals believe that better strategies will bring future success.

Hebert et al. (1998) explored how teacher efficacy varies as a function of teaching experience. Thus, they surveyed both teachers and teacher education students. In addition to the traditional Likert-scaled items of Guskey and Passaro’s (1994) modification of the Teacher Efficacy Scale, the researchers also asked two open-ended questions that accessed why teachers rated their level of confidence as they did, and what factors beyond their control influence their confidence to impact student learning.

The analysis of the first question of why the teachers rated themselves with high teacher efficacy yielded responses in six main categories:

1. Confidence in Knowledge (37% of the teacher responses (T); 31% of the pre-service teacher responses (PST)) – gained via experience, preparation, professional development, and personal experience
2. Evidence of Effectiveness (19% T; 0% PST) – from own observations, feedback from parents and students, and teacher evaluations
3. Personal qualities (19% T; 47% PST) – such as a caring attitude, motivation, positive outlook, social skills
4. Using Effective Teaching Strategies (11% T; 4% PST) – including specific instructional approaches, attention to planning, and communication with parents
5. Positive Relationships with Students (6% T; 0% PST)
6. General Feeling of Confidence (8% T; 18% PST).

As a basis of high efficacy, experienced teacher most often depended on knowledge gained via experience, whereas pre-service teachers tended to cite personal qualities such as a caring attitude. These findings are consistent with Bandura’s (1986) conception of efficacy beliefs being dependent on personal experience.

In comparison, participants provided many fewer responses about reasons for low teaching efficacy, which could be grouped four categories:

1. Student Home Environment (36% T; 0% PST)
2. Student Characteristics (28% T; 16% PST)
3. Limited Contact with Students (20% T; 0% PST)
4. Lack of Experience (16% T; 84% PST).

These findings illustrate the complexity of what informs self-perceptions of teaching competence. Teachers depend on the benefits of mastery experience to inform positive personal assessments. Moreover, they use the lack of experience, along with student factors that impact analysis of the task to explain their low levels of efficacy.

The responses to the second open-ended question about what external factors influenced their efficacy expectations were overwhelmingly those with negative implications. They were coded into six categories:

1. Home/Family (39% T; 48% PST) – including home environment/problems, characteristics of parents (e.g., education, financial status), lack of parental involvement in education and lack of discipline at home
2. School Context (23% T; 7% PST) – involving lack of equipment, facilities, supplies, classroom space, and administrative support

3. Student Characteristics (23% T; 19% PST) – such as motivation/attitudes, behavior, and abilities

4. Community (7% T; 5% PST) – consisting of environment/neighborhood and peer pressure

5. Administrative Factors (3% T; 16% PST) – such as funding and standardized testing

6. Society (4% T; 5% PST) – concerning violence, drugs, and television’s effects on students.

Parallel to categories proposed by Ashton and Webb (1986), Hebert et al. (1998) identify Student Characteristics as *microsystem* variables, Home/Family and School Context as *mesosystem* variables, and Society’s impact on students as a *macrosystem* variable. Once again, the micro- and macrosystem factors map well onto analysis of what is involved in being successful in the teaching task while the mesosystem variables influence the analysis of the teaching context.

In her mixed methods study of English as a foreign language Venezuelan middle school teachers, Chacon (2002) interviewed 10 low and 10 high efficacy teachers to explore differences in instructional strategies, classroom management and student engagement. Patterns of comparison of the teachers’ responses to four vignettes that illustrated different English teaching strategies revealed no obvious differences between low and high efficacy teachers in regards to the use of communicative-oriented strategies.
and grammar-oriented strategies. However the data suggested that high efficacy teachers were more likely to use group work activities and choose more challenging tasks and mastery experiences for their students. Further, high efficacy teachers were more likely to pursue self-directed learning through planning courses of action to improve their English proficiency.

In regards to management strategies, Chacon found that low efficacy teachers tended to handle classroom discipline by using authority, while high efficacy teachers used more humanistic or custodial strategies. Factors that EFL teachers identified as affecting their teaching effectiveness and assumedly their efficacy were class size, time allotted to English, students’ social environment, classroom environment, lack of instructional resources, teacher proficiency of English, student motivation and teacher motivation. All factors except motivation were mentioned by both high and low efficacy teachers. High efficacy teachers did not mention motivation as a constraint in their teaching, but they (as well as low efficacy teachers) did see it as a cause of poor student achievement.

Moreover, both efficacy levels of teachers also mentioned that lack of good English models (teachers), teachers’ lack of professional development, outdated curriculum and lack of time as causes of poor student achievement. Finally, 17 of the 20 teachers interviewed believed that they were not sufficiently prepared to teach English by their training programs. They felt they lacked adequate vicarious experiences and successful mastery experiences that would help to build strong efficacy beliefs about their capabilities as EFL teachers.
Milner (2002) conducted a case study of an experienced English teacher’s self-efficacy and persistence through crisis situations. Over five months Milner made extensive observations of Mrs. Albright’s teaching. He also carried out 5 in-depth interviews with Mrs. Albright to explore her sources of efficacy. Through identifying repeated patterns in the transcriptions of the interviews and observations, Milner developed codes to thematically analyze the data. Milner determined that verbal persuasion from students, teachers and colleagues initially supported Mrs. Albright’s efficacy in the midst of the crisis of being criticized by her gifted students for not being challenging enough. Milner explains that it was through verbal persuasion that the teacher learned of the success of her choice to persevere by “stepping up to the plate” and moving on to mastery experience instead of succumbing to discouragement. He suggests that “more attention may need to be paid to sources of self-efficacy that guide teachers’ thinking about their abilities until mastery experiences occur” (p. 6). He makes the observation that much of the literature discusses teacher self-efficacy linearly and calls for the consideration of the connections and convergences among the sources that inform how specific tasks are defined and thus how specific tasks are evaluated and interpreted. Although the present research does not focus on sources of efficacy, the concept of what impacts how an individual defines a task is central to considering the relationship between self-efficacy and epistemological beliefs.

In their case study of an African American teacher in a predominantly White high school, Milner and Woolfolk Hoy (2003) explore the sources of efficacy that encouraged the teacher’s persistence in an unsupportive environment. The researchers’ multiple
participant observations and interviews over a five-month period resulted in rich, thick
descriptions from which several thematic patterns of sources of efficacy were identified
and interpreted. Dr. Wilson’s experience of social and collegial isolation as the only
African American female teacher (with a doctorate degree) at the school significantly
impacted her efficacy, yet she persisted. As the authors point out, this is powerful
example of the lack of positive verbal, social persuasion – one of the four sources of
efficacy information as theorized by Bandura (1986).

The researchers also explain that Dr. Wilson’s definition of the teaching task,
which is theorized as central to the cognitive processing in the cyclical model of teacher
efficacy (Tschannen-Moran, Woolfolk Hoy & Hoy, 1998), involves challenging and
combating pre-existing beliefs about African Americans – quite a lofty task! Thus, this
“responsibility” to enlighten colleagues and students and invalidate stereotypes increases
the difficulty of the teaching task and impacts Dr. Wilson’s teaching efficacy. Analysis of
the interview data also revealed the importance of students’ and parents’ perceptions and
respect on Dr. Wilson’s efficacy judgments. She would often reflect on reaffirming
mastery experiences with her students whenever she began to doubt herself or her reasons
for teaching at the predominantly White school. Further, although she believed that her
achievement of a PhD had precipitated some of the avoidance and isolation she received
from her colleagues, Dr. Wilson learned to reflect on her credentials and the prior
mastery experience of attaining them in a predominantly White university program to
enhance her sense of efficacy in a similar unsupportive environment. This case study
vividly illustrates how the context of teaching and teachers’ analysis of that context, greatly influence their self-efficacy.

Burke-Spero and Woolfolk Hoy (2003) investigated the role of individual variables and teaching context in the development of prospective teachers’ self-efficacy. They conducted three interviews and multiple observations of five pre-service teachers over a nine-month cross-cultural immersion experience. Their analyses were partially guided by the cyclical model of teacher efficacy proposed by Tschannen-Moran, et al. (1998). However, the researchers introduced a modification of the model with their exploration of the role of the individual’s hegemonic/cultural lens in shaping one’s sense of teaching self-efficacy. They suggest that a teacher’s hegemonic/cultural lens, which is defined as a “cognitive filter that can be inferred from statements about personal beliefs, behaviors, and attitudes that have their origin in a specific sociocultural frame” (p. 3), alters perception of efficacy sources. As a result of the filtering, teachers’ perception of their efficacy is unstable, and shifts according to the specifics of the content and/or context of the situation – a process Burke-Spero and Woolfolk Hoy call “instability of interpretation.”

The researchers initially created chronological “emplotted narratives” for each of the five preservice teachers. The data were coded to identify relationships, themes, and patterns within each case and across cases using narrative analysis and analysis of narrative. Through analysis of frequency report data indexes, the researchers identified a malleable period in efficacy development during which instability of interpretation was the greatest. Malleability occurred when the individual became cognizant of his or her
limited teaching experience, knowledge, teaching skills or abilities, and it provided an apparent window of opportunity for maximum education influence and input.

Three phases of efficacy development were identified. The malleable period and the concern for survival appeared to be the initial phase, which the researchers called “The Physical Self.” New information and experiences do not fit into the teacher’s existing schemata, resulting in disequilibrium and subsequent verbal protection of personal perspectives. The preservice teachers sought to identify where one’s personal control existed within the new situation. In the second phase entitled “The Reflective Self,” the teachers’ several months of experience resulted in a dissipation of the disequilibrium caused by the unfamiliar, and soon feelings of familiarity emerged. The preservice teachers’ “conversational language was more self-reflective and metacognitive about their prior beliefs within the context of what they had now personally experienced” (p. 25). The final phase, entitled “The External Self,” is defined as finding comfort with the “other” and is characterized by a level of comfort with the students so as to be flexible and take personal risks in the classroom.

The researchers’ qualitative analysis illuminates the path by which the five preservice teachers’ analyses of the teaching task and context were transformed by the four sources of efficacy. This study postulates that there are teacher beliefs (in this case the hegemonic/cultural lens) that impact their interpretations of efficacy sources and their analyses of the teaching task and context, thereby expanding the cyclical model of teachers’ sense of efficacy.
**Clarifying the components of the cyclical model through the qualitative findings.**

In the present research, I will qualitatively explore Tshannen-Moran, Woolfolk Hoy, and Hoy’s (1998) integrated model, and more specifically, the analysis of the teaching task and context. Thus, as I summarize the findings of the qualitative studies reviewed here, the analysis of the teaching task and context will serve as the framework of analysis. I seek to identify what these studies have revealed about instructional strategies, student engagement and classroom management. Furthermore, I identify three additional aspects that impact the analysis of the teaching task and context. Additionally, Table 2.1 presents a summary of the reviewed studies along with the methods utilized, the questions asked and their findings.
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<tr>
<th>Study</th>
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<th>Data Analysis</th>
<th>General Questions</th>
<th>Pertinent Findings</th>
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<tbody>
<tr>
<td>Ashton &amp; Webb (1986)</td>
<td>97 middle and high school teachers</td>
<td>Classroom observations; Interviews; document analyses</td>
<td>Thematic analysis</td>
<td>Explored (1) the nature of teachers’ efficacy attitudes, (2) factors that facilitate and inhibit development of a sense of efficacy, (3) teacher behaviors associated with teachers’ sense of efficacy, and (4) the relationship between teachers’ sense of efficacy and student achievement.</td>
<td>Identified differences between high and low efficacy teachers on teaching low-achieving students, the student-teacher relationship, classroom management strategies, and instructional strategies. Findings support hypothesis that teachers’ sense of efficacy is related to student achievement.</td>
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<tr>
<td>Anderson, Greene &amp; Loewen (1988)</td>
<td>12 low and 12 high efficacy teachers from TES score</td>
<td>1 pre- and 1 post- semi-structured interview</td>
<td>Not provided</td>
<td>Addressed teachers’ perceptions of their efficacy, factors that enhance or detract, teaching style and perceived role.</td>
<td>Identified four categories of factors influencing teacher efficacy: teacher, student, school, and home and community.</td>
</tr>
<tr>
<td>Czerniak &amp; Schriver (1994)</td>
<td>49 preservice teachers for questionnaire; 7 high &amp; 7 low efficacy for videotaping</td>
<td>Open-ended questionnaire; videotaped teaching; interviews</td>
<td>Phenomenological approach; Textbase Alpha software</td>
<td>How do quantitative efficacy scores from Czerniak’s (1989) science teacher self-efficacy compare with qualitative data? Are levels of efficacy related to the pedagogical strategies chose for teaching science lessons?</td>
<td>Highly efficacious teachers hold beliefs about science teaching that are congruent with current goals in science education and they more frequently use the types of instructional strategies promoted in science education.</td>
</tr>
<tr>
<td>De Laat &amp; Watters (1995)</td>
<td>5 low and 5 high efficacy teachers from among 37 scores from STEBI</td>
<td>Interviews</td>
<td>Case Study</td>
<td>In review of a school’s science program, examined antecedent factors associated with levels of science teaching efficacy. Sought to understand practices of individual teachers and school community.</td>
<td>Intrinsic interest generated by positive experiences with science were antecedents for developing high personal science teaching efficacy. Low PSTE teachers confined science within narrow dimensions and none taught constructivistically.</td>
</tr>
<tr>
<td>Huinker and Madison (1995)</td>
<td>2 pre-service elementary teachers with math minors</td>
<td>Classroom observations; Interviews; artifacts</td>
<td>Cases</td>
<td>Examined preservice elementary teachers’ beliefs and conceptions of math during a conceptually-based math methods course and fieldwork.</td>
<td>Increases in mathematics teaching efficacy were related to ability to transition from a traditional to a constructivist paradigm and thereby redefine the task of teaching mathematics.</td>
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Table 2.1. Qualitative studies of teacher efficacy (Continued)
### Table 2.1: Continued

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<thead>
<tr>
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<th>General Questions</th>
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</thead>
<tbody>
<tr>
<td>Vinson (1995)</td>
<td>6 pre-student-teaching novices</td>
<td>2 interviews, one before and after clinical placement</td>
<td>Thematic analysis</td>
<td>What are the factors and their influences affecting the variance in pre-student-teaching novices’ sense of efficacy? Who has had the most influence upon their gte and pte?</td>
<td>Contextual factors influencing efficacy included a cooperative faculty and a supportive principal, and students from two parent homes of high SES. Family members who were teachers, college professors and authentic practicum experience had the most influence on efficacy.</td>
</tr>
<tr>
<td>Ginns and Watters (1996)</td>
<td>2 novice teachers</td>
<td>Semi-structured interviews</td>
<td>Not provided</td>
<td>What are the sources of science teaching efficacy? What is the relationship between efficacy and the nature and style of science teaching?</td>
<td>Sources that emerged included negative science related experiences, involvement with science on a personal level, the applied components of university courses, and positive interactions with children.</td>
</tr>
<tr>
<td>Ramey-Gassert, Shroyer, and Staver (1996)</td>
<td>10 elementary teachers with varying scores on the MTEBI</td>
<td>Interviews, surveys, and indepth questionnaires</td>
<td>Thematic analysis</td>
<td>How do science teaching efficacy beliefs develop? How are the component os science teaching self-efficacy, PSTE, and STOE related?</td>
<td>Internal factors influencing PSTE were interest in science and desire for professional growth and collegiality. External factors beyond teachers’ control impacting efficacy were students’ academic abilities, parental support and school environment.</td>
</tr>
<tr>
<td>Wilson (1996)</td>
<td>23 preservice teachers enrolled in a NSF program</td>
<td>Interviews</td>
<td>Not provided</td>
<td>Focused on the effect of field experiences on the development of self-efficacy in elementary preservice teachers</td>
<td>Realistic field experiences involving developing and presenting lessons and interaction with students had greatest impact on efficacy beliefs.</td>
</tr>
<tr>
<td>Huinker and Madison (1997)</td>
<td>23 preservice elementary teachers; this article focuses on one of them.</td>
<td>Semi-structured interviews and observations</td>
<td>Case</td>
<td>Examined the impact of methods courses on preservice elementary teachers’ personal efficacy beliefs and outcome expectancy beliefs in science and mathematics teaching.</td>
<td>Efficacy increased as they developed and taught lessons, integrated pedagogical and content knowledge and experienced children enthusiastically learning math. Even failures can raise efficacy beliefs if the poor performances are attributed to faulty strategies rather than inability and the individuals believe better strategies will bring future success.</td>
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<tbody>
<tr>
<td>Hebert et al. (1998)</td>
<td>83 preservice and 156 experienced teachers</td>
<td>2 open-ended questions added to a quantitative survey</td>
<td>Thematic analysis</td>
<td>Explored how teacher efficacy varies as a function of teaching experience, why teachers rated their level of efficacy as they did, and what factors beyond their control affect their confidence to impact student learning.</td>
<td>Explanations for high efficacy were: confidence in knowledge, evidence of effectiveness, personal qualities, use of effective teaching strategies, and positive relationships with students. Factors influencing efficacy were: students’ home/family, school context, student characteristics, community, administrative factors, and society.</td>
</tr>
<tr>
<td>Chacon (2002)</td>
<td>20 Venezuelan middle school EFL teachers</td>
<td>Semi-structured interviews; responses to vignettes</td>
<td>Thematic analysis</td>
<td>Explored differences in high and low efficacy teachers for instructional strategies, classroom management and student engagement</td>
<td>High efficacy teachers used more group work, challenging tasks and mastery experiences. Low efficacy teachers used more authoritarian classroom management; high efficacy teacher were more humanistic. Contextual factors influencing efficacy were class size, time allotted, availability of resources, and teacher English proficiency.</td>
</tr>
<tr>
<td>Milner (2002)</td>
<td>1 Experienced English teacher</td>
<td>Interviews and observations</td>
<td>Case study</td>
<td>Considered sources of efficacy, how teacher defines the task</td>
<td>Need to consider sources of efficacy prior to mastery experiences. Emphasizes import of how teachers define, evaluate and interpret teaching task.</td>
</tr>
<tr>
<td>Milner and Woolfolk Hoy (2003)</td>
<td>1 African American teacher</td>
<td>Interviews and observations</td>
<td>Case study</td>
<td>How do contextual factors influence the definition of the teaching task?</td>
<td>Issues that influenced teacher efficacy involved social and collegial isolation, the burden of invalidating stereotypes, the importance of students’ and parents’ perceptions and respect, the role of self-reflective experiences.</td>
</tr>
<tr>
<td>Burke-Spero and Woolfolk Hoy (2003)</td>
<td>5 prospective teachers</td>
<td>Interviews and observations</td>
<td>Thematic analysis; frequency report data indexes</td>
<td>Investigated the role of individual variables and teaching context in the development of prospective teachers’ self-efficacy</td>
<td>Introduced hegemonic/cultural lens modification to integrated model. Three phases of efficacy development were identified: surviving the unknown, equilibrium, and comfort with “the other.”</td>
</tr>
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</table>
Analysis of the Teaching Task. Tshannen-Moran and Woolfolk Hoy (2001) explain that as teachers analyze the *teaching task and its context*, they must assess what will be required of them in the anticipated teaching situation. This analysis produces inferences about the difficulty of the task and what it would take for a person to be successful in this context. (p. 228)

Tshannen-Moran and Woolfolk Hoy suggested that the factors that teachers consider in their analysis of the teaching task include the students’ abilities and motivation, appropriate instructional strategies, managerial issues, the availability and quality of instructional materials, access to technology, and the physical conditions of the teaching space. However, when Tshannen-Moran and Woolfolk Hoy (2001) analyzed the items of their TSES instrument, the teaching tasks identified were instructional strategies, student engagement, and classroom management. An examination of the qualitative studies of teachers’ sense of efficacy revealed that the majority of the findings related to analysis of the teaching task – what is required for success and what are the available resources and constraints – could be categorized as involving instructional strategies, student engagement, and classroom management. However three additional categories of findings related to analysis of the teaching task were identified. They were coded as subject knowledge and beliefs, teachers’ personal characteristics and student characteristics.

*Instructional strategies.* Analysis of the task of using appropriate instructional strategies in the reviewed studies was dependent on how the teachers defined the teaching task. For example, De Laat and Watters, (1995) found that high efficacy teachers sought to develop students’ problem solving and logical thinking skills for real life situations, used themes to integrate science into other subjects, and emphasized hands-on science
experiences. They did not depend solely on recommended curriculum guides, but rather developed their own curriculum consistent with these instructional strategies. In contrast, low efficacy teachers expressed a desire for prescriptive materials that provided step-by-step guidance and answers to problems.

Similarly, Czerniak and Shriver (1994) found that although both high and low efficacy teachers used a wide variety of teaching strategies including discussion, experiments, games, hands-on activities, demonstrations, literature, simulations, lecture, writing and student project, the types of strategies chosen and reasons for employing them were significantly different. High efficacy teachers selected student-centered strategies (e.g., learning centers) that emphasized students’ conceptual understanding. They supported their instructional strategy decisions with educational theory. Low efficacy teachers used more teacher-centered strategies that emphasized factual knowledge (e.g., lecture, text book reading). They rarely referred to educational theory to substantiate their selected strategies and were usually more concerned about student behavior. High efficacy teachers chose strategies that promoted student autonomy, and higher-level thinking and problem solving skills. In contrast, teachers with low efficacy appeared more concerned with choosing an approach that was interesting and fun. Ramey-Gassert et al. (1996) also found that high PSTE teachers used a more hands-on/minds-on, process skills approach to teaching science and displayed a low reliance on the textbook as compared to teachers with low PSTE. The importance of appropriate instructional strategies in the analysis of the teaching task was reiterated by high efficacy teachers in Hebert et al.’s study (1998) who identified both evidence of effectiveness and use of effective teaching strategies as significant reasons for their high level of efficacy.
Subject knowledge and beliefs. Although related to instructional strategies, teachers’ subject knowledge, beliefs and attitudes appeared to have distinct influences on teachers’ analysis of the teaching task. Teachers in Hebert et al.’s (1998) study responded that the number one reason that they rated themselves as high in teaching efficacy was because of their confidence in their knowledge. Although subject knowledge is not specified, this reason was identified separately from the reason of their use of effective teaching strategies, so the teachers were likely referring to both subject and pedagogical knowledge.

De Laat and Watters observed that teachers with low personal science teaching efficacy confined science within narrow dimensions and lacked understanding of its potential to develop important life skills. As a result, their analysis of the science teaching task was limited in scope, and none of the low efficacy teachers adopted a constructivist approach. However, the high mathematics teaching efficacy preservice teacher in Huinker and Madison (1995) qualitative study was able to transition from a traditional to a constructivist mathematics teaching paradigm, whereas her low mathematics efficacy classmate enrolled in the same reform-oriented mathematics methods course was not. Thus, mathematics teaching efficacy appears to influence teachers’ ability to develop new conceptual understandings of mathematics which results in more effective mathematics teaching methods. This is consistent with Raudenbush, Rowan, and Chong’s (1992) proposal that teacher efficacy mediates the relationship between knowledge and action.

When queried about subject areas as they related to sense of efficacy, the six preservice teachers in Vinson’s (1995) study indicated that mathematics was more difficult to understand and less interesting than other subjects. They also expressed that
mathematics was the most difficult to teach to students who were the most difficult to teach. These preservice teachers who expressed low mathematics efficacy also believed that mathematics achievement was more attributable to inborn tendencies as opposed to increased levels of effort or the application of effective teaching techniques.

Furthermore, Ramey-Gassert et al. (1996) found that low efficacy teachers articulated negative prior science experiences and poor science backgrounds. In contrast, high efficacy teachers spoke of strong science backgrounds at home and through coursework as well as high interest in science. Moreover, low STOE teachers demonstrated a lack of understanding of the amount of time necessary to develop conceptual knowledge of science. They thereby perpetuated their beliefs that “science was too hard for me, and it’s too hard for my students." Apparently domain specific teacher efficacy is related to teacher’s content knowledge and beliefs and their resultant attitudes toward teaching science.

Student engagement. Analysis of the task of student engagement was markedly disparate between teachers who had high and low teacher efficacy. Ashton and Webb (1986) found that low efficacy teachers were unable to spark student interest in academic work and unwilling to challenge students or closely monitor their academic progress. They were prone to sort and stratify their classes according to ability and gave preferential treatment to more advanced students, while neglecting low performers. They were more often frustrated by their students and lacked understanding on the time required for students to develop conceptual knowledge. Their own prior lack of success in science often led to empathy for students, reinforcing beliefs that their students would
not be able to understand science (Ramey-Gassert, Shroyer & Stave, 1996). Moreover, some teachers cited limited contact with students as a factor that led to their low efficacy (Hebert et al., 1998).

In contrast, high efficacy teachers had positive relationships with their students (Hebert et al., 1998; Milner & Woolfolk, 2001; Ashton and Webb, 1986). They expressed a willingness to teach all students and a determination to help all students succeed. High efficacy teachers communicated and reinforced high expectations for academic performance and their students were observed to be consistently more on task than low efficacy teachers. High efficacy teachers also exhibited a “with-it-ness” and awareness of student comprehension (Ashton & Webb, 1986).

In terms of specific classroom behavior related to student engagement, Gibson and Dembo (1984) observed that low efficacy teachers responded more negatively to students’ incorrect responses than high efficacy teachers. Moreover, low efficacy teachers displayed greater lack of persistence by responding to incorrect responses by giving the answer, asking another student, or allowing another student to call out before a student gave the correct response. In contrast, high efficacy teachers were more effective in leading students to correct responses through their questioning. Additionally, high efficacy teachers demonstrated better flexibility in use of small group and whole class instructional strategies thereby attaining greater student engagement.

Czerniak and Shriver (1994) found that high efficacy teachers assessed their teaching successes in terms of student engagement, citing children’s interest, evidence of learning, on-task behavior, and participation as examples. High efficacy teachers focused on providing students opportunities to make choices and independently discover the
concepts being taught. In contrast, low efficacy teachers tended to assess their teaching success through concrete examples of the students’ actual work or correct answers and in terms of their ability to maintain step-by-step control.

**Classroom management.** Only four of the qualitative studies on teachers’ sense of efficacy addressed the issue of classroom management. Ashton and Webb (1986) found that low efficacy teachers tended to put discipline at the center of their teaching practice and defined the classroom situation in terms of conflict. However, high efficacy teachers built warm relationships with their students that strengthened their authority and made teaching more enjoyable and classroom management easier. They made fewer and less negative comments about their students and were able to handle misbehavior quietly and directly. In comparison, low efficacy teachers focused on maintaining control of the classroom and were frustrated by a constant threat of disorder. They were apt to use public embarrassment of students who misbehaved and often separated them from their classmates. Similarly, Chacon (2002) found that low efficacy teachers tended to handle classroom discipline by using authority, while high efficacy teachers used more humanistic or less custodial strategies.

The low efficacy teachers in Czerniak and Shriver’s (1994) study believed their teaching strengths were reflected in their ability to maintain step-by-step control; they perceived the lack of a smooth functioning class and inability to control student behavior as their greatest weaknesses. When they evaluated their lesson success or failure, low efficacy teachers rarely mentioned personal mistakes or lack of content knowledge; they more often placed the blame for classroom management problems on the students.
In contrast, when high efficacy teachers mentioned classroom management in their interviews and journals, it was out of concern for keeping students on task so they could learn a concept. In their evaluations of lesson success or failure, high efficacy teachers were more likely to place the credit or blame on themselves. They did not seem concerned with classroom control or noise, but rather connected classroom management problems with their own lack of skill or poor planning, directions, transitions, or questioning techniques. They identified not providing enough individual attention and lack of time to effectively communicate the lesson as the main weaknesses.

Burke-Spero and Hoy (2003) observed that prospective teachers in their first phase in the development of a sense of personal teaching efficacy expressed a need to protect their own personal perspectives on who had control in the classroom, what aspect they controlled, and how they would maintain the control. Two of the White participants’ concepts of classroom control conflicted with what they perceived to be “yelling at the students” on the part of the African American faculty at their field site. The authors cite this classroom management issue as a prime example of how cultural lenses influence the development of teacher efficacy.

*Teachers’ personal characteristics influence on analysis of the teaching task.*

Ramey-Gassert et al. identified two primary categories of factors that influenced the development of PSTE that they termed internal and external factors. Internal factors were defined as factors which were within the teacher’s immediate or personal control. They included teacher characteristics such as desire for change or improvement, desire for personal or professional growth, desire for collegiality, and image of self or role definition. Ramey-Gassert et al. also found teachers with high PSTE expressed a
generally positive attitude, were independent, and professionally active. Hebert et al. (1998) reported that 19% of teachers and 47% of preservice teachers participating in their study listed personal qualities such as a caring attitude, motivation, positive outlook and social skills as a significant reason for their high sense of efficacy for teaching. Anderson et al. (1988) found that teachers believed their efficacy was impacted by their personality and their relationships with their students.

*Impact of student’s characteristics impact on analysis of the teaching task.*

Although Tschannen-Moran and Woolfolk Hoy (2001) label the three factors of their TSES as student engagement, management issues, and instructional strategies, the first factor was difficult to name (Woolfolk Hoy, 2003, class discussion). Although some of the existing qualitative studies identify the issues related to what is commonly understood to be student engagement, a broader range of student characteristics is distinguished as being part of what teachers take into account as they are analyzing the task. For example, in their discussion of the microsystem, Ashton and Webb (1986) considered student characteristics such as socioeconomic class, race, and classroom conduct, which impact teachers’ expectations about student ability.

They found that low efficacy teachers did not accept any responsibility for their students’ lack of achievement, but rather conveyed it was due to lack of ability to learn, insufficient motivation, character deficiencies (bad classroom behavior) or poor home environments. In contrast, high efficacy teachers took pride in their ability to reach the very students their colleagues defined as unteachable. They built warm relationships with their low performing students and made fewer and less negative comments about them.
The six novice teachers that Vinson (1995) interviewed all expressed that some students – especially boys, those of lower socioeconomic groups and from a minority race, those less attentive or not willing to learn or try, special education students and those from homes with only one parent – were more difficult to teach than others. Anderson et al. (1988) found that teachers believed their efficacy was impacted by student factors including students’ personality, motivation, ability and family background (especially whether the student came from a “broken home”). Hebert et al.’s (1998) found that high efficacy teachers cited their positive relationships with students as one of the sources of their efficacy. In comparison, low efficacy teachers listed student home environment, limited contact with students, and a variety of unspecified student characteristics as the reasons for their limited efficacy. When asked about external factors that influenced their efficacy expectations, 39 percent of the experienced teachers and 48 percent of the preservice teachers responded with students’ home and family characteristics such as family problems, education level of parents, financial status, lack of parental involvement and discipline. Moreover, 23 percent of experienced teachers and 19 percent of preservice teachers listed student characteristics such as motivation, attitudes, behavior and abilities as impacting their efficacy. Finally, a small percent of both types of teachers held that societal issues of violence, drugs, and television impacted students and thereby influenced their efficacy.

Chacon (2002) learned that that many Venezuelan EFL teachers attributed students’ social environment as a constraint in their analysis of the teaching task. However, only low efficacy teachers cited student motivation as impacting their teaching effectiveness. High efficacy teachers did not mention motivation as a constraint in their
teaching, but they (as well as low efficacy teachers) did see it as a cause of poor student achievement. It is interesting to note that gifted children can negatively impact teacher efficacy as evidenced in Milner’s (2002) study of Mrs. Albright, an experienced teacher who was told she was not challenging enough. Finally, in their case study of an African American teacher in a predominantly White high school, Milner and Woolfolk Hoy (2003) also discovered that students’ social environment as expressed in their preexisting racial and cultural beliefs influenced Dr. Wilson’s definition of the teaching task, thereby impacting her teaching efficacy.

Analysis of the teaching context. As teachers analyze the teaching task, they must also consider its context. Tschannen-Moran, et al. (1998) identified pertinent contextual factors to include supportiveness of other teachers, leadership of the principal, and the school climate. The external factors that teachers self-identified as influencing their efficacy expectations were markedly those with negative implications. They included school context involving lack of equipment, facilities, supplies, classroom space, and administrative support; the surrounding community consisting of the environment and peer pressure; and administrative factors such as funding and standardized testing (Hebert et al., 1998). In a study by Vinson (1995), (presumably White) preservice teachers described an environment supportive of efficacy to include a predominantly Caucasian, middle or upper socioeconomic level population, where students have two parents who are actively involved in their education and where there is cooperation among the faculty members and a supportive principal. In terms of a grade level that would support their efficacy, the participants expressed a conflict between older elementary students’ lack of respect for their teachers and younger students’ lack of maturity and independence.
Ashton and Webb (1986) investigated the effects of school size, structure, philosophy, demographic characteristics, collegial relations, principal-teacher relationships, and decision making structures on teacher efficacy. They found that teachers working within a middle school structure and philosophy had a higher sense of efficacy than teachers in a junior high structure. Moreover, the middle-school teachers had greater satisfaction with teaching and higher expectations for students’ academic success, although they also had more difficulties in their relationships with colleagues.

Anderson et al. (1988) found that teachers perceived their efficacy was impacted by school factors including leadership support, quality of staff, interruptions, availability of supplies, number of students in a classroom, and policies that teachers are not able to control. Furthermore, the researchers emphasized that teachers’ sense of efficacy appeared to be greatly dependent on context situations. Ramey-Gassert et al. (1996) also identified external factors (i.e., beyond the teacher’s direct control) that impacted efficacy to include availability of resources, peer/administrative support, and opportunities for decision making and professional growth, as well as family/community support and resources for science teaching. The unsupportive environment that Milner and Woolfolk Hoy’s (2003) persistent Dr. Wilson had to teach in involved collegial isolation and racism. Thus, common themes observed in studies that considered the effect of context on teacher efficacy include faculty and administrative support, availability of resources, and teacher involvement in decision making.

Summary of qualitative findings. Findings from qualitative studies of teacher efficacy have been considered in light of Tschannen-Moran, et al.’s (1998) cyclical model of teacher efficacy. Specifically, the cognitive processing component, analysis of
the teaching task, has been explored through six categories of data that were identified in the qualitative data: instructional strategies, student engagement, and classroom management, as well as subject knowledge and beliefs, teachers’ personal characteristics and student characteristics. The component of analysis of teaching context was also used to explore the qualitative findings.

This analysis of the qualitative studies has illuminated the possibility that teachers’ analysis of the teaching task in the cyclical model needs to somehow include the impact of subject knowledge and beliefs. This finding substantiates the need to consider the relationship between teacher efficacy and teacher epistemological beliefs. The present study uses a multi-method approach to further explore the relationship between subject knowledge and beliefs and teachers’ sense of efficacy through quantitative measures as well as through data obtained from observations and interviews of teachers.

Mathematics Self-Efficacy

Research on mathematics self-efficacy has demonstrated the construct’s ability to predict student’s academic motivation and achievement (Pajares, 1986). Mathematics self-efficacy beliefs are likely to have as powerful an impact on elementary teachers’ mathematics “performances” in their classrooms. Mathematics self-efficacy beliefs would theoretically play a crucial role in the amount of effort, persistence, and perseverance preservice teachers exert to successfully solve mathematics problems, which would, in turn, impact their beliefs about their competence to teach mathematics. Thus, it is hypothesized that teachers’ efficacy for solving basic arithmetic, algebra, and
geometry mathematics problems, which are necessary content knowledge requirements of the elementary mathematics teaching task, will predict their mathematics teaching efficacy.

Numerous studies support Bandura’s (1986) claim that self-efficacy beliefs predict academic outcomes. For example, Hackett and Betz (1989) evaluated the relationship between college student’s mathematics self-efficacy and their actual performance on an equivalent set of mathematics problems. Using the Performance subscale of the Dowling (1978) Mathematics Confidence Scale, they developed the Mathematics Problems Performance Scale (MPPS) to assess confidence in mathematical problem solving as compared to actual performance on similar problems. The overall correlation between self-efficacy and performance revealed a moderately strong positive relationship between the two factors. The authors emphasize that teachers of mathematics need to pay as much attention to students’ self-evaluations of competence as to their actual performance.

In another study investigating the relationship between mathematics self-efficacy and mathematics achievement, Pajares and Miller (1994) conducted a path analysis to evaluate Bandura’s (1979) hypothesis that self-efficacy beliefs not only predict performance, but also mediate the effects of other determinants such as prior experience, specifically in mathematical problem solving. They explore whether mathematics self-efficacy has a stronger direct effect on performance than mathematics self concept, mathematics anxiety, perceived usefulness of mathematics, prior experience, and gender. Their study of 350 undergraduates revealed that all of the factors correlated significantly
with mathematics performance. Yet, as the authors hypothesized, self-efficacy had significantly stronger direct and total effects on performance than any of the other variables.

Prior experience and gender’s significant indirect effects on performance were largely mediated by self-efficacy. Women had lower mathematics performance, mathematics self-efficacy, and self-concept, but these gender differences were mediated by self-efficacy perception. Women’s poorer mathematics performance and self-concept largely resulted from lower judgments of their mathematics ability. It is interesting to note that 57% of the students were overconfident in their efficacy judgments (overestimated their mathematics performance) whereas 20% were underconfident (underestimated their mathematics performance). The authors believe that the roots of low mathematics self-efficacy and the resulting avoidance of mathematics courses begin in elementary or middle school. They call for more research on the process by which self-efficacy beliefs are developed, arguing that “if self-efficacy assessments were to begin early in a student’s academic career, inaccurate perceptions could also be identified early and appropriate interventions undertaken” (p. 201). This applies to teacher education students as well.

Pajares and Kranzler (1995) extended the same line of research by adding a measure of general mental ability to Pajares and Miller’s (1994) path model. They surveyed 329 high school students and determined that students’ mathematics self-efficacy had strong direct effects on mathematics performance and anxiety even when general mental ability was controlled. The direct effect of mathematics self-efficacy on performance was as strong as that of general mental ability. The authors call these
findings “striking” due to the expected powerful influence of ability. They also found that high school students were even more overconfident about mathematics abilities than college students. The authors explain that the more experience individuals attain, the more accurate they become in appraising their own abilities.

However, Pajares and Kranzler point out that Bandura (1986) suggests that overestimation of ability can be useful because it can increase effort and persistence. This may have detrimental implications for female students (and teachers) who tend to underestimate their mathematics ability (Betz & Hackett, 1983). Pajares and Kranzler’s path analysis also indicated that African American students had significantly lower mathematics self-efficacy, however they were more overconfident than their peers. There were no gender differences in mathematics performance, self-efficacy or overconfidence among African American students, but girls were higher in mathematics anxiety. As in the 1994 study, they determined that when male and female students did differ in mathematics performance, it was largely mediated by mathematics self-efficacy.

In addition to predicting academic outcomes, self-efficacy beliefs contribute to academic motivation in several ways. As previously mentioned, self-efficacy beliefs determine the goals students set for themselves, the amount of effort they will expend, how long they persevere when they encounter difficulties, and their resilience to failures (Bandura, 1986). Collins (1982) studied the problem solving behavior of students with varying mathematics ability levels. She reported that despite the strong relationship between ability and performance, those students with high mathematics self-efficacy were more persistent in reworking incorrect problems and eventually correctly completed
more problems, regardless of their ability level. It is probable that teachers’ self-efficacy beliefs will similarly impact their problem solving behavior which is so key to effective mathematics teaching.

One approach to exploring the impact of mathematics knowledge and beliefs on efficacy to teach mathematics is to consider teachers’ self-efficacy to “do” mathematics. The mathematics self-efficacy literature has demonstrated the construct’s ability to predict student’s academic motivation and achievement. It seems reasonable that ascertaining teacher education students’ beliefs about their ability to do mathematics and their beliefs about their pedagogical abilities as measured in a more global teacher efficacy measure (e.g., TES) would predict their efficacy to teach mathematics. Moreover, Schoon and Boone (1998) found that preservice teachers who performed well on a science principles test also had higher levels of science teaching efficacy. Therefore, the first question of this present study explores the ability of teacher efficacy, teachers’ self-efficacy to solve mathematics problems and their mathematics knowledge as demonstrated by their performance on those problems to predict mathematics teaching efficacy.

Teachers’ Beliefs About Mathematics

The three domains of knowledge and beliefs that are involved in the practice of teaching include general pedagogical knowledge and beliefs, subject matter knowledge and beliefs, and pedagogical content knowledge and beliefs (Borko & Putnam, 1996). The current study is concerned with teachers’ mathematics subject matter knowledge and beliefs. Subject matter knowledge and beliefs include the knowledge and beliefs about
the key facts, concepts, principles, and explanatory frameworks of a discipline, as well as the rules of evidence used to guide inquiry in the field (Grossman, Wilson & Shulman, 1989).

Thompson (1992) explains, “a teacher’s conception of the nature of mathematics may be viewed as that teacher’s conscious or subconscious beliefs, concepts, meanings, rules, mental images, and preferences concerning the discipline of mathematics. Those beliefs, concepts views, and preferences constitute the rudiments of a philosophy of mathematics, although for some teachers they may not be developed and articulated into a coherent philosophy” (p. 132). Understanding teachers’ beliefs about the nature of how mathematics is known is central to identifying what constitutes good mathematics teaching.

Some teachers perceive mathematics as “a discipline characterized by accurate results and infallible procedures, whose basic elements are arithmetic operations, algebraic procedures, and geometric terms and theorems. For them, knowing mathematics is equivalent to being skilful in performing procedures and being able to identify the basic concepts of the discipline” (Thompson, 1992, p. 127). Teachers with this view of mathematics knowledge tend to present concepts and procedures in a clear manner and students are given the opportunity to practice identifying concepts and performing procedures for mastery. This approach can lead to instruction that over-emphasizes the manipulation of symbols whose meanings are rarely addressed.

In contrast, another understanding of the nature of mathematics knowledge is based on the ongoing practice of mathematicians and depicts mathematics as “a kind of mental activity, a social construction involving conjectures, proofs, and refutations,
whose results are subject to revolutionary change and whose validity, therefore, must be judged in relations to a social and cultural setting” (Thompson, 1992, p. 127). From this understanding, mathematics deals with ideas created by humans, which are thus fallible. From this view, knowing mathematics is making mathematics. Teachers with this understanding of the nature of mathematics create opportunities for students to engage in meaningful activities that develop out of problem situations and require “reasoning and creative thinking, gathering and applying information, discovering, inventing, and communicating ideas, and testing those ideas through critical reflection and argumentation” (Thompson, 1992, p. 128).

**Epistemological Beliefs**

As teachers’ beliefs about what it means to know mathematics are explored, it is important to have a theoretical understanding of epistemological beliefs and how they have been measured. This section begins with a definition of epistemology and a brief history of epistemological beliefs research. Because the present study focuses on the dimensions of epistemological beliefs, Schommer’s (1990, 1992, 1993, 1995, 1997, 2000) studies of the dimensions of epistemology are explored in detail. Then concerns with Schommer’s questionnaire (the SEQ) and the issue of epistemological beliefs domain specificity are discussed. Alternative domain specific measures of epistemological beliefs (e.g., DEBQ and DSBQ) are also examined. The section is concluded with a review of the mathematics beliefs research as considered through the lens of the epistemological beliefs literature.

*Brief overview of personal epistemologies research.* Epistemology is a branch of philosophy that studies the nature and justification of knowledge and has a long tradition
dating back to the early Greek philosophers. However, in the past 30 years, the study of epistemological beliefs has focused on the empirical investigation of personal epistemological development and how individuals’ beliefs influence their processes of thinking and reasoning, especially in academic settings (Hofer & Pintrich, 1997). Much of the current empirical study has sprung from Perry’s (1970) landmark study of the moral and intellectual development of college students.

Although Perry did not conceptualize his research as epistemological, from his interviews with male Harvard students, he developed a scheme of students’ intellectual development. Students’ varied perspectives were associated with different levels of education. He observed that younger students tended to have more dualist views in which knowledge was perceived as either right or wrong. However, more advanced students tended to express more relativistic views, highlighting the contextual nature of knowledge. Perry’s four levels of intellectual development - dualism, multiplicity, relativism, and commitment - incorporated epistemological beliefs about the structure and nature of knowledge, along with the source and justification of that knowledge (Buehl & Alexander, 2001).

As Hofer and Pintrich (1997) delineate in their thorough review of the research on epistemological theories and their relation to learning, epistemological beliefs studies since Perry’s have addressed several distinct issues. Some researchers focused on the refinement and extension of Perry’s developmental sequence (King & Kitchener, 1994; Kitchener, 1986). Others have sought to develop more simplified measurement tools for assessing epistemological development (Baxter Magolda & Porterfied, 1985). The primary objective of the work of Baxter Magolda (1992) and Belenky, Clinchy,
Godberger, and Tarule (1986) was to explore gender-related patterns in knowing. King and Kitchener (1994) and Kuhn (1991) examined how epistemological awareness is a part of thinking and reasoning processes. Furthermore, dimensions of epistemological beliefs have been identified by Schommer (1990, 1994b). Several researchers have sought to assess how epistemological beliefs link to other cognitive and motivational processes (Hofer, 1999; Schommer, 1990, 1993; Schommer, Crouse, & Rhodes, 1992; Schutz, Pintrich & Young, 1993). Most recently, research has explored whether epistemological beliefs are domain specific or domain general (Buehl, Alexander & Murphy, 2002; Hofer, 2000).

Schommer. Among those who have developed models representing beliefs about knowledge, Schommer (1990, 1992) is known for her empirical research on the link between epistemological beliefs and academic classroom learning and performance (Hofer & Pintrich, 1997). She was the first to develop a quantitative instrument to measure epistemological beliefs. Moreover, Schommer challenged the prevalent unidimensional conception of epistemological beliefs, and proposed that personal epistemology is a belief system comprised of at least five more or less independent dimensions: the structure, certainty, and source of knowledge, and the control and speed of knowledge acquisition.

Schommer derived the first three dimensions from Perry’s (1970) findings that entering college students believe that knowledge is simple, certain, and handed down by authority. The control of knowledge acquisition dimension was derived from Dweck and Leggett’s (1988) findings that students hold either entity or incremental views of intelligence. Children in their study who had a strong belief that the ability to learn is
fixed displayed helpless behavior in the face of a difficult task. However, children who had a strong belief that the ability to learn can be changed perceived the same task as a challenge, tried different study strategies, and persisted in their efforts. Finally, Schommer based her speed of knowledge acquisition dimension on Schoenfeld’s findings that high school students believed in quick, all-or-nothing learning in mathematics.

Schommer (1990) used a 63-item epistemological questionnaire with 266 undergraduate students to evaluate her conceptualization of epistemological beliefs. Factor analysis revealed four factors: Factor 1 was “Ability to learn is innate,” Factor 2 was “Knowledge is discrete and unambiguous,” Factor 3 was “Learning is quick or not at all, and Factor 4 was “Knowledge is certain.” There was not a distinct factor related to source of knowledge. A survey of students’ education and home background was also administered to explore variables that might predispose students to have certain epistemological beliefs. Schommer found that background variables predicted epistemological beliefs, with an especially strong effect on Simple Knowledge and Quick Learning. Older students were found to believe that the ability to learn is acquired. Furthermore, the more classes a student had completed in college, the more likely they believed that knowledge is not certain.

The second phase of Schommer’s (1990) experiment assessed the relationship between epistemological beliefs and reading comprehension. Students were requested to read a passage at home and then in the next class session were asked to indicate their confidence of how well they understood the passage and the number of classes they had taken in related domains. They also were asked to write a conclusion for the passage and
given a mastery test that evaluated recognition and application of the main ideas in the passage. Epistemological beliefs appeared to affect students’ processing of information and monitoring of comprehension.

Those students who believed in quick, all-or-nothing learning wrote comparatively oversimplified conclusions, performed poorly on the mastery test, and were overconfident of their comprehension. Those who believed in certain knowledge wrote more absolute conclusions. Once again, the more classes a student had, the more tentative their conclusions were. Thus these epistemological beliefs impacted the students’ critical interpretation of knowledge and their accuracy in assessing their own comprehension. Schommer (1990) agrees with Schoenfeld (1983) that there is evidence that indicates that high school students’ disabling epistemological beliefs are a result of how they are taught in grade school. She argues that teachers hold a key to preventing self-defeating epistemological beliefs.

In a subsequent study, Schommer et al. (1992) focused on the epistemological belief of Simple Knowledge and explored its influence on academic performance as measured by the planning and assessment of learners’ comprehension. The researchers surveyed 424 undergraduates using Schommer’s Epistemological Questionnaire (SEQ). Three of Schommer’s four theorized factors of epistemological beliefs were confirmed using a 1.0 eigenvalue as the cutoff in this study. Factor 1 was Innate Ability, Factor 2 was Simple Knowledge, and Factor 3 was Certain Knowledge. Using an eigenvalue of 0.95 in a second factor analysis, four factors were high loading: Factor 2 was simple
knowledge, Factor 3 was quick learning, Factor 4 was certain knowledge, and because innate ability items did not load on Factor 1, it was retitled “externally controlled learning.”

Then 138 of the participants were asked to read a statistics passage, rate their comprehension confidence, complete a statistical comprehension test for the passage, report prior courses in mathematics and statistics, and complete a measure of study strategies. The authors confirmed their hypothesis that students’ with strong beliefs that knowledge is merely isolated facts would perform poorly on a comprehension test that requires integration and application of information. Furthermore, Schommer, Crouse and Rhodes (1992) hypothesized that students with belief in simple knowledge would only choose study strategies that increased factual learning and use recall of facts as their comprehension criterion. They found a substantial relationship between simple knowledge belief and test-preparation strategies and between test-preparation strategies and test performance. Belief in simple knowledge is negatively associated with comprehension and meta-comprehension and the influence of simple knowledge on comprehension might be mediated by selection of study strategies.

Schommer (1993) also studied the development of epistemological beliefs of high school students and the influence their beliefs had on academic performance. She found that belief in simple and certain knowledge and quick learning was significantly lower among seniors as compared to freshmen. Schommer also found that epistemological beliefs predicted GPA. The less that students believed in quick learning, simple knowledge, certain knowledge, and fixed ability, the higher were their GPAs. Furthermore, girls were less likely to believe in fixed ability or quick learning. Schommer
(1993) suggests that this difference may explain some of the difference between girls’ and boys’ confidence in comprehension in her previous studies. Perhaps girls’ tendency to believe in gradual learning prevents them from too quickly assuming they understand what they have read.

Despite the significant increase in higher levels of epistemological development, Schommer suggests that it is possible that students with strong, resistant beliefs in quick learning and simple and certain knowledge may drop out of school. Therefore, Schommer (1997) later conducted a longitudinal study of secondary students to study the development of epistemological beliefs. Students completed the SEQ as freshmen and then again as seniors. Repeated measure analysis demonstrated that beliefs in fixed ability to learn, simple knowledge, quick learning, and certain knowledge decreased significantly over the four years, thereby confirming epistemological development in the high school years. Once again, the less students believed in quick learning, the better GPAs they earned.

Other SEQ studies. Qian and Alvermann (1995) used the SEQ to examine the relationships between epistemological beliefs, learned helplessness, and conceptual change in 212 9th to 12th graders. They explored the SEQ data with exploratory factor analyses and decided on a three-factor model. The three dimensions underlying the SEQ were identified as learning is quick, knowledge is simple and certain (combined), and ability to learn is innate. They found no significant relationship between students’ epistemological beliefs and their learned helplessness. Students’ beliefs about the simplicity and certainty of knowledge, along with their beliefs about the speed of learning, predicted the level of conceptual change they experienced.
Others studies using the SEQ have demonstrated that epistemological beliefs are related to how students integrate and acquire new knowledge. For example, Kardash and Scholes (1996) found that the more students believed in the uncertainty of knowledge, the more likely they were to express the inconclusive nature of contradictory evidence in a reading text on a controversial topic such as HIV and AIDS. However, students who viewed knowledge as certain were more likely to misinterpret contradictory evidence. Further, Rukavina and Daneman (1996) used 12 questions of the SEQ to consider the role of students’ beliefs about the structure of knowledge and their ability to integrate and comprehend competing scientific theories. Students who believed in the complex, integrated nature of knowledge were identified as those having mature beliefs, whereas students who viewed knowledge as a simple collection of isolated facts were labeled as having immature beliefs. They found that students with mature beliefs about the complexity and integration of knowledge demonstrated greater learning and integration of new information than student with immature beliefs.

*Concerns with the SEQ.* However, there is disagreement in the literature about the measurement of epistemological beliefs. Hofer and Pintrich (1997) argue that Schommer’s factors of quick learning and fixed ability address beliefs about learning and intelligence, and are thus not epistemological. They explain that “beliefs that learning is quick may predict comprehension and performance, but this does not mean it is an epistemological belief about the nature of knowledge, or how knowledge is justified” (p. 109). Instead, they proposed a new model of epistemological beliefs that incorporated dimensions related to the nature of knowledge (i.e., the certainty and simplicity of
knowledge) and the nature of knowing (i.e., the source of knowledge and the justification for knowing). Within each of these areas there appear to be two dimensions.

Within nature of knowledge, there are the dimensions termed certainty of knowledge and simplicity of knowledge. Under the area of nature of knowing there are two other dimensions, labeled source of knowledge and justifications of knowledge. Their dimensions of certainty and simplicity of knowledge are similar to those Schommer conceptualized. Source of knowledge is on a continuum from knowledge originating outside f the self and residing in an external authority from whom it may be transmitted to the conception of self as knower, with the ability to construct knowledge with others. This again is similar to Schommer’s fifth dimension of source of knowledge with a focus on beliefs about authority. This dimension has not been identified empirically. Hofer (2000) states that the dimension of justification of knowledge includes “how individuals evaluate knowledge claims, including the use of evidence, the use they make of authority and expertise, and their evaluation of experts” (p. 381). At lower levels, individuals justify beliefs through observation or authority whereas at higher levels knowledge is justified by the use of rules of inquiry and personal evaluation and integration of views of experts.

Buehl and Alexander (2001) agree with the concern about Schommer’s conception of the dimensions of epistemological beliefs involving learning and intelligence; however, they explain that it is sometimes difficult to pose direct epistemological questions.
Thus, although some items or questions may not necessarily be explicitly epistemological in nature, they may provide an indirect, yet rich avenue to individuals’ epistemological beliefs. Moreover, attempting to examine beliefs about schooled knowledge in a manner divorced from the broader academic context in which they reside may distort understanding of the constructs under study. (p. 389)

However Buehl and Alexander warn that “this circuitous route” to epistemological beliefs may increase the likelihood of accessing related beliefs – such as those about learning, intelligence and teaching – and thereby contribute to the definitional problems that plague the construct.

Schommer responded to these concerns about including the acquisition of knowledge in the definition of epistemological belief as she discussed findings from a study of 7th and 8th grade students. Schommer-Aikens et al. (2000) found that beliefs associated with knowledge acquisition (learning) were more developed than knowledge beliefs (structure and certainty) in these younger students. The researchers suggest that learning beliefs may be precursors to beliefs about knowledge. In this study Schommer-Aikens et al. also found that the less students believed in fixed ability and quick learning, the higher GPA they earned. The researchers argue that beliefs about knowledge acquisition once again appeared to have a critical impact on academic outcomes and are an integral part of personal epistemologies.

**Domain specificity.** There is also a debate in the literature over the question of domain specificity versus generality of epistemological beliefs. Using the SEQ, Schommer and Walker (1995) found that mathematics epistemological factors correlated with corresponding social science epistemological belief factors. Epistemological beliefs in both domains predicted passage comprehension similarly, and most college students in
their study showed a consistent level of epistemological sophistication across domains. Schommer and Walker (1995) concluded that their results supported the idea that individual epistemological beliefs tended to be domain independent.

However, other studies indicate that epistemological beliefs are related to fields of study. For example, Stodolsky, Salk, and Glaessner (1991) interviewed 60 5th graders to determine their views of learning mathematics and social studies. The researchers’ premise was that instructional patterns, derived in part from different kinds of knowledge and goals of the two subjects, influence students’ perceptions and relation to each subject. Most of the students they interviewed defined mathematics in terms of basic number facts and arithmetic operations. When asked if they thought they could learn mathematics on their own if they had all the books and materials they needed, only seven of the 60 students thought they had the ability to do so. However, nearly half of the students thought they could learn social studies on their own. To learn mathematics on one’s own was limited by the state or progress of the student’s existing abilities. For example, one student’s response was, “I don’t think I could have learned like dividing mixed numbers because you sort of have to know what you’re doing before you can do it” (p. 106). However, social studies did not have as many knowledge requirements.

When asked what they depended on to learn a subject, students expressed a strong reliance on the teacher in math. Self-instruction using the text-book was less conceivable in math. Furthermore, methods of learning that require a knowledgeable authority to provide assistance were much higher in mathematics than in social studies. The typical instructional patterns students are exposed to lead them to believe that they will be told by their teacher how to do mathematics correctly.
Thus, Stodolsky et al. (1991) argue that teachers’ epistemologies are vitally important because the way a subject is presented over the years of schooling affects how students perceive and relate to it. The students in their study expressed different assumptions about how mathematics and social studies are learned and about how accessible knowledge is in the two fields. The authors believe that the documented differences in the instruction of mathematics and social studies derive in part from different kinds of knowledge and goals in the two subjects. Mathematics is largely taught as arithmetic computation with relatively little emphasis on conceptual development and discovery. The emphasis in mathematics class, whether the teacher is explaining a procedure or students are doing computation exercises, is on knowing how to “get it right.” Furthermore, Stodolsky et al. explain that the majority of elementary students were positively disposed towards math, “perhaps in part due to the structure and predictability afforded by its computational character, clear expectations, and instructional patterns” (1991, p.111). In summary, 5th graders perceived mathematics as more clearly defined and certain than social studies and expressed a greater dependence on an outside source to learn mathematics problems, whereas they believed they could learn social studies on their own. Thus Stodolsky et al.’s (1991) research provides support to the conception of domain specificity of epistemological beliefs.

Moreover, Hofer (2000) used a shortened version of the SEQ (Qian & Alvermann, 1995) and developed the Discipline-Focused Epistemological Beliefs Questionnaire (DEBQ) to investigate the dimensionality of personal epistemology. Exploratory factor analyses of the DEBQ revealed four factors for both the psychology and science disciplines. The factors related to (a) certainty/simplicity of knowledge (e.g.,
“most of what is true in this subject is already known.”), (b) justification of knowing by personal experience (e.g., “First hand experience is the best way of knowing something in this field.”), (c) justification of knowing by authority (e.g., “if you read something in a textbook for this subject, you can be sure that it is true.”), (d) attainability of truth (e.g., “Experts in this field can ultimately get to the truth.”). Her findings suggest that there is an underlying dimensionality to epistemological theories that does cut across disciplinary domains. However her participants, first year college students, were able to discriminate as to how these theories differ by discipline. Her participants perceived knowledge in science as more certain and unchanging than in psychology and regarded authority and expertise as the source of knowledge more in science than in psychology.

At the same time that Hofer was developing the DEBQ, Buehl, Alexander and Murphy (2001) also expressed concern about Schommer and Walker’s (1995) use of the SEQ to determine domain specificity. Because the SEQ was not devised to test for domain specific beliefs and there were concerns about its validation (subscales instead of actual items were used for factor analysis), Buehl et al. developed the Domain Specific Belief Questionnaire (DSBQ). The DSBQ focuses on mathematics, a more well-structured area of study, and history, which is perceived as be more ill-structured (VanSledright & Frankes, 1998). The items were designed to tap into Schommer’s four dimensions as well as potential domain differences (e.g., production vs. process). The measure was subjected to validity and reliability testing and then the revised instrument was administered to 633 college students.

Although based on the SEQ, factor analysis revealed only two distinct factors for each domain that involved the acquisition of knowledge and the nature of knowledge and
problem solving. Their findings revealed that undergraduate students believe that more effort is required to acquire knowledge in mathematics than in history. They also believed that mathematics knowledge is more integrated with the knowledge in other areas than is history knowledge. The results suggested that academic epistemological beliefs are largely domain specific. Even so, Buehl et al. (2001) conceptualize epistemological beliefs as multidimensional and multilayered in nature and thus can be characterized both as domain general and domain specific, depending on what level they are assessed. Believing that the DSBQ would most accurately measure domain-specific mathematics epistemological beliefs, the instrument was selected as a measure in the present study.

Studies exploring both epistemological and efficacy beliefs. Schutz, Pintrich and Young (1993) recognized the importance of combining motivational and cognitive components involved in academic performance to develop an integrated model that would provide a more realistic description of learning. One purpose of their research was to investigate the relations between students’ epistemological beliefs and their motivation with respect to goal orientation, self-efficacy, and test anxiety. They used the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich, Smith, Garcia, & McKeachie, 1993) to measure self efficacy of 103 college students in an educational psychology course for preservice teachers. They used six of Perry’s yes/no questions to evaluate epistemological beliefs. A sample item was: “Educators should know by now which is the best method, lectures or small discussion groups. True or False? Please explain your answer.” Those students with more sophisticated epistemological beliefs were more likely to use elaboration strategies and have an intrinsic goal orientation focused on
mastery and learning towards the course. However, the researchers found no significant relationship between self-efficacy and epistemological beliefs.

Hofer (1999) considered the relations between college students’ beliefs about knowledge and their motivation, learning strategies and academic performance in two different instructional contexts (both pedagogically and underlying epistemological assumptions) of an introductory Calculus course. Hofer selected items from the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1993) and adapted them to measure mathematics self-efficacy, goal orientation, and self-regulation strategies. She developed a six-item measure developed from a list of typical student beliefs about the nature of mathematics (Lampert, 1990; Schoenfeld, 1992). She found that sophistication of epistemological beliefs was correlated with mathematics self-efficacy ($r=-.13, p=.001$), as well as with intrinsic motivation, self-regulation, and course grades. Those with more sophisticated mathematics beliefs reported that they were mastery-oriented and believed they were capable of being successful in the mathematic course.

Stipek et al. (2001) conducted a multimethod study of teachers’ beliefs and practices related to mathematics instruction. They developed a quantitative instrument to assess 21 4th-through 6th-grade teachers’ beliefs at the beginning and end of a school year about (a) the nature of mathematics (i.e., procedures to solve problems versus a tool for thought), (b) mathematics learning (i.e., focusing on getting correct solutions versus understanding mathematical concepts, (c) who should control students’ mathematical activity, (d) the nature of mathematical ability (i.e., fixed versus malleable), and (e) the value of extrinsic rewards for getting student to engage in mathematics activities. Stipek
et al also assessed teachers’ self-confidence and enjoyment of mathematics and mathematics teaching. Although not future-oriented, the teacher self-confidence questions addressed beliefs about teaching task issues similar to those of teacher efficacy items (e.g., “I am confident that I understand the math material I teach;” “When I teach math I often find it difficult to interpret students’ wrong answers”).

In the qualitative portion of their study Stipek et al. evaluated teachers’ classroom practices via the use videotapes. The researchers developed codes for seven dimensions characterizing teachers’ practices. These dimensions included the degree to which the teacher emphasized performance outcomes such as getting correct answers, speed in completing tasks, student effort and its ability to lead to success, and students’ focus on understanding and mastery, as well as the degree to which the teacher encouraged student autonomy or fostered a high risk and threatening environments where wrong answers must be avoided.

Stipek et al. (2001) found that teachers who scored high on the more traditional beliefs were less self-confident about teaching mathematics and enjoyed it less. The teachers’ beliefs that mathematics is a set of operations and procedures to be learned and that the teacher should be in complete control were positively associated with an emphasis on performance rather than learning in the classroom and negatively associated with an emphasis on understanding, student autonomy, a low risk environment and teacher enthusiasm. Teachers’ understanding of mathematics as operations and procedures was also positively associated with their emphasis on speed and negatively associated with their emphasis on effort. Teachers’ emphasis on performance rather than
on understanding was also associated with the belief that mathematics ability is fixed. As predicted, more traditional teacher beliefs were associated with more traditional practices.

**Epistemological beliefs summary.** An individual’s beliefs about knowledge have a powerful impact on their academic performance and knowledge acquisition. Three of the four beliefs assessed by the SEQ were found to predict academic performance among college students. The more students believe in quick learning, the more poorly they comprehend text and monitor their comprehension. The more students believe in certain knowledge, the more likely they are to interpret tentative information as absolute (Schommer, 1990). In addition, the more students believe in simple knowledge, the more difficulty they encounter in understanding statistical text (Schommer et al., 1992). Furthermore, Schommer (1993) found that beliefs in fixed ability to learn, simple knowledge, quick learning, and certain knowledge decreased significantly over four years, thereby confirming epistemological development in the high school years. Others (Kardash & Scholes, 1996; Rukavina & Daneman, 1996) have also used the SEQ to demonstrate the relationship between students’ sophistication of epistemological beliefs and their ability to comprehend and integrate new information.

Although some researchers (Hofer & Pintrich, 1997; Beuhl, Alexander & Murphy, 2001) have expressed concern over Schommer’s use of items addressing learning and intelligence on the SEQ, it appears that these indirect ways of accessing epistemological beliefs are useful in depicting a more contextualized understanding of the construct. Moreover, several studies (Stodolsky, Salk, & Glaessner, 1991; Hofer, 2001) challenge Schommer and Walker’s emphasis of domain generality. These studies
revealed the possibility of what Buehl et al. (2001) identify as the multidimensional and multilayered nature of epistemological beliefs as they reflect both domain general and specific characteristics.

Despite the concerns with the analysis of the SEQ and definitions of epistemological beliefs, Schommer’s five proposed dimensions of epistemological beliefs – the structure, certainty, and source of knowledge, ability to learn, and speed of knowledge acquisition are helpful in measuring and classifying individuals’ beliefs about mathematics. Further, one can interpret Buehl et al.’s (2001) factor of the acquisition of knowledge as comprising source of knowledge, ability to learn, and speed of knowledge acquisition. Whereas their factor of the nature of knowledge and problem solving involves the structure and stability of knowledge which other researchers have identified as a combined simple/certain knowledge. In the current study, these six dimensions will serve as the thematic framework for the qualitative analysis of teachers’ epistemological beliefs.

*Mathematics Beliefs: Quantitative Studies*

As is evident in the Stodolsky et al. study and Schommer’s use of findings from Schoenfeld’s studies, the dimensions in the educational psychology-related epistemological beliefs literature have parallels in the teacher education-oriented mathematics beliefs literature. In fact, as will be explored in this section, examples of all of Schommer’s dimensions of epistemological beliefs can be found in the mathematics belief literature. Historically, beliefs about mathematics have been primarily qualitatively explored to gain access to more descriptive data. However, several studies have quantitatively assessed beliefs about the nature of mathematics and how it is known with
survey instruments. In this quantitative discussion and in the subsequent qualitative section, beliefs of both teachers and students are explored to gain a broader understanding of findings on mathematics beliefs that flesh out the dimensions of epistemological beliefs.

Brown et al. (1988) report the findings of the National Assessment of Educational Progress (NAEP) that examined beliefs about mathematics among 7th- and 11th-grade students. Brown et al. (1988) found that 83% of 7th-grade students and 81% of 11th-grade students believed that there is always a rule to follow in solving mathematics problems. They analyzed items addressing students’ perceptions of mathematics and identified two main characteristics. Mathematics was perceived as a static and rule-oriented (as opposed to process-oriented) subject. Furthermore, both 7th- and 11th-grade students lacked an understanding of what mathematicians do and did not recognize mathematics as a dynamic, cohesive discipline.

The purpose of Kloosterman and Stage’s (1992) study was to develop and validate a set of scales for measuring students’ beliefs about mathematics as a subject and about how mathematics is learned. The authors explain that although interviews and observations can provide insightful qualitative data, they chose to develop easily administered scales for more practical administration to large samples. They believed that certain beliefs about a domain (e.g., mathematics is useful in everyday life) result in high student motivation whereas other beliefs diminish interest and understanding. They developed their scales to measure beliefs that are related to motivation and thus achievement on mathematical problem solving.
Three belief scales measure beliefs about the individual as a learner of mathematics. The first belief, “I can solve time-consuming mathematics problems,” was selected to assess Schoenfeld’s claim that many students believe that mathematics problems can be solved in five minutes or less. Another belief, “understanding concepts is important in mathematics,” was evaluated because students who simply memorize procedures and who do not believe it is important to understand why a particular algorithm works, will not be successful in application of mathematical concepts. The final belief about learners of mathematics, “Effort can increase mathematical ability,” taps into beliefs about whether mathematics ability is innate or can be improved.

Another two belief scales measure beliefs about the discipline of mathematics. “There are word problems that cannot be solved with simple, step-by-step procedures” was included because students who believe all mathematical problems can be solved by apply rules will give up or apply an inappropriate rule when no appropriate rule can be found. The final belief about mathematics as a discipline, “Word problems are important in mathematics,” is in contrast with the belief that mere computation is the key to mathematics, which the authors claim leads to low motivation in problem solving. However it was the only scale for which the reliability coefficient was not acceptable.

Kloosterman and Stage (1992) administered their *Indiana Mathematics Belief Scales* to 517 university students, about 45% of whom were enrolled in college mathematics courses for elementary teachers. They found that students who felt word problems could be reduced to step-by-step procedures tended to be the same ones who felt effort would improve their ability. These findings suggest that many students believe
the best students in mathematics are the ones who can find an algorithm for solving any word problem. This indicates that in these students’ mathematics courses, step-by-step solutions of word problems were rewarded with success.

In a study of seven teachers of 4\textsuperscript{th} and 5\textsuperscript{th} grade and their 158 students, Carter and Norwood (1997) found that the students of teachers whose beliefs were in alignment with the NCTM standards had significantly different beliefs about factors that lead to success in mathematics than did other students. To measure teacher beliefs, they used a revised form of the “Beliefs about Mathematics” survey which was developed by the National Center for Research on Teacher Education. Sample items from the beliefs about mathematics section included:

- A lot of things in mathematics must simply be accepted as true and remembered: there really isn’t any explanation for them.
- To be good at mathematics you need a mathematical mind.

Beliefs about learning mathematics included:

- If students disagree over the right way to solve a problem, it can interfere with learning mathematics.
- When students can’t solve problems it is usually because they can’t remember the right rule or formula.

Students’ beliefs were measured with a different instrument that included subscales on task orientation, ego orientation, work avoidance, and beliefs about causes of success such as interest and effort.

Carter and Norwood (1997) found that students whose teachers reflected reform movement beliefs, such as the use of questions and listening rather than telling, the
investigation of problems rather than memorization of algorithms and use of open-ended problems with multiple solutions rather than isolated computations, derived greater satisfaction from solving challenging problems and from working hard on mathematics problems. These students also believed that individuals do well in mathematics when they understand the work, emphasizing the importance of teachers’ conceptual understanding of mathematics.

In their longitudinal study, McGinnis and Parker (1999) reported how the beliefs about mathematics of 104 preservice teachers evolved over three years. They developed the *Attitudes and Beliefs about the Nature of and the Teaching of Mathematics and Science* instrument to evaluate whether enrollment in teacher preparation program helped teacher candidates to develop beliefs about the nature of mathematics and science that are compatible with use of constructivist instructional strategies, emphasis on connections between mathematics and science, appropriate use of technology, and encouragement of students from diverse backgrounds to participate in challenging and meaningful learning.

McGinnis and Parker initially observed several prevalent beliefs about mathematics. The first was that only certain people with special abilities can truly understand mathematics. Also, it is more important to get the correct answer for a problem than to investigate the problem in a mathematical manner. Furthermore, the preservice teachers believed that to understand mathematics, students must solve many problems following the examples provided by the teacher. However, after three years, the researchers found significant levels of improvement in the Beliefs about the Nature of
Mathematics and Science and in the Beliefs about Teaching Mathematics and Science scales, indicating that mathematics beliefs, as measured in this study, can change over time in the context of a constructivist teacher preparation program.

Mathematics Beliefs: Qualitative Studies

Thompson (1985) presents in depth case study analyses of two teachers’ conceptions of mathematics as evidenced in their instructional practices. Jeanne, a junior high mathematics teacher for 10 years, perceived mathematics as a “coherent collection of interrelated concepts and procedures, and as a subject free of ambiguities and arbitrariness” (p. 285). This was reflected in her emphasis on the fixed and predetermined nature of the content of mathematics. She saw her role as teacher to present the material in a clear, logical and precise manner, stressing the reasons underlying the mathematical procedures and providing the logical relations among concepts. Jeanne felt responsible to direct and control all instructional activities so students would understand her explanations, and thus had a high need to control the classroom discourse. Students were to attend to her explanations and respond to her questions. She did not think about mathematics as a developing scientific discipline, but rather as finished product to be assimilated. Jeanne did not express awareness of the relevance of mathematics outside the classroom.

In contrast, Kay, a middle school mathematics teacher who had been a computer programmer for 2 years, viewed mathematics as a subject that involves discovery of properties and relationships through personal inquiry. She perceived mathematics as a subject of ideas and mental processes, not just facts to be learned. For Kay, the main objective in studying mathematics was to develop reasoning skills that are necessary for
solving problems. She openly expressed enjoyment and enthusiasm for mathematics and made clear the importance of mathematics in many professions. Kay actively encouraged students to ask questions, guess, theorize, and not fear being wrong. Thompson (1985) also comments that Kay was highly confident about her knowledge of mathematics and her ability to teach it.

Schoenfeld (1988) conducted a year-long case study of a 10th-grade geometry class. He used weekly observations, videotapes, interviews with the students and teacher, and a questionnaire analysis of students’ perspectives regarding the nature of mathematics to explore subject-matter understanding and development of that understanding. Schoenfeld believed the class would be highly ranked according to any of the measures typically employed in classroom research: high test performance, class was run well, the teacher established rules of protocol for classroom interactions, and the relationship between the teacher and students was cordial and respectful. Straight lecture was kept to a minimum, and the vast majority of classes focused on working problems, with students presenting their solutions at the board. Questions were invited and students had a high percent of time on task.

However, Schoenfeld identified several “very unhealthy things” taking place in the class that resulted in the students forming erroneous beliefs about mathematics. For example, constructions were taught as step-by-step procedures that had to be memorized, and if they were not drawn exactly, no credit was given. Furthermore, the teacher emphasized accuracy and speed in performing the sequence of steps that constituted the constructions. Conceptual understanding without exact following of procedures was not rewarded. With proofs, a large portion of class time was spent discussing what was
legitimate and acceptable. As a result of the instruction, the students came to believe that the form of expression, as much as the substance of mathematics is what is important.

Furthermore, the structure of homework assignments and test problems in this class, as in many mathematics classes, required that many “problems” be completed in a short period of time. Commenting on the 20 homework problems that were to be presented by the students in a 54-minute class period, Schoenfeld (1988) argues that the tasks were actually exercises that emphasized students should be able to solve mathematics problems quickly. Schoenfeld believes the teacher’s advice to the students summed things up in a nutshell: “You’ll have to know all your constructions cold so you don’t spend a lot of time thinking about them” (p. 159). The presumption underlying the assignments was that if you understand the material, you should be able to complete the exercises quickly; if you can’t, you don’t understand the material and you should seek help. When asked how long it should take to answer a typical homework problem, the students’ responses were an average of only 2.2 minutes. When asked what a reasonable amount of time was to work on a question before you know it is impossible, the response was an average of only 11.7 minutes.

From Schoenfeld’s observations of many K-12 classrooms, at each grade level there was a standard body of knowledge consisting of facts and procedures which the teachers attempted to get their students to master. “There was little sense of exploration, or of the possibility that the students could make sense of the mathematics for themselves” (p161). Students got the impression that they had to memorize what experts determined was important and regurgitate it on exams. Schoenfeld’s main point was that students develop their mathematical epistemologies from their classroom experiences. If
the teacher presents error-free, mechanical performance where memorization and procedural accuracy are rewarded, that is what students come to believe that mathematics is all about. “Indeed, typical classroom instruction (such as word problem key word procedures) subverts understanding even further by providing methods for solving problems that allow students to answer problems correctly, without making an attempt to understand them” (p. 163).

Ball (1990) reported findings from a longitudinal study on the understandings of mathematics held by 252 preservice teacher candidates (217 as they entered their teacher education programs. Each participant completed a questionnaire that included a multiple choice fraction division problem that required the preservice teachers to select an appropriate story problem illustration of what \( \frac{1}{4} \) divided by \( \frac{1}{2} \) means. Only 30 percent of the participants chose the correct representation. Then 35 of the preservice teachers were selected for an interview in which they were asked how they were taught to divide fractions and asked them to show how by doing \( 1 \frac{3}{4} \) divided by \( \frac{1}{2} \). They were also asked to provide a picture, model or real world representation of the problem. Only four out of 35 teacher candidates were able to describe a completely appropriate representation. All of the teacher candidates had significant difficulty unpacking the meaning of division with fractions.

On the questionnaire, a third of the secondary candidates and two thirds of the elementary candidates thought that most of mathematics could not be explained. However, when asked for explanations, most interview participants merely gave rules. Ball also found that preservice teachers conceptions of mathematics were primarily that knowing mathematics means knowing “how to do it,” doing mathematics means
following set procedures step-by-step to arrive at answers, and that mathematics is largely an arbitrary collection of facts and rules. Thus, for these preservice teachers knowing mathematics was centered on memorizing rules and being able to use standard procedures.

Lampert (1990) presents a case on the mathematical knowing and teaching of exponents from her own 5th-grade classroom. Lampert asserted that from the way mathematics is taught and the activities that are assigned, students tacitly, if not explicitly learn what counts as mathematical knowledge and how to “place mathematics appropriately in the lexicon of ways of knowing” (p. 33). She compared how mathematics is known in school and how it is known in the discipline. In American culture and most classrooms, mathematics is associated with certainty, with being able to get the right answer quickly. There is little creating, exploration, reevaluation, or uncertainty that is foundational to the discipline of mathematics. Thus, knowing mathematics in school basically means to have a set of unexamined beliefs.

Lampert also identified intellectual authority as one of the key differences between mathematics in school and in the discipline. Lampert observed that her students typically believe that there is one answer to mathematical problems and the teacher is the only one who can tell them the correct answer. She attempted to impact her students understanding of the nature of mathematics by introducing them to how mathematicians approach their work. She emphasized how mathematicians “zigzag” between revising their conclusions and assumptions in the process of coming to know, how they submit their work to their colleagues, and how overtime mathematical conclusions that were unquestioned in the past are reconsidered. Thus, Lampert claimed that, “For student to
see what sort of knowing mathematics involves, the teacher must make explicit the knowledge she is using to carry on an argument with them about the legitimacy or usefulness of a solution strategy” (p. 41).

Lampert (1990) challenged her students to use intellectual courage to risk opening one’s assumptions to revision and admit one’s inappropriate conclusions. They were also to have intellectual honesty to change their beliefs, and wise restraint to not revise beliefs without good reason. She gave the responsibility of figuring out how to solve a problem to her students and modeled that there are multiple routes to a solution. Lampert explains that students must learn to generate strategies and argue their legitimacy; through this process students demonstrate what they truly know about mathematics. “It is the strategies used for figuring out, rather than the answers that reveal the assumptions a student is making about how mathematics works” (p. 39). In this way, “the problem is not the question and the answer is not the solution” (p. 40).

Furthermore, in conventional mathematics classrooms students believe that the teacher knows the correct answer, and the teacher believes that the right answer can be found by using rules in the textbook. Because the teacher is the one with the most education in the class, she or he represents the most expert knower of mathematics. In this role the teacher has the potential to demonstrate the nature of mathematical expertise to students who seek to acquire it. However, if the teacher only demonstrates how to follow rules and explain whether a student’s answer is correct, the students will get a very limited understanding of mathematics expertise (Lampert, 1990).

Beliefs about authority are closely related to beliefs about how learning takes place. On one extreme is this teacher as master and judge who validates correct answers
and tells students what to do. On the other extreme is teacher as learner, equal with the
students as they discover or create knowledge together. From this perspective the teacher
will allow students to struggle in the processes of gaining conceptual understanding
(Orton, Ball, & Cooney, 1995). From the constructivist and reform standpoint, students
need to verify their own thinking rather than to depend on the teacher to tell them if they
are right or wrong (Putnam et al., 1992).

Even when teachers attempt to use more constructivist techniques, Putnam,
Heaton, Prawat, and Remillard (1992) found that teaching as telling often still lurks
beneath the surface. These researchers conducted case studies of four 5th-grade teachers
to explore their knowledge and beliefs about mathematics and how it is best taught and
learned. All four of the mathematics teachers observed and interviewed adhered to the
belief that understanding mathematics involved knowing how to use various mathematics
tools to solve problems in everyday life. The teachers contextualized mathematics into
everyday life, but that link apparently only involved students learning which concepts or
procedures to apply. Thus problem solving became merely “applying well-practiced
computational skills in particular situations, rather than opportunities to figure out what is
reasonable and sensible in those situations” (p. 224). These four teachers were attempting
to implement reform standards, however, were unable to avoid the ingrained tendency to
teach through telling, modeling and explaining. Students had little chance to generate
ideas, actively grapple with ideas or demonstrate what and how they knew
mathematically.

Furthermore, the teachers held the belief that understanding was important, but
because learning is seen as a rigidly sequential, hierarchical process, understanding must
wait until the arithmetic basics are first mastered. This view of problem solving is consonant with the hierarchical view of learning in which the students must learn the basics before they can understand and apply them. Additionally, the teachers expressed the view that learning takes time so that important mathematics ideas should be revisited in increasingly rich ways, i.e. spiral curriculum. This belief subtly undermines reformers efforts to focus mathematics instruction on understanding and problem solving because teachers can fall back on “they’ll see it again” when their students do not comprehend the material. Finally, Putnam et al. (1992) identify the erroneous belief that young children do not have the abstract thinking abilities necessary for problem solving. One teacher stated, “I believe that they should learn just the procedures sometimes and then later when their mind is more mature, they can understand” (p. 220). This belief once again supports teaching as telling and attempts to justify avoiding teaching for conceptual understanding.

Dimensions of Epistemological Beliefs About Mathematics

Schommer’s five dimensions of epistemological beliefs – the structure, stability, and source of knowledge, and the control and speed of knowledge acquisition which were discussed in the epistemological beliefs literature are also evident in the mathematics beliefs research. These dimensions are helpful in measuring and classifying individuals’ beliefs about mathematics. A sixth dimension, which I propose as the Form of Knowing, is often discussed in the mathematics beliefs literature in terms of procedural versus conceptual knowledge or a mechanistic compared to a problem solving way of knowing mathematics. This dimension of form of knowing is what Buehl, Alexander, and Murphy
(2001) identified as the nature of knowledge and problem solving and was also repeatedly identified in SEQ studies as a combined factor of certain/simple knowledge. This epistemological belief dimension is characterized by the distinction between computation as compared to argumentation and justification, as well as by the manipulation of symbols in contrast to the understanding of what they represent. Thus it is distinct from the dimension of structure of knowledge, which captures characteristics of the type of knowledge one possesses. Form of knowing describes the manner by which that knowledge is obtained and processed (e.g., through argumentation and justification in problem solving which leads to understanding). Further examples of this proposed dimension are presented in Table 2.2.

These six identified dimensions of mathematics epistemological beliefs will be used as a framework to analyze the elementary teachers’ epistemological beliefs in this present study. Table 2.2 identifies each dimension, describes the continuum or contrast it captures, and provides examples from the mathematics beliefs literature. The examples of each dimension from the mathematics beliefs literature will serve to inform the identification of teachers’ mathematics epistemological beliefs in the interview and observation data of the present research.

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Table 2.2: Dimensions of epistemological beliefs

<table>
<thead>
<tr>
<th>Epistemological Dimension Names</th>
<th>Continuum or Contrast</th>
<th>Examples in Mathematics Beliefs Literature</th>
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<tr>
<td>Structure of Knowledge</td>
<td>Isolated bits and pieces -- complex interrelated networks</td>
<td>- Preservice teachers simply gave rules to explain mathematics problems and perceived mathematics as an arbitrary collection of facts and rules (Ball, 1990). - Middle school math teacher perceived mathematics as a subjects of ideas and mental processes, not just facts to be learned (Thompson, 1985). - Connectedness vs. compartmentalization of math topics (Thompson, 1992).</td>
</tr>
<tr>
<td>Form of Knowing</td>
<td>Procedural/conceptual; mechanistic/problem solving; Computation/argumentation and justification; manipulate symbols/understand what they represent</td>
<td>- Because of her conception of the nature of mathematics she did not understand why making sense of the problem should be part of the instructional activity; Teachers unintentionally teach “mindless mimicry mathematics” not because they do not care about their students’ learning, but because of their own mistaken beliefs about the nature of mathematics, how mathematics is known (Battista, 1994). - 83% of 7th-grade and 81% of 11th-grade students believed there is always a rule to follow in solving mathematics problems (Brown et al., 1988). - Education students believed that word problems could be reduced to step-by-step procedures that could be memorized (Kloosterman &amp; Stage, 1992). - The teachers held the belief that understanding was important, but because learning is seen as a rigidly sequential, hierarchical process, understanding must wait until the arithmetic basics are first mastered; - Problem solving as merely “applying well-practiced computational skills in particular situations, rather than opportunities to figure out what is reasonable and sensible in those situations” – although attempting to implement reform standards, were unable to avoid the ingrained tendency to teach through telling, modeling and explaining (Putnam et al., 1992). - Word problem key word procedures subverts understanding by teaching how without why (Schoenfeld, 1988). - Sense-making, discovery of properties and relationships through personal inquiry – subject of ideas and mental processes, not just facts to be learned, encourage students to question, guess, theorize and not fear being wrong; - Discovery of properties and relationships through personal inquiry – subject of ideas and mental processes, not just facts to be learned (Thompson, 1985). - Tests emphasize efficient performance and computations skills, focus on procedural mastery, fail to measure true math understanding, mere manipulation of symbols; - Knowing math means knowing how to do it, doing math means following set procedures step-by-step to arrive at answers (Thompson, 1992).</td>
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<tr>
<th>Epistemological Dimension Names</th>
<th>Continuum or Contrast</th>
<th>Examples in Mathematics Beliefs Literature</th>
</tr>
</thead>
</table>
| Stability of Knowledge (Certain Knowledge) | Unchanging -- evolving | - Students perceived mathematics as static (Brown et al., 1988).  
- A lot of things in math must simply be accepted as true and remembered – there really isn’t any explanation for them. (Carter & Norwood, 1997).  
- Mathematicians zigzag between revising their conclusions and assumptions in the process of coming to know, how they submit their work to their colleagues, overtime math conclusions that were unquestioned in past are reconsidered (Lampert, 1990).  
- Always a rule to follow – static, rule-oriented (Schoenfeld, 1983).  
- Standard body of knowledge consisting of facts and procedures that teachers get students to master (Schoenfeld, 1988).  
- Math viewed primarily as set of algorithms or procedures and the goal of instruction is to help students master those procedures (Stodolsky, 1985).  
- Teachers did not see math as a developing scientific discipline, but rather as a fixed product to be assimilated;  
- Subject free of ambiguities and arbitrariness – emphasis on fixed and predetermined nature of mathematics content (Thompson, 1985).  
- Knowing mathematics is making mathematics – reasoning and creative thinking, gathering and applying information, discovering, inventing, and communicating ideas and testing those ideas through critical reflection and argumentation” (Thompson, 1992). |
| Ability to Learn (Malleability of Learning Ability) | Belief in fixed ability -- ability to learn | - “To be good at mathematics you need a mathematical mind” (Carter & Norwood, 1997).  
- Only certain people with special abilities can truly understand mathematics (McGinnis & Parker, 1999).  
- Erroneous belief that young children do not have the abstract thinking abilities necessary for problem solving. “I believe that they should learn just the procedures sometimes and then later when their mind is more mature, they can understand” – (Putnam et al., 1992). |
| Speed of Knowledge Acquisition (Speed of Learning) (Belief in quick learning) | Quick learning or not-at-all -- gradual learning | - View that learning takes time, thus important ideas should be revisited in increasingly rich ways. This belief subtly undermines reformers’ efforts to focus math instruction on understanding because teachers can fall back on “they’ll see it again” when students do not comprehend (Putnam et al., 1992).  
- Accuracy and speed – conceptual knowledge without following procedures not rewarded;  
- Students believed a typical homework problem should take 2.2 minutes (Schoenfeld, 1988).  
- Teachers’ belief in mathematics as operations and procedures was positively associated with their emphasis on speed in problem solving (Stipek et al., 2001). |
Table 2.2: Dimensions of epistemological beliefs

<table>
<thead>
<tr>
<th>Epistemological Dimension Names</th>
<th>Continuum or Contrast</th>
<th>Examples in Mathematics Beliefs Literature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of Knowledge (Control of Knowledge Access)</td>
<td>Teacher as sole authority and validator -- student autonomy in proposal of problem and validation of solution Expert – experience Handed down from Authority or determined by reason.</td>
<td>- In conventional mathematics classes students believe that the teacher knows the correct answer, and the teacher believes that the right answer can be found by using rules in the textbook. (Lampert, 1990). - On one extreme is this teacher as master and judge who validates correct answers and tells students what to do. On the other extreme is teacher as learner, equal with the students as they discover or create knowledge together. (Orton, Ball, &amp; Cooney, 1995). - Students see themselves as recipients of the inert math knowledge that others possess, not as math thinkers – so teachers think they have engaged the students’ learning commitment, but students rarely see significance in the learning because it is someone else’s math. So problems are approached with someone else’s knowledge and reasoning. Reasons behind the memorized methods or why they are useful are rarely provided (Pea, 1987). - Students verify their own thinking rather than depending on the teacher to tell them they are right (Putnam et al., 1992). - Only geniuses can discover, create or really understand math – so studied passively, accepting what is passed down from above without expectation they can make sense of it for themselves; inborn ability or natural talent (Schoenfeld, 1983). - Obtain knowledge from a knowledgeable person – not expected to figure out on own; - Conversation is one-way – little dialogue – one way of knowing – math concepts and skills must be learned from the teacher and then practiced vs. psychology, multiple ways of knowing-reading, research, reflection, can solve the problem or resolve confusion on own. In social studies students are taught to become independent learners and develop research skills; - Dependence on text book; foster dependence on teacher helpless student all-knowing teacher (Stodolsky, 1985). - Cannot learn math on own, reliance on teacher to tell them what to do (Stodolsky et al., 1991). - Encourage students to question, guess, theorize and not fear being wrong (Thompson, 1985).</td>
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CHAPTER 3

RESEARCH METHODS

To obtain rich data, both quantitative and qualitative research methods were employed in this study of teachers’ sense of efficacy to teach mathematics and their epistemological beliefs about mathematics. First, self-reported surveys were used to obtain quantitative data from preservice elementary education teachers. Subsequently, a purposefully selected sample of these individuals was interviewed and observed as second year teachers. The research methods that were utilized are described in the quantitative and qualitative sections below.

Quantitative Research Methods

Setting

The context in which the quantitative portion of this study was situated was a Master of Education initial teaching certification program at a large state university in the Midwest. The teacher preparation program of the participants in this study was based on a Holmes Group Professional Development School model. The program required that each student already have an undergraduate degree. This Master’s of Education was completed in five consecutive quarters. Program coursework included methods courses in
mathematics, science, social studies, literacy, art, and music. Additional courses included Child Development/Learning, Technology, Educational Psychology/Pedagogy, Assessment, Equity, and School and Society. Issues of diversity and preparation for teaching in urban settings were also emphasized in the program. The program required that the prospective teachers were in school placements for most of the year, progressing from three days of observation in the fall to from four to ten weeks of full time student teaching in the spring. The student teaching experiences were in the local urban public schools and several suburban school districts.

Participants

The 60 students in the sample were representative of the gender and ethnic diversity generally found in education programs. That is, the sample was predominantly female and Caucasian. The students were from four cohorts – two at the main campus and two at a branch campus. The two cohorts of students at the main campus took mathematics methods courses taught by two different professors, while the two cohorts at the branch campus took mathematics methods courses which were both taught by a third professor. Participation in this study was voluntary, informed consent forms were obtained from each student prior to data collection, and participants were assured anonymity.

Measures

*Background information.* In addition to demographic information including age, gender and race, the prospective teachers’ preference of grades and subjects to teach, prior mathematics experience as defined by the number and level of high school and
undergraduate mathematics courses completed, and undergraduate major were obtained using a Background Information Questionnaire (Appendix A). Whether participants completed Mathematics 105 and 106 (math courses taught specifically for elementary education teachers) was also established.

**Teacher efficacy.** An abbreviated 10-item version of the Gibson and Dembo (1984) Teacher Efficacy survey was used to measure overall teacher efficacy (see Appendix A). The 10 items were selected by Woolfolk and Hoy (1990) because they had the highest factor loadings in prior research. Hoy & Woolfolk (1993) reported a Chronbach’s $\alpha$ coefficient of .77 for the PTE scale and .72 for the GTE scale. A sample personal teaching efficacy question is: “If a student did not remember information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson.” A sample general teaching efficacy item is: “If parents would do more for their children, I could do more.” Responses to the items are along a 6-point Likert scale ranging from “strongly disagree” (0) to “strongly agree” (5).

**Mathematics teaching efficacy.** The Mathematics Teaching Efficacy Beliefs Instrument (MTEBI-B) (Huinker & Enoch, 1995) for preservice teachers, comprised of 13 personal mathematics teaching efficacy items and 8 mathematics teaching outcome expectancy items, was used to measure mathematics teaching efficacy (see Appendix A). Huinker and Enoch (1995) reported a Chronbach’s $\alpha$ coefficient of .88 for the PMTE scale and .77 for the MTOE scale. Huinker and Enoch’s (1995) instrument was modified from a 5-point to a 6-point Likert response scale, ranging from strongly disagree (0) to strongly agree (5).
Domain Specific Beliefs Questionnaire (DSBQ). To explore epistemological beliefs about mathematics, the students completed a modified version of the Domain-Specific Beliefs Questionnaire (DSBQ) (Buehl & Alexander, 2001). Buehl, Alexander, & Murphy (2002) reported a Chronbach’s α coefficient of .84. The modified instrument addressed epistemological beliefs in the domain of mathematics. The response scale was modified to range from strongly disagree (0) to strongly agree (5), with a maximum score on mathematics epistemological beliefs of 125. A copy of the DSBQ can be found in Appendix A.

Mathematics self-efficacy. The Mathematics Confidence Scale (MCS) (Dowling, 1978) has been consistently used as a template for measuring mathematics self-efficacy (e.g., Pajares & Kranzler, 1995). Pajares & Kranzler (1995) reported a Chronbach’s α coefficient of .91. The measure is comprised of 18 problems with six problems each in arithmetic, algebra, and geometry. Each of these three categories is comprised of six problems which represent three levels of cognitive demand (computation, comprehension, and application) in two problem contexts (real and abstract). An example of the items on the MCS is “There are three numbers. The second is twice the first and the first is one third of the other number. Their sum is 48. Find the largest number.”

The instrument instructs participants to indicate how confident they are to correctly solve each of the problems. The instructions indicate that the participants will have to solve similar problems following this measure. Responses to the items were along a 6-point Likert scale ranging from “highly unconfident” (0) to “highly confident” (5),
with a maximum score of 90. This instrument was administered prior to the mathematics
methods course and following the student teaching experience. Two parallel forms of the
MCS (A and B) can be found in Appendix A.

*Mathematics content knowledge.* The mathematic performance measure was
comprised of the same 18 mathematics problems as the Mathematics Confidence Scale.
The measure served as an indication of mathematics content knowledge. Answers were in
a multiple-choice format with five options (a through e). A dichotomous variable (1 =
correct, 0 = incorrect) was used to score each item. The measure was scored using the
total number of correct answers, with a maximum score of 18. Two forms (A and B) of
the Mathematics Performance Measure comprised of the same number and types of
problems – one for prior to the preservice teachers’ second mathematics methods course
and one for after the student teaching experience - are in Appendix A.

*Student teaching evaluation.* Following the student teaching experience,
participants completed a student teaching evaluation that requested information on
variables that could possibly influence teacher efficacy and mathematics teaching
efficacy (see Appendix A). Questions included type of school, subjects taught,
relationship with cooperating teacher, student’s evaluation of overall and mathematics
teaching experience, and cooperating teacher’s support of the implementation of
conceptually-based approaches to teaching mathematics. The evaluative items were
scored on 6-point Likert response scale, ranging from strongly disagree (0) to strongly
agree (5), with a maximum score of 35. The number of hours per week of teaching of
mathematics was also obtained.
Procedure

There were three points of quantitative data collection. The first was at the beginning of the third quarter of a five-quarter Master of Education program, just prior to the students’ second mathematics methods course. The second collection of data occurred one quarter later, following the mathematics methods course, but before the student teaching experience. The final data collection was after the student teaching experience, following the fourth quarter of the program.

Measures of mathematics self-efficacy, mathematics performance, mathematics teaching efficacy, and beliefs about mathematics were obtained through self-report instruments. In the first data collection, the measures were administered in two separate sessions (A and B) due to time limitations. In session A students completed a background information questionnaire and the measures on teacher efficacy, mathematics teaching efficacy, and mathematics epistemological beliefs. In session B students completed the mathematics self-efficacy and mathematics performance measures. Sessions A and B took approximately 25 minutes each.

In the second data collection, students only completed the teacher efficacy, mathematics teaching efficacy, and mathematics epistemological beliefs measure in one session of an approximate duration of 15 minutes. The survey was abbreviated in order to maintain a high percentage of participation. However, in the third data collection after student teaching, measures of mathematics self-efficacy and performance were once again obtained in addition to teacher efficacy, mathematics teaching efficacy, and
mathematics epistemological beliefs. Furthermore, a student teaching experience evaluation was also completed. See Table 3.1 for the schedule of the administration of the measures.

Data Analysis

The first research question addressed the relationships between teacher efficacy, mathematics self-efficacy, mathematics content knowledge as indicated by performance on a mathematics test and mathematics teaching efficacy. Specifically, the purpose of this question was to determine to what extent the first three variables predict mathematics teaching efficacy. Thus, a linear regression was conducted with teacher efficacy, mathematics self-efficacy, and prior mathematics experience as the independent variables and mathematics teaching efficacy as the dependent variable.

The second research question addressed the changes in M.Ed. students’ teacher efficacy, mathematics teaching efficacy, mathematics epistemological beliefs, and mathematics self-efficacy over time. To assess these changes a repeated measures MANOVA was conducted with time as the within subjects variable and teacher efficacy, mathematics teaching efficacy, and mathematics epistemological beliefs as the dependent variables.

Measures of these dependent variables were obtained three times: 1) at the beginning of the third quarter of the Master of Education program, which was prior to a second mathematics methods course, 2) after the completion of the mathematics methods course, and 3) at the completion of the fourth quarter of the program, following the student teaching experience. Because mathematics self-efficacy was measured only
twice, prior to the methods course and after the student teaching experience, a dependent
\(t\) test was conducted.

<table>
<thead>
<tr>
<th>Order</th>
<th>Data Collection 1</th>
<th>Data Collection 2</th>
<th>Data Collection 3</th>
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<tbody>
<tr>
<td></td>
<td>Beginning of Winter Quarter</td>
<td>End of Winter Quarter</td>
<td>Beginning of Summer Quarter</td>
</tr>
<tr>
<td>1st</td>
<td>Background Information</td>
<td>Mathematics Self-Efficacy</td>
<td>Teacher Efficacy</td>
</tr>
<tr>
<td>2nd</td>
<td>Teacher Efficacy</td>
<td>Mathematics Performance</td>
<td>Mathematics Teaching Efficacy</td>
</tr>
<tr>
<td>3rd</td>
<td>Mathematics Teaching Efficacy</td>
<td>Mathematics Epistemological Beliefs</td>
<td>Student Teaching Experience Evaluation</td>
</tr>
<tr>
<td>4th</td>
<td>Mathematics Epistemological Beliefs</td>
<td>Mathematics Epistemological Beliefs</td>
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</tr>
<tr>
<td>5th</td>
<td>Mathematics Self-Efficacy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6th</td>
<td>Mathematics Performance</td>
<td></td>
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</table>

Table 3.1: Schedule for Administration of Quantitative Measures.
The third research question concerns the influence that mathematical epistemological beliefs have on change in mathematics self-efficacy and mathematics teaching efficacy during the preservice training. To first explore the relationship between epistemological beliefs and mathematics self-efficacy and mathematics teaching efficacy, Pearson correlation analyses were conducted. Then, the students’ composite mathematics epistemological beliefs scores were used to divide the participants into three groups. The epistemological beliefs scores were equally distributed, thus 21 students were placed into the low level of sophistication (1) group, 20 into the moderate level of sophistication (2), and 21 into the high level of sophistication (3) group.

Once the three levels of epistemological beliefs were established, they were used as the between subjects variables in a repeated measures MANOVA with mathematics self-efficacy and mathematics teaching efficacy as dependent variables. Post hoc analyses were conducted using Tukey’s HSD. Then a follow-up ANOVA was conducted with mathematics epistemological beliefs level as the independent variable and change in mathematics teaching efficacy and mathematics self-efficacy as the dependent variables. Post hoc analyses were once again conducted using Tukey’s HSD.

Qualitative Research Methods

Research Design

As Marshall and Rossman (1989) explain, different purposes of qualitative research require different approaches that result in distinctive products. Because I desired a research design through which I could examine epistemological beliefs and gain understanding into the sources that impact teachers’ analyses of the teaching task and
context as well as their assessment of their personal competence to teach mathematics, I used a collective instrumental case study approach (Stake, 2000). Three particular teacher cases were explored to provide insights into the relationship between mathematics teaching efficacy and mathematics epistemological beliefs.

Participants

My population of interest was the 60 novice elementary teachers who participated in my quantitative survey study of preservice teachers’ beliefs about mathematics. The individuals from whom I recruited participants were graduates of the Master of Education initial teacher certification program and were in their second year of teaching. In order to effectively explore the relationships in question, the three individuals I interviewed and observed were purposefully selected based on their mathematics teaching efficacy scores as measured in the previous study. As Patton (1990) explains, “the logic and power of purposeful sampling lies in selecting information-rich cases for study in depth” (p. 169).

I recruited the three novice teachers through an email that was sent to all previous participants in the quantitative study. The email requested the teachers’ participation in a qualitative study of interviews and classroom observations (See Appendix B) that would also provide opportunity to reflect on their mathematics teaching. Although five individuals responded to the recruitment email, three were purposely selected according to their mathematics teaching efficacy scores. The first individual selected was of moderate mathematics teaching efficacy and served as the pilot case through which I
evaluated the effectiveness of the interview protocol and observation techniques. Then two additional individuals, one with low and one with high mathematics teaching efficacy were selected.

The context of teaching was also considered in the selection process. It would have been advantageous to have teachers all from the same type of school to avoid confounding of contextual variables, but the lack of volunteers for participation prohibited this. However, the contrasts apparent between the urban and rural settings highlight the influence of teaching context on teacher efficacy. The three selected individuals were contacted via email and then by telephone to arrange for interview and observation times. All three teachers were in their second year of teaching after completing their M.Ed. program.

Marie is a White teacher at a small public city school that serves about 190 preschool through fifth graders. She is a middle aged mother of five and has a bachelor’s degree in accounting. She was a kindergarten aide three years and taught preschool for six years prior to her graduate work. This year Marie has a combined fourth and fifth grade class, however, she teaches mathematics to only eight fifth graders while the others go to a resource room for mathematics. Last year, Marie was a second grade teacher at the same school.

Donna is a White teacher of third graders in a small rural Catholic elementary school. Each grade has only one class, and all but one of Donna’s 15 students have been together since kindergarten. The school is very homogeneous, both racially and socio-economically. Donna enjoys teaching in an environment where spirituality is valued.
Connie is White teacher in a public city school that serves one of the more affluent neighborhoods in the same district in which Marie teaches. Prior to teaching, Connie obtained her M.B.A. and created her own social service organization that obtained computers for the disadvantaged. Connie is married with three children. Two of Connie’s sons attend her elementary school, which she describes as “not quite suburban.” She lives two blocks from the school.

Data Collection Methods

Interviews. Interviews served as the primary qualitative data collection method. I used a series of semi-structured interviews with each of the three selected teachers. The initial interview was via telephone and comprised of two open-ended questions addressing the teacher’s perceptions of their overall teaching experience and more specifically, their mathematics teaching experience. The questions sought to gain understanding of the teacher’s efficacy for instructional strategies, classroom management, and student engagement, as well as on the impact of environmental and demographic factors. Each teacher’s assessment of her teaching context, including her relationships with colleagues and administration was explored. Changes in mathematics teaching efficacy and perceived causes since the completion of her M.Ed. were also explored. The initial telephone interview was approximately 20 minutes in length. Two classroom observations were also scheduled at that time.

Each of the two classroom visits was preceded by a 30 minute pre-observation interview that was conducted either at the school just prior to the observation or via phone the night before, depending on the teacher’s schedule. Through the first pre-
observation interview questions, I gained insight into each participant’s mathematics
teaching efficacy as I explored her approach to teaching mathematics. We discussed her
plans (including objectives and content) for teaching the upcoming mathematics lesson,
along with her perceptions of how well the students would understand the lesson. The
second pre-observation interview focused more intently on the teachers’ understandings
of mathematics - what it is, how mathematics is known, how it is best taught, and how
her perceptions of teaching mathematics have changed since beginning to teach. We then
again discussed the teacher’s mathematics lesson plans for that day and how she believed
the lesson would proceed, including her perceptions of how well the students’ would
understand. Thus, I qualitatively accessed each teacher’s definition of the imminent
teaching task and her assessment of her personal competence to accomplish that task.

Following each of the two observations of mathematics teaching (discussed
below), a 30-minute post-observation interview was also conducted at the school
immediately afterward or via phone that evening. Both of the post-observation interviews
gave the teacher an opportunity to reflect on the lesson and provide further insight into
her epistemological beliefs about mathematics. Additionally, during the post-observation
interviews I explored the teacher’s perceptions of the factors that influenced her
mathematics teaching efficacy. Member check interviews along with any needed
clarification questions were conducted via telephone following each classroom visit as
well as following initial analysis of the data. Connie, the third participant, provided very
limited responses to the interviews. To gain a richer understanding of her beliefs I asked
her for an additional follow-up interview. This interview was comprised of the questions
from the Tschannen-Moran and Woolfolk Hoy (2001) TSES, along with questions exploring each of the six dimensions of epistemological beliefs (see Appendix C).

Each interview was audio taped and transcribed verbatim by the researcher for analysis. A consent form was signed prior to the first observations that included permission to be recorded. Permission to interview and observe the three teachers was also obtained from their school principals.

I followed Spradley’s (1979) conceptualization of the ethnographic interview as “a series of friendly conversations into which the researcher slowly introduces new elements to assist informants to respond” (p. 58). The semi-structured interviews had a flexible design, reflecting the emergent process of qualitative research. An interview protocol (see Appendix C) was used to ensure that pertinent issues were addressed, however, I allowed myself to be led where the teacher interviewee wanted to take me in the interview (Pelto & Pelto, 1989). As Fontana and Frey (2000) point out, the very essence of unstructured interviewing is the establishment of relationship with the participant and the desire to understand rather than to explain.

Thus, the interview protocol was created to directly explore teachers’ perceptions of their efficacy to teach mathematics and their understandings of how mathematics is known. The interview questions were designed to specifically access teachers’ analyses of their teaching task – their students’ abilities, appropriate instructional strategies and managerial issues, as well as their analyses of their teaching context including the school environment and administrative support (Tshannen-Moran & Woolfolk Hoy, 2001). Additionally, the interview questions delved into a teacher’s mathematics content
knowledge, pedagogical skills, and the rationales behind instructional practice to more clearly comprehend her assessment of her personal competence to teach mathematics. By giving voice to the perceptions of the teachers themselves, the factors that impact the cognitive processing involved in the cyclical model of teaching efficacy were elucidated. Furthermore, the quantitative findings about the relationships between mathematics teaching efficacy and epistemological beliefs obtained in the first portion of this study were brought to life, and what the initial statistics suggest were further expounded.

**Naturalistic observation.** Recognizing the important distinction between espoused beliefs and enacted beliefs, I also used naturalistic observations as an additional data collection method to gain a more contextualized assessment of the teachers’ mathematics teaching efficacy and mathematics epistemological beliefs in action. Two classroom observations of mathematics lessons for each of the three teachers were made. In addition to collecting field notes of the observations, the mathematics lessons were recorded and transcribed. The field notes were focused on capturing teacher behaviors (facial expressions, writing on the board, use of manipulatives, etc.), classroom environment (layout of room, interactions with individual students, etc.), and small group exchanges that would not be evident from the lesson transcriptions. As Adler and Adler (1994) explain, naturalistic observation “enjoys the advantage of drawing the observer into the phenomenological complexity of the world, where connections, correlations, and causes can be witnessed as and how they unfold” (p. 378).

I was aware of my limitations on taking in everything that occurred in the classrooms while simultaneously making emergent interpretations. Yet to my greatest
ability I attempted to record details that were used to develop a thick and rich description of the mathematics teaching and that revealed the teachers’ mathematics teaching efficacy and epistemological beliefs. I also endeavored to avoid the constant danger of leaping to abstractions in my field notes (Pelto & Pelto, 1986). Furthermore, to ensure the most accurate and detailed recollections, I rewrote my rough field notes into an elaborated account following each observation. I also used member checks following the interviews to ascertain if my interpretations of the observations were consistent with the teachers’ emic perceptions of the teaching experience.

**Data Analysis**

The teacher interview transcriptions and mathematics teaching observation field notes were first transcribed into Word documents. The documents for the pilot participant were then imported into NUD*IST6 software. I analyzed the qualitative data thematically. I used the method of constant-comparison, continually considering new information in light of other collected data to support or refute established and emerging speculations (Lincoln and Guba, 1985). By repeatedly reading through the data, I gained awareness and insight into the specific factors that contributed to the teachers’ efficacy judgments and their mathematics epistemological beliefs. Initially, paragraphs of all of the data for the pilot teacher were categorized and coded into one or more of three broad themes. In regards to teacher efficacy, teachers’ cognitive processing involves analysis of the teaching context and teaching task. Thus, the three primary thematic codes were Efficacy as related to Teaching Context, Efficacy as related to Teaching Task, and Mathematics Epistemological Beliefs.
For teaching context, I identified subcodes of classroom and school environment, as well as student behavior and academic performance. I coded the teaching task data in light of the three main tasks of teaching as conceptualized in the Tschannen-Moran and Woolfolk Hoy (2001) Teacher Sense of Efficacy Scale (TSES): student engagement, student engagement, and instructional strategies. Then these data were further coded according to the twelve questions on the short form of the TSES (see Appendix D).

The mathematics epistemological beliefs data was subcoded based on the six dimensions of mathematics epistemological beliefs that were identified from Schommer’s (1990, 1992) work and other mathematics beliefs literature. These dimensions were: Structure of Knowledge, Form of Knowing, Stability of Knowledge, Ability to Learn, Speed of Learning, and Source of Knowledge. The pilot teacher’s mathematics belief data that did not code into these dimensions was analyzed for any emerging themes. Figure 3.1 presents the coding tree that I used for the thematic analysis of the data and also for the creation of the teacher profiles.

In the analysis of the second and third teachers’ data, I decided to use a more manual approach to coding. Instead of being “distanced” from my data by what I perceived to be cumbersome data analysis software, I used Microsoft Word to cut and paste the data into the three major themes. I then printed out the data and color coded it according to the subcategories for each major theme. In writing the pilot teacher profile, I had encountered the problem of repeating quotes due to multiple coding of data. I thus chose to only code the data of the additional two teachers into one category to streamline the development of the profiles.
Using the insights gained in the pilot teacher data analysis, I developed codes that were in turn analyzed to identify more detailed aspects of teachers’ cognitive processing of the teaching task and its context, in which “the relative importance of factors that make teaching difficult or act as constraints is weighed against an assessment of the resources available that facilitate learning” (Tshannen-Moran & Woolfolk Hoy, 2001, p. 228). I purposefully searched for pertinent data that did not fit into the questions posed by the TSES. I especially focused on identifying any additional emerging themes or factors that the teachers considered in their analyses of the teaching task.

Consistent with the thematic coding framework, the profiles were developed to clearly address the three qualitative research questions:

1) What are the mathematics epistemological beliefs of the three novice elementary teachers in this study?

2) What aspects of the teaching context and task influence three novice elementary teachers’ efficacy judgments for teaching mathematics?

3) How do the mathematics epistemological beliefs of the three novice elementary teachers in this study influence their analysis of the mathematics teaching context and task as theorized in the integrated model of teacher efficacy?
Figure 3.1: Qualitative data coding tree
Role of the Researcher

Constas (1998) states that “Because narratives are collaborative productions, each researcher must possess the social skills and reflective abilities needed to understand the way he or she contributes to, represents, and possibly distorts the narrative account of another person’s experiences” (p. 31). Thus it is paramount that researchers understand their role as the primary research “instrument” in the research process. Lincoln and Guba, (2000) call for reflexivity – “the process of reflecting critically on the self as researcher” (p. 183), as a way of increasing authenticity. As I became more aware of myself in relation to my teacher participants, I attempted to “work the self-other hyphen” (Fine, 2000), and thus I was able to more effectively represent the novice elementary teachers in their full complexity.

Often, my own experiences from last year as a novice mathematics teacher helped me to understand and empathize with the teachers’ challenges, successes and frustrations. I was also distinctly aware of the power differential between researcher and participant and actively sought to not present myself as the expert who was analyzing the teachers’ beliefs and practices. Rather, together with each teacher, I hoped to facilitate the creation of an accurate and insightful portrayal of her perceptions of the issues that affect teachers’ efficacy to teach mathematics and her beliefs about how mathematics is known.

Ensuring Trustworthiness

In terms of qualitative interpretation trustworthiness, I maintained awareness of the concept of co-constructing a narrative with my participants. Through adopting a research as learner approach, I took into account the complex lives of my participants that
were “loaded with multiple interpretations and grounded in cultural complexity” (Christians, 2000, p. 145). I also conducted member checks with my observations and interviews, asking participants to give feedback on my interpretations of our interactions. Moreover, I recruited three doctoral-student readers to review each of the profiles so as ensure greater trustworthiness of my interpretations. Methodological triangulation through collecting a variety of forms of data also led to greater levels of trustworthiness.

**Timeline for the Conduct of the Qualitative Study**

While awaiting IRB approval for the qualitative portion of this study, the email addresses of teacher participants from the 2001 study were verified and updated. Recruitment emails were sent out in January 2003, as soon as IRB approval was obtained. By the third week in January, the 2001 mathematics teaching efficacy scores of those teachers who respond to the recruitment email were evaluated to identify one teacher with low mathematics teaching efficacy, one with moderate, and one with high mathematics teaching efficacy. These three individuals were contacted and interviews and observations were scheduled for February 2003.

The first individual with moderate mathematics teaching efficacy served as the pilot case. That teacher was interviewed and observed in early February. The interview was transcribed and an initial analysis served to adapt the interview protocol and observation procedures accordingly. After the interviews and observations were conducted with the additional two teachers by late March, an initial analysis was completed to identify any outstanding questions. Follow-up telephone interviews (which
were recorded) to clarify any outstanding questions with the two teachers were completed in May. Thorough data analysis was conducted during the spring and summer quarters of 2003.

Research Ethics

All participants were solicited as a result of informed consent. Prior to initiation of the study, all participants were asked to sign an informed consent form approved by the Institutional Review Board of The Ohio State University. Novice teachers who were selected for the qualitative portion of the study were first asked if they wished to participate in the interviews and observations via email. A second consent form was signed at the time of the first observation. There was no deception involved in this study. Moreover, every attempt was made to respect the privacy and confidentiality of the participants. All preservice teachers were assigned an identification number and individual information was kept confidential. Novice teacher’s names and any school identifiers were changed to ensure anonymity.
CHAPTER 4

DATA ANALYSIS

The purpose of this study was to investigate preservice and novice teachers’ epistemological beliefs about mathematics, their efficacy to teach mathematics, and the relationship between the two constructs. To achieve this purpose I first quantitatively examined the relationship between elementary preservice teachers’ mathematics teaching efficacy and epistemological beliefs about mathematics, and considered how these beliefs changed over time. Subsequently, I qualitatively explored three novice teachers’ mathematics epistemological beliefs and mathematics teaching efficacy through interviews and classroom observations. I also looked at the influence of teachers’ mathematics epistemological beliefs on their mathematics teaching efficacy. Furthermore, the qualitative portion of this research sought to clarify Tschannen-Moran, et al.’s (1998) integrated model of teacher efficacy by analyzing the factors impacting teachers’ cognitive processing and analysis of the teaching task and context. In this chapter I first present and analyze the quantitative data that were collected during the preservice teachers’ Master of Education program. Then the interpretations
derived from the qualitative data collected through observations and interviews with the purposefully selected participants one and a half years later are presented in the form of three teacher profiles.

Quantitative Analyses

To verify accuracy of the quantitative data, I used several strategies of data verification. For all but one sheet of background information, scantron sheets were used to record answers. Identification codes were added to response forms the days of each survey administration. The codes were checked for accuracy prior to submission of the scantrons for electronic reading and conversion into SPSS files. Following the reformatting and reverse coding required for analysis, the data were once again compared with the original response forms.

Preliminary Analyses

Prior to analyzing the data in relation to each question, analyses were completed to ensure that the data met the assumptions requisite for the various statistical procedures. Linearity, normality, independence of observations and homoscedasticity for each of the questions were checked for the regression analysis. Multivariate normality, independence of observations and homogeneity of variance-covariance matrices were inspected for the MANOVAs. The data conformed to these assumptions.

Furthermore, it was necessary to verify that there were no statistically significant group variations in the preservice teachers’ efficacy and epistemological beliefs based on the five M.Ed. program groups to which I administered the surveys. Thus a multivariate analysis of variance (MANOVA) was conducted with program groups as the between
subjects variable and teacher efficacy, mathematics teaching efficacy, mathematics epistemological beliefs, mathematics self-efficacy and mathematic performance as the within subjects variables. Using Wilks’ criterion, the results of this analysis revealed no statistically significant main effects for program groups ($F$s $\leq$ 1.258, $p$s $\geq$ .294). Thus the data were combined across groups. Descriptive statistics for preservice teachers’ overall teacher efficacy, mathematics teaching efficacy, mathematics epistemological beliefs, mathematics self-efficacy, and mathematics performance for each of the data collections appear in Table 4.1.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Time One M(SD)</th>
<th>Time Two M(SD)</th>
<th>Time Three M(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n M(SD)</td>
<td>n M(SD)</td>
<td>n M(SD)</td>
</tr>
<tr>
<td>Teacher Efficacy</td>
<td>3.20(0.55)</td>
<td>3.41(0.64)</td>
<td>2.98(0.40)</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>75</td>
<td>64</td>
</tr>
<tr>
<td>Mathematics Teaching Efficacy</td>
<td>3.39(0.52)</td>
<td>3.54(0.59)</td>
<td>3.70(0.53)</td>
</tr>
<tr>
<td></td>
<td>80</td>
<td>74</td>
<td>64</td>
</tr>
<tr>
<td>Mathematics Epistemological Beliefs</td>
<td>3.95(0.44)</td>
<td>3.75(0.55)</td>
<td>3.79(0.52)</td>
</tr>
<tr>
<td></td>
<td>79</td>
<td>74</td>
<td>64</td>
</tr>
<tr>
<td>Mathematics Self Efficacy</td>
<td>3.82(0.74)</td>
<td>-</td>
<td>3.99(0.81)</td>
</tr>
<tr>
<td></td>
<td>78</td>
<td>-</td>
<td>63</td>
</tr>
<tr>
<td>Mathematics Performance</td>
<td>12.15(3.54)</td>
<td>-</td>
<td>10.81(3.59)</td>
</tr>
<tr>
<td>(18 mathematics Problems)</td>
<td>78</td>
<td>-</td>
<td>48</td>
</tr>
</tbody>
</table>

Table 4.1. Descriptive Statistics
Mathematics self-efficacy and mathematics performance were not measured at the second data collection. All of the scores except mathematics performance are on a six-point scale with zero being the lowest score and five being highest. The mathematics performance score is out of 18 mathematics questions. The average percentage score was 67.5% for the first data collection and 60.1% for the third data collection. Only 48 of the 64 participants in the third data collection were willing to complete the final mathematics performance measure.

**Predicting Mathematics Teaching Efficacy**

The first research question addressed the relationship of teacher efficacy, mathematics self-efficacy, and mathematics content knowledge with mathematics teaching efficacy. Specifically, the purpose of this question was to determine to what extent the first three variables predict mathematics teaching efficacy. Thus, a linear regression was conducted with teacher efficacy, mathematics self-efficacy, and mathematics content knowledge as the independent variables and mathematics teaching efficacy as the dependent variable.

The analysis resulted in an $R^2$ value of .219, indicating that teacher efficacy, mathematics self-efficacy and mathematics content knowledge account for 22% of the variance in mathematics teaching efficacy. Furthermore, Table 4.2 illustrates that teacher efficacy with a standardized coefficient of .384 ($p \leq .001$) was the only significant predictor of mathematic teaching efficacy. Mathematics self-efficacy ($\beta=.219$, $p=.071$) and mathematics content knowledge ($\beta= -.049$, $p = .676$) were not significant predictors of mathematics teaching efficacy.
<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>β</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>(Constant)</td>
<td>1.732</td>
<td>.397</td>
<td>4.369</td>
<td>.000</td>
</tr>
<tr>
<td>Teacher efficacy</td>
<td>.360</td>
<td>.099</td>
<td>.384</td>
<td>.000</td>
</tr>
<tr>
<td>Math self-efficacy</td>
<td>.155</td>
<td>.084</td>
<td>.219</td>
<td>.071</td>
</tr>
<tr>
<td>Math knowledge</td>
<td>-.007</td>
<td>.017</td>
<td>-.049</td>
<td>.676</td>
</tr>
</tbody>
</table>

Table 4.2: MANOVA with mathematics teaching efficacy as the dependent variable

*Changes Over Time*

The second research question addressed the changes in preservice teachers’ overall teacher efficacy, mathematics teaching efficacy, mathematics epistemological beliefs, and mathematics self-efficacy over time. The first data collection was at the beginning of the third quarter of the M.Ed. program and prior to a middle school level mathematics methods course. The second data collection was following the mathematics methods course at the end of the third quarter of the program. The third data collection was at the end of the fourth quarter and following a student teaching experience.

To assess the changes over the three data collection times, a repeated measures MANOVA was conducted with time as the within subjects variable and teacher efficacy,
mathematics teaching efficacy, and mathematics epistemological beliefs as the dependent variables. An overall MANOVA was first found to be statistically significant ($F=13.822$, $p<.001$, partial eta squared=.260). Then a follow-up univariate analysis of variance was carried out. Both teacher efficacy ($F=11.217$, $p\leq.001$, partial eta squared=.158) and mathematics teaching efficacy ($F=13.575$, $p\leq.001$, partial eta squared=.185) had significant changes. However, no significant change in mathematical epistemological beliefs ($F=3.063$, $p=.052$, partial eta squared=.049) was observed. Table 4.3 presents the results of a Bonferroni posthoc analysis ($p<.05$) that revealed a significant ($p=.019$) increase in teacher efficacy from before to following the mathematics methods course and a significant ($p<.001$) decrease in teacher efficacy from before to following the student teacher experience.

<table>
<thead>
<tr>
<th>Measure</th>
<th>(I) TIME</th>
<th>(J) TIME</th>
<th>Mean Differences (I-J)</th>
<th>Std. Error</th>
<th>Sig.(a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher Efficacy</td>
<td>1</td>
<td>2</td>
<td>-.203*</td>
<td>.072</td>
<td>.019</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>.223</td>
<td>.094</td>
<td>.064</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>.203*</td>
<td>.072</td>
<td>.019</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>.426*</td>
<td>.103</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>-.223</td>
<td>.094</td>
<td>.064</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>-.426*</td>
<td>.103</td>
<td>.000</td>
</tr>
<tr>
<td>Mathematics Teaching Efficacy</td>
<td>1</td>
<td>2</td>
<td>-.184*</td>
<td>.072</td>
<td>.038</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>-.329*</td>
<td>.059</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>.184*</td>
<td>.072</td>
<td>.038</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>-.144</td>
<td>.063</td>
<td>.078</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>.329*</td>
<td>.059</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>.144</td>
<td>.063</td>
<td>.078</td>
</tr>
</tbody>
</table>

Table 4.3: Pairwise comparisons based on estimated marginal means
*The mean difference is significant at the .05 level.
The overall result was that there was no significant difference between the mean teacher efficacy score at the beginning and the end of the study. Furthermore, mathematics teaching efficacy had a significant ($p=.038$) increase from before to following the mathematics methods course. However, there was no significant change in mathematics teaching efficacy from before to following the student teaching experience. The overall change in mathematics teaching efficacy from the beginning to the end of the study was significant ($p<.001$). Figure 4.1 illustrates the means of teacher efficacy and mathematics teaching efficacy across the three data collection times. Mathematics self-efficacy was measured only at the first and third data collections, so a paired samples t test was conducted. The t test indicated a significant ($p=.023$) difference in mathematics self-efficacy between the first ($M=3.78$) and third ($M=4.01$) data collections.

Figure 4.1: Means of teacher efficacy and mathematics teaching efficacy by time
Effect of Mathematics Epistemological Beliefs

The third research question concerned the effect of mathematical epistemological beliefs (as measured in data collection 1) on the change in mathematics self-efficacy and mathematics teaching efficacy from the beginning to the end of the study. To first explore the relationships of mathematics epistemological beliefs to mathematics self efficacy and mathematics teaching efficacy, Pearson correlation analyses were conducted. The relationship of mathematics epistemological beliefs to mathematics self-efficacy was significant at the 0.05 level (2-tailed), but of relatively weak magnitude ($r=.277$). The relationship of mathematics epistemological beliefs to mathematics teaching efficacy was significant at the 0.01 level (2-tailed) and of moderate magnitude ($r=.666$).

Participants were divided into three groups based on their mathematics epistemological beliefs. The students’ composite mathematics epistemological beliefs scores were equally distributed, thus 21 students were placed into the low level of sophistication (1) group, 20 into the moderate level of sophistication (2), and 21 into the high level of sophistication (3) group. The three levels of epistemological beliefs were used as the between subjects factors in a repeated measures MANOVA with mathematics self-efficacy and mathematics teaching efficacy as the dependent variables that correspond to each combination of the within-subjects factor of time (time 1 is the first data collection; time 3 is the third data collection) (See Table 4.4).

Using Wilks’ criterion, the multivariate test revealed that there was a significant effect of mathematics epistemological belief level ($F=6.386, p<.0001$) and time ($F=17.537, p<.0001$) on at least one of the dependent variables. Furthermore, there was
no interaction between time and mathematics epistemological belief levels ($F=1.518$, $p=.202$). The within-subjects analyses (using Greenhouse-Geisser criterion) found that time had a significant effect on both mathematics self efficacy ($F=5.672, p=.020$) and mathematics teaching efficacy ($F=35.385, p<.0001$).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Epistemological Belief Level</th>
<th>Time 1 M(SD)</th>
<th>Time 3 M(SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>n</td>
</tr>
<tr>
<td>Mathematics Self-Efficacy</td>
<td>1 - Low Sophistication</td>
<td>3.66(.58)</td>
<td>3.74(.75)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>2 – Moderate Sophistication</td>
<td>3.75(.94)</td>
<td>4.19(.78)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3 – High Sophistication</td>
<td>3.93(.76)</td>
<td>4.10(.81)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>3.78(.77)</td>
<td>4.01(.79)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>62</td>
<td>62</td>
</tr>
<tr>
<td>Mathematics Teaching Efficacy</td>
<td>1 - Low Sophistication</td>
<td>2.99(.40)</td>
<td>3.44(.47)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>2 – Moderate Sophistication</td>
<td>3.45(.41)</td>
<td>3.70(.50)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>3 – High Sophistication</td>
<td>3.66(.35)</td>
<td>3.99(.47)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>All</td>
<td>3.37</td>
<td>3.71(.53)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>62</td>
<td>62</td>
</tr>
</tbody>
</table>

Table 4.4: Descriptive statistics for epistemological belief level on mathematics self-efficacy and mathematics teaching efficacy by time.
The between-subjects analyses indicate that mathematics epistemological beliefs levels had a significant effect on mathematics teaching efficacy ($F=14.236, p<.0001$, partial eta squared$=.326$). However, there was no significant effect of mathematics epistemological belief level on mathematics self efficacy ($F=1.400, p=.255$, partial eta squared$=.045$). The Tukey HSD post-hoc analysis revealed significant differences in mathematics teaching efficacy between epistemological belief levels 1 (low sophistication) and 2 (moderate sophistication) ($p=.008$) and between 1 (low sophistication) and 3 (high sophistication) ($p<.001$), however the difference in mathematics teaching efficacy between level 2 (moderate sophistication) and 3 (high sophistication) were not significant (Table 4.5). Yet when a follow-up ANOVA was run with Mathematics Epistemological Beliefs Level as the independent variable and change in mathematics teaching efficacy as the dependent variable, the results were not significant ($F=1.459; p=.240$). Thus, level of sophistication of mathematics epistemological beliefs did not significantly influence change in mathematics teaching efficacy from the beginning to the end of this study.
<table>
<thead>
<tr>
<th>Measure</th>
<th>(I) Math Epistemological Beliefs Level</th>
<th>(J) Math Epistemological Beliefs Level</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>MTE</td>
<td>1</td>
<td>2</td>
<td>-.3608*</td>
<td>.11656</td>
<td>.008</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>-.6111*</td>
<td>.11513</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>.3608*</td>
<td>.11656</td>
<td>.008</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2</td>
<td>-.2503</td>
<td>.11656</td>
<td>.089</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>.6111*</td>
<td>.11513</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>.2503</td>
<td>.11656</td>
<td>.089</td>
</tr>
<tr>
<td>MSE</td>
<td>1</td>
<td>2</td>
<td>-.2751</td>
<td>.20974</td>
<td>.394</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>-.3214</td>
<td>.20716</td>
<td>.275</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>.2751</td>
<td>.20974</td>
<td>.394</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>2</td>
<td>-.0463</td>
<td>.20974</td>
<td>.974</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>1</td>
<td>.3214</td>
<td>.20716</td>
<td>.275</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>.0463</td>
<td>.20974</td>
<td>.974</td>
</tr>
</tbody>
</table>

Table 4.5: Mean comparisons of difference in mathematics teaching efficacy and mathematics self-efficacy by level of epistemological beliefs.
* The mean difference is significant at the .05 level.

Qualitative Analyses

Introduction to Teacher Profiles

Tschannen-Moran and Woolfolk Hoy (2001) explain that as teachers analyze the teaching task and its context, they weigh the relative importance of factors that make teaching difficult or act as constraints against an assessment of the resources available that facilitate learning. Moreover, these researchers reason that as teachers make judgments about efficacy, they “must assess what will be required of them in the
anticipated teaching situation. This analysis produces inferences about the difficulty of the task and what it would take for a person to be successful in this context” (p. 228).

Thus, as I developed profiles of the three teachers, I first considered the context in which they taught. I have conceptualized teaching context to include not only the environment of the school and support of administration and other teachers, but also the characteristics of a teacher’s students, including their behavior and academic achievement. It is much more challenging to teach mathematics to children with a plethora of behavioral and academic difficulties than to those with positive behavior and high academic performance. All of these contextual factors can vary greatly thereby impacting efficacy, both within and among schools.

Furthermore, the beliefs that teachers hold about the nature of mathematics and how it is known also shape the parameters in which teachers teach mathematics. In other words, teachers’ epistemological beliefs about mathematics are part of the context in which they teach mathematics. Thus, the three teachers’ epistemological beliefs are considered prior to their analysis of the teaching task. The six dimensions of mathematics epistemological beliefs identified in the literature review – structure of knowledge, form of knowing stability of knowledge, ability to learn, speed of learning, and source of knowledge - are used as a framework to analyze each teacher’s epistemological beliefs about mathematics.

Whereas the teachers’ scores on the DSBQ provided quantifiable measures of low to high sophistication of mathematics epistemological beliefs, the dimensions of epistemological beliefs provide a structure through which a more descriptive
understanding of the three participants’ epistemological beliefs are accessed. Each
dimension has a continuum of beliefs, ranging from those which have been termed in the
literature as lower levels, naïve, immature or less sophisticated to higher levels, mature,
or more sophisticated beliefs. Quotes from interviews and classroom observations serve
as illustrations to develop a thick description of each teacher’s epistemological beliefs. In
this chapter as I present the qualitative data, I attempt to allow the teachers’ voices speak
for themselves. However, I do include some evaluative interpretations of each teacher’s
level of epistemological beliefs as deduced from the interview and observational data.

After teaching context and epistemological beliefs are considered, I then present
findings on each teacher’s mathematics teaching efficacy beliefs as she considers the
tasks involved in teaching mathematics. Consistent with Tschannen-Moran and Woolfolk
Hoy’s (2001) factor analyses of their Teacher Sense of Efficacy Scale (TSES), analysis of
the findings from the existing qualitative studies on teacher self-efficacy has revealed
three distinct aspects of the teaching task that impact self-efficacy. These are student
engagement, management issues, and instructional strategies.

Additionally, in Tschannen-Moran and Woolfolk Hoy’s cyclical model, as
teachers consider these three aspects of the teaching task, they also make assessments of
self-perceptions of their teaching competence. Thus teachers judge their personal
capabilities (e.g., skills, knowledge, strategies, or personality traits) compared to their
personal weaknesses or liabilities within a particular teaching context. Thus, assessment
of teaching competence is seen as part of, but not the whole of, teacher efficacy.
Judgments of teacher sense of efficacy or their predictions of future capability, involve both the analysis of a particular teaching context and task, as well as an individual’s assessment of teaching competence.

Rather than separating out analysis of task and assessment of competence in a disjointed manner, I will consider them together, in an integrated fashion that is more consistent with the cognitive processing that occurs in self-efficacy evaluations. As the factors that impact analysis of the different teaching tasks are presented, I attempt to also integrate direct expressions of the teacher’s assessment of her teaching competence for that particular task. Moreover, observational data is also presented because it discloses the teacher’s current competency for the task, thereby revealing the important distinction between teachers’ espoused and enacted efficacy beliefs.

As I present each teacher’s efficacy data, I consider the questions from the Teacher Sense of Efficacy Scale (TSES) (Tschannen-Moran & Woolfolk Hoy, 2001) to explore what impacts teacher’s efficacy for student engagement, classroom management, and use of appropriate instructional strategies. Thus, in the section on efficacy for student engagement, beliefs about abilities to accomplish the four student engagement teaching tasks that are identified in the TSES are explored. These include (1) getting students to believe they can do well in mathematics, (2) helping students value learning mathematics, (3) motivating students who show low interest in mathematics and (4) assisting families in helping their children do well in mathematics. In the section on efficacy for classroom management, beliefs about abilities to accomplish the four classroom management teaching tasks that are identified in the TSES are considered. These include (1)
controlling disruptive behavior, (2) getting children to follow classroom rules, (3) calming a student who is disruptive or noisy, and (4) establishing a classroom management system. And finally in the section on efficacy for instructional strategies, the four instructional strategies teaching tasks that are identified in the TSES are examined. These include (1) using a variety of assessment strategies, (2) providing an alternative explanation or example when students are confused, (3) crafting good questions, and (4) implementing alternative strategies. If a particular task was not discussed in the interviews or observed in the classroom interactions, it is simply eliminated from the profile.

With each of the three teachers, I further analyzed the qualitative data to identify themes related to the teaching task that were not considered in the TSES. As Tschannen-Moran and Woolfolk Hoy (2001) claim, “greater specification is needed to understand what information is drawn from the teaching task, the context, and an assessment of personal teaching competence to form self-efficacy” (p. 239). Through the following three teacher profiles I seek to elucidate our understanding of novice teachers’ mathematics epistemological beliefs and refine our conceptions of what impacts their mathematics teaching efficacy. I also begin to answer my third research question concerning the relationship between these two constructs. I briefly present data that most vividly illustrate how each teacher’s epistemological and efficacy beliefs about mathematics are related. This relationship is also considered in greater depth in Chapter 5.
Marie, a fifth grade teacher in an urban public school, was the first volunteer in the qualitative portion of this research and served as the pilot case. Following her student teaching experience in 2001, Marie self-reported a moderate level (scored in the middle third) of mathematics teaching efficacy on the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) as compared to the other 60 participants in the study. The second profile is that of Donna, a third grade teacher in a rural parochial school. Donna had scored in the highest third on the MTEBI as compared to the other M.Ed. students. The final profile is that of Connie, a third grade teacher in an urban public school. Connie scored in the lowest third on the MTEBI. In each profile I provide some evaluative analysis of the teacher’s epistemological and efficacy beliefs, however, more in-depth and comparative analysis will be presented in Chapter 5.

Marie: “Welcome to My World”

Mathematics Teaching Efficacy: Analysis of The Teaching Context

As part of the process of making efficacy judgments about their abilities to teach mathematics, teachers analyze the context in which they work. In this section I describe Marie’s school and classroom environment, her students’ behavior and their academic performance. For each of these aspects of the mathematics teaching context I present Marie’s belief statements that reveal her efficacy for teaching mathematics within this context.

School and Classroom Environment

Marie is a White teacher at a small public city school that serves about 190 pre-school through fifth graders. About 95% of the students are African American and the
entire student population participates in a free lunch program. Marie is a middle-aged mother of five; she did not enter the work world after obtaining her bachelor’s degree in accounting, but rather stayed home to raise her children. She later was a kindergarten aide for three years and then taught preschool during the six years prior to enrolling in the M.Ed. program. Last year, Marie was a second grade teacher at the same school; this year she has a combined class of fourth and fifth graders.

The elementary school is old, but appears well kept. Marie’s classroom is on the second floor. The individual desks are in three rows facing the main chalkboard to the right. Three computer stations are on the left and Marie’s desk is in the corner at the rear of the classroom. Many posters, maps and a calendar cover the walls. However, the first thing I noticed was the level of noise because there were tile floors throughout the building and no doors on the classrooms.

Each morning Marie teaches social studies and science to her 22 fourth and fifth graders. Fourteen of her students who require special education go to the resource room for mathematics and reading. So in the afternoons, Marie teaches mathematics to just the eight fifth graders; half are African American girls, and the remaining four consist of two White and two African American boys. Of these eight students, one girl and one boy are also on individualized education plans (IEPs), but are not in the resource room due to lack of space. Marie’s eight mathematics students are the lowest performing fifth graders in the school.
Marie describes her principal (a White female) and other teachers (primarily White females) as “wonderful” and “very supportive.” She mentioned their Friday after school social outings twice in our conversations.

Everyone is really helpful because you know my situation is probably the worst, but everyone else is experiencing similar problems… It’s a small school, so there is a real good camaraderie among the staff. People get along pretty well. I really like the staff.

When asked about having such a difficult class this year, Marie said, “I think that they (the administration) think I can handle it!”

As there is a district-wide mandated curriculum for each core subject, Marie is not given much freedom to select curriculum, but she remarked, “I don’t have time for freedom either. I am expected to teach what is in the [district’s] curriculum guide on the time levels they expect me to teach it on, and that is what I do.” However, Marie desires to improve her teaching skills and actively participates in the in-services and graduate education course provided at her school.

**Student Behavior**

Marie stated her students’ behavior is “really really not good” and admits, “I’m struggling with behavior.” When Marie mentioned she had two “humdinger” girls, I asked if they were real talkers. She responded,

No, it goes beyond talking. You know, back talkers. These kids [referring to all her students] are not real nice to each other, and they’re not nice to me… and they don’t have a lot of self-control and very little impulse control. So if you tell them to do something and it is not something they want to do right now, you get the foot stomping and the eye-rolling and all that kind of stuff.

Marie explained that her students come from tough family backgrounds and “lots of times they’ve got other problems, and those problems take priority.” Marie relayed how
during the morning of our first pre-observation interview, one of her fourth graders who was in the resource room was “going berserk and out of control,” and Marie had to assist the teacher as she put the child into a basket hold in the hallway. That same day, another female student simply refused to sit down and was thus sent to PEAK (detention room). Then one of her boys who had started a fight in the restroom and was suspended the week before got into an argument with another male classmate. He told Marie, “I am going to hit him, you better get him away from me or I am going to hit him. I have gotta go to PEAK or I am going to hit him.” Marie’s analysis of the occurrences: “And that’s daily. You never know who is getting along with whom and who isn’t. It’s just a zoo.”

A week later Marie also shared:

I was talking to another teacher in the coatroom there [inside her classroom] and the minute they saw me out of sight, one girl got up and was running on top of the desks.
Researcher: Oh my goodness!

Marie: That’s what I thought. Oh my goodness. How old are you? You know. Can you believe it? I turn around and walk back into the classroom and there she is running across the tops of the desks. You know it’s really discouraging to try to expect them to learn and try to teach them when they are doing stupid stuff like that.

Almost daily, Marie appeared to encounter frustrating behavior problems with her students.
Marie repeatedly expressed her frustration over her students’ lack of basic skills.

It just drives me nuts that they managed to get to fifth grade and not know their times tables…to be that far behind in their math facts…they don’t know their addition facts. They don’t know their subtraction facts without counting on their fingers! They’re not in their head. So that’s something I’ve been pushing really, really hard for because of course you can’t teach them how to find the average if they don’t know basic math facts—to multiply and divide. So when I got in there and found out they couldn’t do this, I was like, “O my gosh!”

During my two observations of Marie teaching on story problems and creating equations to describe a given problem, all of students appeared to be struggling with the level of difficulty of the mathematics content.

In fact, Marie’s students are reading on a third-grade level or lower; the two on IEPs have the best reading fluency, although “their comprehension is terrible.” As for mathematics, all of her fifth graders are performing on a third grade or lower level, and yet Marie points out that she is required to teach a fifth grade curriculum.

One of the things I’m up against is especially on directions or any kind of word problems. They can read the words, but they don’t understand what to do or how to do it - most of your basic math skills.

In summary, the context in which Marie teaches is very challenging. Although she works with a principal and colleagues whom she has experienced as very supportive, she is struggling with her students’ behavior and level of academic performance. Marie’s analysis of her teaching context in regards to her students’ behavior and academic performance is candidly captured in her statement: “Sometimes they are idiots in the
morning and sometimes they are idiots in the afternoon. They are not operating at a normal fifth grade level. That’s for sure. On any level, reading, math, maturity - any of those levels.”

Epistemological Beliefs

Structure of Knowledge

A teacher’s epistemological beliefs about structure of knowledge can be described on a continuum from understanding knowledge as isolated bits and pieces of information to comprehending knowledge as complex interrelated networks of concepts. Although Marie’s beliefs likely span this continuum, a pattern of beliefs emerged from our conversations that indicated a limited and disjointed understanding of mathematics. On several occasions, Marie expressed frustration over a disconnect between the activities suggested in the district’s curriculum guide and the types of knowledge her students were required to demonstrate on her district’s target teach tests.

I think the activities in the curriculum guide are very good, and very valid, but … this year I didn’t feel that they always translated into something mathematical. There’s lots and lots of hands-on type things in there. Sometimes they don’t translate very well. There’s not a whole lot of calculation and things going on and they don’t get the connection between the hands on activity that they’re doing and the math that’s behind it. So they just think they’re just doing this fun activity. And they don’t make the transfer between that and, “Oh this is why we’re doing it.”

Marie does not appear to recognize that how an instructor structures an activity influences whether students make the connection to the conceptual understanding. Beyond the issue of epistemological beliefs, and similar to the low efficacy teachers in Guskey (1981) and Ashton and Webb’s (1986) studies, Marie does not take responsibility for her students’ outcomes.
Marie explained further,

> You have to actually do it on the paper; you have to put the manipulatives aside. [Last year] we were just working with the manipulatives and it was not transferring over into… OK, here’s how you borrow the one and cross this number out and go over here and make it a 10, you know, and that becomes this. At some point, you *have to teach the skill and not worry about why you’re doing it*. At least that’s what I think.

It is evident that Marie believes the hands-on activities are not an integral part of mathematics, which according to her definition, apparently must involve some form of computation. In our last interview I asked Marie about the extent to which her students understood her explanation of a problem involving fractions. Her response revealed her epistemological beliefs about the disjointed structure of mathematics knowledge: “It is difficult for them. The fractions themselves are not particularly the problem. It is the math.”

*Form of Knowing*

The proposed epistemological belief dimension termed form of knowing is characterized by a continuum of beliefs that range from an emphasis on procedural and computational ways of knowing mathematics to a more sophisticated conceptual understanding of mathematics that involves creativity, argumentation, and justification in problem solving. It appears that Marie recognizes the importance of the inquiry process of mathematics problem solving as she explains how one “group was going to work on figuring out an equation. And really, you want that because they can kick around ideas and you know, what about this, what about that and stuff.”
Yet as Marie further described one student’s process of developing an equation for a story problem, it became evident that her primary form of knowing in mathematics was procedural. Although the following dialogue between Marie and two students is lengthy, it vividly illustrates Marie’s beliefs.

They’re trying to figure out an equation for this problem and right away Justin knew it was seven. I said ok, you have to come up with an equation for it. “Well, three times seven is 21.” I said no. No, no, seven is at the end. So I wrote “= 7.” So you have to figure out how to get to that 7. So they’re going 11 +, first they started out 3+4. No, you have to work with these numbers in here [points to the problem on the sheet]. 3 and 21. So then they say 11+ something = 21 [students voice]. No [her voice], it has to come out to 7. Once again I say, you have to work with these numbers: 3 and 21. Those are the only 2 numbers you can work with. What are you going to do? And he said, “Multiply!” I said no, what is the opposite of multiply? “Subtract.” No. Subtract is the opposite of add. And then he finally guessed divide. Yea, divide. So it took all of that to get two boys to come up with 21 divided by 3 will equal seven. Even though they knew the answer the minute they looked at it.

When asked how she dealt with students’ novel solutions to problems, Marie responded,

“I let them solve it any way they want if that’s what we’re trying for, but in THIS particular case, they had to write, the outcome of the lesson was to write an equation, so he had to write that equation, and I couldn’t let him use the seven the way he wanted to use it. The only numbers given in the problem were three and 21. So he had to come up with a way to get to that seven. And that’s where the math thinking took place. He came up with the answer real quick because he could visualize that there were three groups, but he had to turn that into an equation.

For Marie, there was one right way to do this problem, regardless of the students’ conceptual understanding. She required them to write the equation in a particular form, apparently unaware that the solution the student devised was equivalent to her answer.

Although Marie tried to encourage her students to ask questions when they did not understand, in my two classroom observations, they asked very few conceptual understanding questions. At one point when all the students were struggling to
understand how to set up the equation for a word problem, one boy asked a question that Marie did not understand clearly. As she turned to write on the board Marie asked the boy, “What do you need to know? What are you unsure of? Go ahead tell me; someone else might have the same problem.” In response, he made a disrespectful gesture to Marie’s turned back. Even though Marie verbally encouraged comprehension questions, her underlying belief may have a greater impact on her students: “My kids want to ask why all the time, but you don’t have to know why. Learn how and then you can start figuring out why. Skills first right now, and the how will follow.”

Stability of Knowledge

Although there were no clear references to the stability of mathematic knowledge in my discussions with Marie and observations in her classroom, the emphasis on following set rules in her approach to mathematics teaching could be indicative of her belief that mathematics is unchanging. Marie referred to the idea of “math facts” twelve times in our discussions and in classroom observations, indicating that she tends to perceive mathematics as a certain or standard body of knowledge consisting of facts and procedures that teachers must get students to master.

Ability to Learn

It is evident that Marie struggles with equating her students’ present functioning level on certain tasks with their capacity to learn. Following my second observation, Marie assessed the mathematics lesson, revealing both epistemological and efficacy beliefs.
People who I expected to get something out of it, did and the others may at some time. So you know, there was mathematical thinking going on by some and others were lost. I just can’t do it all. There are some things that you got to let go of. They are just not developmentally ready.

Marie explained, “you’ve got a bell curve.” Some students are going to be at the low end, many will be in the middle, and some will be at the high end, “no matter what you are doing.” She concluded, “you just keep plugging along and trying to bring them all over to that side.”

It appears that Marie would like to believe in an incremental view of intelligence, however her exasperating experiences of teaching mathematics to her current students have apparently contributed to or have codified a more fixed view of ability to acquire knowledge. This belief is especially evident for students who have been labeled with an IEP. “The kids are not able to think through the activities they have given me to do with them. They have trouble with the application end of the math. And that might just be my kids and their particular level that they are at – their reasoning levels.” Once again consistent with prior observations of low efficacy teachers (Ashton & Webb, 1986), Marie does not take responsibility for being the facilitator who can make mathematics accessible to her students.

**Speed of Knowledge Acquisition**

Marie’s strong belief about the importance of her fifth grade students knowing their mathematics facts is accompanied by her belief that they need to know them quickly. She explained that over the past several months her students have learned “things like 9x9 is 81, and they’ll tell you that right off the top of their head…I want ’em fast, I don’t want ’em just known, but I want ’em on the tip of their tongue.” To attain
this speed of fact recall, Marie expects her students to practice mathematics facts
flashcards fro homework each night and gives them timed multiplication and subtraction
mathematics fact tests.

Moreover, Marie believes that when her students can master the facts on the three
minute tests, “it gives them self-confidence to know they can do this. They think this is
math, and they think ‘Oh I can do that, then I can do this other stuff.’” However, she only
“had two kids who passed all 100 on their multiplication in three minutes.” Although it
is helpful for her students’ to have automatized recall of mathematics facts, Marie’s
repeated emphasis on quick recall fortified a low sophistication in the epistemological
dimension of speed of knowledge acquisition.

In her own theoretical understanding, Marie is able to differentiate between speed
and understanding. “The actual answer of 30 dollars doesn’t really matter because what
we are looking for is how to do the problem. I could take my calculator and figure this
out real quick. The hard part is what those words say and how I am going to work
things.” Even so, Marie sometimes unintentionally reinforces the importance of speed in
problem solving by giving her students limited time to work on problems in class. “Let’s
do the last one here [a rather complicated word problem]. I am going to give you a few
minutes to work on this.” Whether or not this statement was a management strategy said
merely to get her students focused on the task at hand, it communicates a less
sophisticated level of epistemological beliefs about the speed of learning.
Source of Knowledge

As was evident in the teacher efficacy portion of this profile, Marie is greatly dependent on the district’s mandated curriculum guide. Lampert (1990) suggests that teachers who heavily rely on the textbook model a dependence on an outside source for their mathematics knowledge. Yet, Marie did recognize the limitations of merely using the book as her source of knowledge.

I was working out of the book and I thought that would help, but I don’t think the book helped all that much because it was too much of me guiding them, you know, ‘ok, let’s do this one together.’ I don’t think they ever caught onto what was behind it.

She was aware that simply guiding or telling the students what to do was not effective.

Marie’s beliefs about her students’ inability to learn mathematics on their own, however, has fed her belief that a teacher’s role is to show students how to do mathematics. “You just have to kind of hold their hand. ‘Let’s try this one together; let’s try this one together; let’s try this one together,’ and they really can’t go off on their own and do it themselves.” These two contradictory statements appear to indicate that Marie is aware of more sophisticated epistemological beliefs about the source of knowledge acquisition, but is unable to incorporate those beliefs in her practice.

Because Marie’s own mathematics learning experiences included going to professors and asking how and why to solve problems, it is not surprising that Marie unwittingly set herself up as the mathematics expert, fostering student dependence upon her as the source of knowledge. For example, Marie shared, “I enjoy teaching math, and I like to get the manipulatives out and show them how to do that.” Further, “sometimes it takes a lot of modeling before they’re even able to try it on their own. And then I have
them do as much as they can on their own.” It appears that her expressed desire to develop autonomy in her students is overshadowed by her enacted belief in the teacher as the validator of student solutions. When a boy was unable to explain how he had arrived at an answer, Marie explained the problem to him. As she did so, he asked, “What do you mean by that?” Instead of helping the student explain his own answer, Marie’s response was, “You have to show the steps. Sit down. Watch.”

She proceeded to write the solution on the board. After writing the solution to the next problem her students were struggling with up on the board, Marie said, “Write this out so I know that you know how to do it. Show me you know how to do it.” Marie’s instructions not only illustrate how teachers reinforce the belief that they are the source of knowledge in the classroom but also reveal what she believes “knowing how to do” a problem really means.

Mathematics Teaching Efficacy: Analysis of the Teaching Task

As teachers analyze the mathematics teaching task, they consider their abilities to effectively accomplish three primary teaching responsibilities: student engagement, classroom management and instructional strategies. Each of these major facets of teaching mathematics is comprised of more specific tasks that uniquely impact a teacher’s mathematics teaching efficacy. Marie’s judgment of her efficacy to teach mathematics is discussed in terms of her analysis of these various tasks.

Efficacy for Student Engagement

Marie expressed a low level of efficacy for student engagement through her beliefs about her abilities to accomplish the four student engagement teaching tasks that
are identified in the TSES: get students to believe they can do well in mathematics, help
students value learning mathematics, motivate students who show low interest in
mathematics and assist families in helping their children do well in mathematics.

In my first observation Marie had to send one of her students to PEAK for not
cooperating. She then attempted to help two girls figure out a story problem using
manipulatives But when one of them dumped her pennies on the other’s nicely organized
rows, Marie angrily said, “That’s it! We’re done! If you can’t get along in a group we are
just going to do paper work.” Marie then had the class read a problem out loud together,
but most of the students were distracted and not following along. Marie appeared
frustrated by the lack of student engagement. “I am not going to do this.” Quenetta asked,
“What did we do?” Marie replied, “There is no point. The level of cooperation is
nonexistent, and the problems are too hard. You were not paying any attention at all.” As
we began the post-observation interview, Marie simply said, “Welcome to my world.”
She then analyzed the lesson.

I started with the problems from the curriculum guide, but they weren’t getting
them, so I brought out the pennies, but then the girls got into a fight. They just
were not understanding it and so they fought. [There had been a verbal fight
earlier in the class, but as they were working on the penny and nickel problem, the
girls were not fighting. It seemed that Marie had simply had her limit of typical
fifth grade behavior.] So then I went to the text book, but the problems in there
were so difficult we had to stop. So then I tried doing one problem with the whole
group… So I just plug along. I had to do something to get them in their seats.

As with Woolfolk and Hoy’s (1990) low efficacy teachers, authoritarian control has
become essential for Marie.

Due to her frustration with the low performance of her students, Marie often
expresses low efficacy for helping students to believe they can do well in mathematics,
possibly because she sometimes does not believe they can. Marie sadly said of her entire class, “They weren’t capable of doing the work, so they couldn’t do it…I just have to do one problem at a time or they can’t figure it out.” Referring to one female student who is currently on an IEP, Marie blatantly exclaimed, “When math time comes along, she can’t really do it. I mean she just CAN’T do it!” Moreover, due to her students’ poor writing skills, Marie also expressed low efficacy for fostering student creativity in her mathematics teaching. “Getting them to write about their math, [sigh] is probably pretty difficult because they can’t write very well anyway.”

Further, Marie addressed her beliefs about motivating students who show low interest in mathematics by repeatedly communicating that her students’ lack of patience and apparent related disinterest to do mathematics was often a constraint in her classroom. “So, possibly, I might have done more with them one on one to begin with, but they weren’t really in a mood to listen.” On two other occasions in our conversations, Marie mentioned she was so frustrated by students’ disinterest and related misbehavior that she had simply stopped mathematics lessons.

Finally, Marie’s efficacy for assisting families in helping their children do well in mathematics was demonstrated by her attempt to involve parents through the reward system she has established.

I send home a behavior report everyday and they get “paid” if they bring that back signed. And if they don’t bring it back, they owe me five dollars. So I am in contact or potential contact with the parents on a daily basis.

Unfortunately, Marie expressed her low efficacy regarding students’ poor academic performance and behavior as she stated, “Actually, they are reflecting their
parents, and *there is not a whole lot that you can do about that.*” When I asked her if she
guessed she has been able to impact her students’ lives, Marie’s response was,

> They’re learning and that’s what I am here for - to teach them, but they bring a lot
> of problems with them from home. *I can’t solve those problems.* So I just have to
deal with them as they come up.

Thus, as Marie analyzes each of the teaching tasks involved in student engagement, her
mathematics teaching efficacy is negatively impacted.

**Efficacy for Classroom Management**

Marie expressed a very low level of efficacy for classroom management through
her beliefs about her abilities to accomplish the four classroom management teaching
tasks that are identified in the TSES: control disruptive behavior, get children to follow
classroom rules, calm a student who is disruptive or noisy, and establish a classroom
management system. From the beginning of our conversations, Marie honestly admitted,

> “I’m struggling with behavior…It’s been very hard.” Marie’s candid comments reveal
> that she has encountered many challenges to being able to successfully accomplish the
> task of classroom management, thus forming her low self-efficacy in controlling
> disruptive behavior.

> For all the time and energy and money that I invested for this, it is not worth it. I
> can take bad attitudes, acting out, etcetera, but it is hard when they defiantly talk
> back to you. These kids just are not nice.

When I asked Marie if she had considered another context in which to teach, she
resignedly explained that she has a three year contract with this building. I also attempted
to raise the issue of cultural differences in communication. However, Marie’s response focused on her students’ lack of self control. She appeared unaware of the effects of cultural mismatch.

In both observations of Marie teaching mathematics, students were talking back to her and being disrespectful to one another. She repeatedly had to tell students to stop talking and to get on task. It seems that Marie tries to interpret her inability to control the extremely disruptive behavior humorously so that she is not overwhelmed by it.

I had a fight this morning at nine, and they were alright the rest of the morning. And then they went berserk in the afternoon. I had one girl punching a boy being mouthy. (laughing) It is a very very very challenging class and they are way behind and you can see why. And being so far behind makes the behavior worse, and sometimes the behavior causes them to be so far behind.

Her behavior management class has helped Marie to realize that her efficacy to get children to follow classroom rules needs improvement.

I have not done a very good job of teaching them how to get in and out of groups. So that may have been part of the group problem this morning. I am working on that…Especially last year, my first year, I did not know what I was doing, but I am getting better…I have to teach them specifically how to I want them to behave.

As a result of a bathroom fight that one of her students recently instigated, her fifth grade students are not allowed to go to the bathroom unescorted. So Marie has to take all eight of them at once and utilizes skills she is learning in her behavior management class.

I was teaching them how to line up and go down stairs in a line…So I was very specific about the directions I wanted them to do in going down. You have to constantly reinforce that and it has been a lot better.

On several occasions, however, Marie disclosed that things would get so out of control in her classroom that her only viable option was to totally stop the lesson.
We got started on [the math lesson]. Like I said, a fight ensued in the middle of it and I had to break that group up and we had to stop. And then one of the girls was starting to cuss and they were all complaining about it. So this was about 12:20 or so [almost time for lunch], and I said come on everybody sit down. So we just kind of stopped.

In my first observation of Marie’s fifth grade mathematics class, I noticed an example of Marie’s level of efficacy in calming a student who is disruptive or noisy. Two girls who were supposed to be working on word problems started making nasty statements about the other’s family. Unaware of the conversation’s content, Marie directed one of the girls to “move so you two are not confusing each other.” A verbal battle ensued between the girl and Marie. The girls mocked Marie’s commands, “Don’t get smart with me…don’t get smart with me…” After a preliminary warning, Marie told them, “You have lost all of your money and have a lunch detention.” The girls acted like they didn’t care and continued to argue. As a result, Marie sent one of the girls to PEAK. The disrespectful disruptions did not cease, however, and Marie eventually stopped teaching and made the whole class sit quietly.

Finally, Marie maintains a behavioral reinforcement system whereby she rewards good behavior and completed homework by adding dollars to a student “bank” chart each day. Those who are disruptive or do not do their seat work have money deducted. Then each Friday those with money are able to “buy” candy and small toys from Marie’s “store” during a half hour of free time before lunch. Those students who do not have any money sit and do mathematics problems while students with money play games on the computer. In addition to classroom management benefits, Marie likes the system because
it teaches consumer skills. Even so, as Marie analyzes the teaching tasks involved in classroom management her mathematics teaching efficacy is negatively impacted.

*Efficacy for Instructional Strategies*

Marie also expressed a low level of efficacy for instructional strategies through her beliefs about her abilities to accomplish three of the four instructional strategies teaching tasks that are identified in the TSES: use a variety of assessment strategies, provide an alternative explanation or example when students are confused, and implement alternative strategies. Marie did not discuss her ability to craft good questions. Two additional factors appeared to impact her efficacy for instructional strategies: Marie’s mathematics content knowledge and management of instructional time.

Marie’s efficacy for instructional strategies was greatly impacted by her low performing students. She said, “I don’t think I lack confidence at all. I keep trying things until something works. They just have no problem solving skills.” Marie’s efficacy for using a variety of assessment strategies was revealed in three different interviews without my inquiring about specifics of assessment. Each time, Marie described the same story of her most effective way to assess her students in mathematics. In our second post-observation interview she explained

> I was working out of the textbook and they just bombed the target teach test – they did terrible. So this quarter I have gone back to the curriculum guide and I have been doing what’s in the curriculum guide. I am going over these problems, we’ll review, I’ll give them a test…I just changed the numbers and pretty much gave them the same problems, different numbers and they were able to do the problems.

Although her students could do the specific types of problems if the numbers were simply changed, when asked if she was concerned that they were not grasping the
process of problem solving, Marie simply replied, “yes.” As I waited for more of a response, Marie just shrugged her shoulders as if to say—“It’s the best I can do right now.”

Marie’s level of efficacy for providing an alternative explanation or example when students are confused was demonstrated when Marie had the students work on the quiz review questions. It became apparent that she was at a loss as to how to help her confused students. Although several students said, “I don’t get this” or commented on the lesson being “confusing” or “hating” it, Marie walked around, looking at students’ work, and responded, “This is a hard one. Draw a picture.” Students then parroted her statement, “This one is hard.” Still, Marie’s only suggestion was, “Draw a picture.” After the students struggled with the problem for another couple of minutes, Marie said, “Alright, I want you to draw 8 bookmarks. These bookmarks are going to blue, and these are going to be yellow.” Without asking the students for ideas or encouraging them to ask questions, Marie solved the problem. She gave no explanation for how she selected eight bookmarks, a quantity that was not mentioned in the problem. Apparently, she simply expected students to copy down her solution without any understanding, or believed copying alone meant they understood.

Marie’s frustration about not being able to help her students solve problems was not limited to just fifth grade level mathematics. She explained,

Last year I was having trouble when I had to teach how to carry and borrow from addition and subtraction because, you know, there’s a whole thought process there. I know how to do it, but I don’t know how to teach it. And this was not in the curriculum guide. There was nothing in the curriculum guide that taught those second graders specifically how to carry and how to borrow. So I used the textbook a lot because the lessons were laid out right there.
Following my first observation in her class Marie exasperatedly said, “They do not understand that division is the reverse of multiplication.” When I asked, “Is there any alternative way that you could explain the relationship between division and multiplication?” Marie resignedly said, “I am out of ideas.” I asked Marie, “How do you deal with the situation when you know that they are not grasping [a mathematics problem], but you need to move on?” Her reply was,

I just move on. You know you just keep repeating stuff as often as you can and hope that eventually something will come in. This stuff is repeated every single year, you know, you get the same math concepts year after year after year, just keep going up to a higher level, so if they do not get it this year, maybe they will get it next year.

This dependence on the fact that her students will see the material again in the future indicates Marie’s low efficacy for providing alternative explanations to alleviate their confusion (Putnam et al., 1992).

When Marie was asked if she ever created her own lesson plans, she disclosed her efficacy for implementing alternative strategies. “I just go by the curriculum guide and use the suggestions they have. I teach from the curriculum guide, that way if they do not do well, I can say, well I did what you told me to do.” Furthermore, Marie explained that one reason she just uses the curriculum guide is because, “there is not enough time to invent something new.”

Marie explained that would like to use constructively-based mathematics teaching methods such as CGI, but she feels confined by her students’ apparent abilities.
I really like that cognitively guided instruction, I really like that and I would always be striving in that direction where students are trying to solve these problems on their own. BUT like I say, in this particular setting, that doesn’t always work. And, I also found that without the modeling to begin with, you can’t just hand them the problem and say here, figure it out. You have to model it first, show them how to do it, you know, try this, try that, and THEN give it to them and let them try to figure it out. Otherwise, they just get frustrated and throw the paper on the floor. And they do not have the patience to keep trying until they come up with the answer.

Additionally, as Marie analyzed the teaching task, one factor that frequently arose was the issue of time, indicating her efficacy for managing instructional time. Marie repeatedly mentioned the pressure she felt to keep up with the time schedule of the district curriculum guide.

This curriculum guide really moves through pretty fast, about four or five days per section, and in my opinion they need more time than that. But I don’t have that kind of time, so I try to go through it as fast as they want me to run through it. It would be a lot better if I had time to develop it more.

When analyzing her students’ academic abilities and the limited time she has to teach mathematics, Marie frustratedly expressed her low efficacy by stating, “My students don’t catch on real quickly so they need more practice than I can usually give them.”

Finally, Marie’s efficacy for mathematics content knowledge was revealed by her first response to my inquiry about what influenced how she taught mathematics. “I think my own past because I was not a good math student.” When asked to assess her own mathematics teaching, Marie said,

I feel like I can always do better, and I am constantly trying to think what I can do to improve things….I’m not afraid of math or feel like I’m incompetent as a math teacher. I have a degree in accounting, so math doesn’t scare me. There’s a lot of math. One of the things I’m not very good at is algebra, you know, substituting x’s and y’s….
So it is evident that content knowledge is an additional factor that has a negative influence on Marie’s beliefs about her abilities to teach mathematics.

**Relationship Between Epistemological and Efficacy Beliefs About Mathematics**

The relationship between Marie’s epistemological beliefs about mathematics and her efficacy to teach mathematics was most clearly seen in her frustration over the apparent disconnect between the district’s curriculum guide and the mathematics knowledge her students were expected to learn for testing. Marie explained,

> There’s a big gap between what’s being asked of them and what’s being recommended to do in the curriculum guide, which is a lot of hands-on. But there’s a gap between that and the actual math [emphasis on the math]. This matching activity is a lot easier than these review problems. I found that throughout there will be this really nice hands on activity, working with manipulatives or something like that, but then you’ve got to transfer that to the math. And that is where the big gap comes. Where does this transfer come – how is the problem set up?

I asked Marie if she had thought of any ideas on how to bridge the “big gap” of her students’ inability to translate from the hands-on activities she was having them do in class to the level of problem solving required on the quizzes. Her discouraged response was,

> No. I haven’t figured it out. That’s why I - I first started out with just the curriculum guide stuff. Then I saw that this was not carrying through to the math part, where the numbers – how do you work the numbers? What do you do with those numbers?

The frustrating lack of transfer and “big gap” are graphic analogies of how Marie’s epistemological beliefs about the disjointed structure of mathematics knowledge negatively impacts her efficacy to teach mathematics. In addition to her general lack of mathematics knowledge, she does not grasp that the activities and use of manipulatives
are mathematics. Her lack of integration in her epistemological beliefs about the structure of mathematics knowledge prevents her from perceiving that although the activities provided in the curriculum guide may not involve calculations, they are actually mathematics. Her mechanistic form of knowing mathematics prohibits her from developing strategies that would connect the activities to an understanding of mathematics that would enable her and her students to know what to do with the numbers. Thus, as she analyzes the teaching task of developing effective instructional strategies, her mathematics teaching efficacy is powerfully and negatively impacted.

Donna: Attempting to “Own It”

Mathematics Teaching Efficacy: Analysis of the Teaching Context

As part of the process of making efficacy judgments about their abilities to teach mathematics, teachers analyze the context in which they work. In this section I describe Marie’s school and classroom environment, her students’ behavior and their academic performance. For each of these aspects of the mathematics teaching context I present Donna’s belief statements that reveal her efficacy for teaching mathematics within this context.

School and Classroom Environment

Donna teaches third grade in a small rural Catholic elementary school. As I walked into the old school building I felt as if I were stepping back in time about 30 years. I felt warmly welcomed by the friendly staff and cheerful, courteous students. Each grade has only one class, and all but one of Donna’s 15 students have been together since
kindergarten. Most of the children’s parents are either farmers or factory workers. Donna
admitted that the school is very homogeneous, and after student teaching in an urban
school, she misses the racial and cultural diversity.

Shortly after completing her M.Ed., Donna moved to the area with her husband
who is a pastor in a rural church. Donna was offered a teaching position at the local
public school, but she declined because she wanted to teach where spirituality was
valued. Donna explained, “I like the fact that we can talk about God and not have to
worry about getting sued…I think that is very important, and I think it makes a
difference in how kids look at the world.”

Donna shared that “most of the teachers are really great” and her principal “has
been very supportive of what I want to do.” Donna had been concerned that she might not
fit into such a traditional school, but she soon discovered that her principal “encourages
us to do things our way.” She also said,

He’ll do anything he can for you, and he really treats us well. We do not get paid
much at all, so he tries to make up for it with incentives to let us know that we are
appreciated. We work really hard here, and we do not get the breaks that public
school teachers get as far as a planning period and stuff like that.

Although Donna feels supported by her principal, she has not had much support
from other teachers in regards to teaching mathematics. She has not had a mentor teacher,
and her two closest colleagues, the fifth and sixth grade teachers, do not have to teach
mathematics. Donna has also had conflicts with the fourth grade teacher who is “a very
regimented and in control person…She doesn’t believe in critical thinking, and she does a
lot of worksheets.” Although Donna wants to teach her students so they have a strong
conceptual understanding of mathematics, she explained,
The fourth grade teacher drives me nuts. That’s where the kids go after me... If they don’t carry, or regroup, she takes points off if she does not see the 1’s and 2’s and all that. So I have to teach them that, and that really drags out what I end up doing... I don’t try to teach toward what they are going to get with her, but sometimes I feel like I have to so they are not completely blown away when they get into fourth grade.

Despite her lack of support for teaching mathematics, overall Donna appeared to thrive in creating a warm and nurturing learning environment in her classroom. Besides the troubling fourth grade teacher and lack of a mentor, it appears the school environment has a fairly positive impact on Donna’s analysis of the teaching context.

**Student Behavior**

Donna described her students as a very caring class. Teaching at a Catholic school, she often talks about spiritual issues with her students, “and that seems to carry over into how they treat each other.” Before they left for lunch, most of the students happily sang a blessing. When I asked Donna what she hoped her students were learning, a portion of her response was “to be good citizens, to be good Christians, to be good to each other, moral people with principles who stand up for what’s right.” During my observations all of the students worked very well together in pairs. Donna positively said, “I only have one student that I have a difficult time with in her dealing with group work and getting along with people, but we keep working on it.” I was impressed by how well behaved the students were. They raised their hands to ask questions and obediently followed directions.

When they did briefly get distracted or started talking, Donna would simply look at them and point. Without her saying a word, the students would redirect their attention.
By the number of students who raised their hands during lessons, however, it was evident that they felt very comfortable asking questions, sharing their thoughts, or sometimes even disagreeing with Donna. She admitted,

> They talk a lot, but that is ok. We tend to get off task really fast, like we were doing math and somebody asked me why if you have 603 why you can’t just leave a blank there [for the zero]? So we had to discuss that and try to figure out why…and the kids had some really good answers for that.

It was also obvious that the students enjoyed mathematics. When Donna transitioned from spelling, she said, “Are we ready for math?” Most of the kids happily yelled, “Yeah!” Donna conveyed that when they do projects, the “carnival atmosphere” in her classroom irritates the fourth grade teacher because they are sometimes a bit loud! As I observed them solving problems as partners, they were intently engaged and stayed on task. They worked on one problem for about 10 minutes as Donna walked around to interact with each group. Thus, it appears that her students’ behavior has a primarily positive effect on Donna’s analysis of the teaching context.

**Student Academic Performance**

From my observations, I perceived Donna’s students to have fairly strong problem solving skills. However her perception was that “they aren’t taught problem solving and thinking on their own as far as mathematics is concerned, so I have to kind of jump start them a little bit. So it is hard.” Moreover, Donna bemoaned, “oh my gosh, my kids have no numbers sense – it drives me nuts!...I don’t think they are taught it.” She went on to describe how one boy had added 200 + 400 and ended up with 200 and something, and he saw nothing wrong with the answer even after Donna questioned him about it. She also told about one student who was really struggling academically. “He can
not stay focused for any amount of time…We are getting him tested because we think that there might be some physical conditions that might be causing him not to be able to perform.”

Donna believes that overall, however, the class is “mostly above average as far as academics and their gifts.” When I observed the two lessons on pattern strategies in problem solving and on multidigit subtraction, most of the students appeared to understand and were able to solve the problems. Donna explained,

   Compared to last year’s class, this class is a lot easier, especially in math. Last year’s class - every time we did anything, it was like the two-headed monster had entered the room. This year’s class is like, “Whatever! We already know this.”

Apparently, Donna’s students’ academic performance is sometimes frustrating, but overall it appears to have a moderately positive impact on her analysis of the teaching context.

   Epistemological Beliefs

   Structure of Knowledge

   When I asked Donna to define mathematics, she said, “It’s a lot of things. The things that come to mind are trying to find order and pattern in things. I think of money. Just the everyday things that make life work: measurement, money, problem solving.” As Donna discussed learning mathematics facts and teaching for conceptual understanding, she explained, “I do believe that there are certain facts that they need.” Yet Donna emphasized the importance of students learning “the process of how to get that information.”

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In regards to mathematics facts, Donna further expounded,

They are not going to know those facts engrained until they have used them a lot. So I don’t feel like they need to know every single fact. She [the fourth grade teacher] fusses because they don’t. They forget. I sometimes forget what eight plus four is!

Nevertheless, Donna expressed an integrated conceptual mathematics understanding as she discussed how she taught addition.

When we reviewed basic facts at the beginning of the year, I worked a lot with counting on and missing addends. Or I talked to them like it was algebra, that ten minus six equals four is the same as four plus six equals ten.

Donna’s integrated structure of knowledge was also evident during one of my observations as she explained to the students,

We’re going to talk about different strategies. We have talked about different strategies before in reading, now we are going to talk about them in math. Remember a strategy is just a way to help you solve something. Help you to figure it out, whether it is a word, or a math problem or a social studies activity, a strategy helps you to figure something out.

Instead of knowing isolated facts, Donna wants her students to learn to “think in a mathematical or scientific way. I mean science and math and actually a lot of things combined together – it’s that logic, that making sense of things.”

Form of Knowing

Donna’s epistemological beliefs about the form of knowing mathematics range from procedural to conceptual in nature. Donna explained, “I like the idea of problem solving, but I don’t think it works for everything. I don’t think you can do it for everything. Maybe you can, but I don’t think you can.” I asked her to describe a situation where problem solving was not possible. Donna responded,
I think in learning the math facts. I think you can make it, once you’ve got the math facts down. Models work…You can do it at times, but I think to get the math facts into your head you drill and practice and counting out and stuff like that.

As Donna discussed a lesson I was about to observe, she explained her objectives:

First of all, to figure out the language that tells you that it is a pattern – to find the clues that tell you that this is the kind of problem that you can use a pattern to solve. Second of all to get them to be able to express how to solve a problem. To be able to say this is how you solve this problem; to explain it to me or to others.

During that lesson Donna also attempted to develop argumentation and justification in problem solving.

Let’s have Jessica and Kaitlyn come up and explain their answer. As they talk, in your head I want you to think about how you solved this problem and see what was similar about how they solved it and what was different.

After the girls explained their answer, Donna asked, “Did anyone have a different way?” One pair of boys described a creative and effective way of solving the problem that no one else had thought of. To challenge their thinking that there was only one way to solve the problem, Donna asked the class, “Is that ok to do?” Several students said “no.” So she asked the boys to demonstrate their solution on the overhead.

It is evident that Donna wants her students to understand, and is growing in her ability to teach mathematics in a way that supports a conceptual form of knowing.

Discussing teaching multidigit subtraction last year, Donna said, “I taught it straight from the text book, but I am not doing it that way this year.” She explained that this year her students “understand why we regroup, and that’s the biggest thing. If you don’t
understand why you do it then it’s pointless.” Thus, Donna appears to be in transition, attempting to implement more sophisticated beliefs about the form of knowing mathematics into her teaching.

**Stability of Knowledge**

Although Donna did not address stability of mathematics in any great depth, she emphasized to her students that there was not one set procedure for answering a mathematics problem. “I want you to explain to me how you got the answer. Ok? And it is ok if the way you got the answer is different from the way other people got the answer.”

**Ability to Learn**

Donna believes that

Kids bring all kinds of things to the table on all different subjects. That’s just the way it is. … because we all have different abilities and gifts or areas that we’re just not into. So I just try to find the things that will help them.

Donna sees it as her role to

help them believe they can do this and even if they don’t get it right now, that in time they will get it. I mean I talk a lot to the kids about how there are things that I didn’t get for a long time, but eventually it all made sense. And then to believe that is going to happen to them eventually. And also to try to figure out the way that works for them so they get it, though they might not get then, but try to get it.

Discussing her students’ understanding of multi-digit subtraction, Donna also expressed,

I think a lot in math or any subject, you are going to run into kids that do not understand exactly what’s going on. But we are going to keep practicing. I have a number of problems they are going to do and hopefully they will start to see it.
Donna articulated her belief in incremental intelligence even more clearly when she said, “I really do believe that eventually most kids will get it. It’s just a matter of clicking. It’s that everything coming together to make sense kind of thing. And it just takes time and experience and practice.”

**Speed of Knowledge Acquisition**

As is evident from Donna’s acknowledgement of her own struggles with learning mathematics (e.g., “there are things that I didn’t get for a long time”), she believes that learning mathematics is often not a quick process. However, as Donna discussed one of her best mathematics students, she described how “things come really easy for him, so he doesn’t think about it. And so when he is required to think, he gets really frustrated very quickly.” I asked, “Do you think we communicate to kids that the quicker you are, the smarter you are?” Donna’s reply was,

Yes, I think that is communicated. I try not to communicate it. It is hard because one of the rewards you give a child when they are done is that they get to do something that they enjoy cause you are trying to wait for everyone to finish and you want them to be doing something else.

In my observations of Donna teaching mathematics I was impressed by how she gave her students 10 minutes to work on one problem. She was very patient, and her students were amazingly on task. At one point she asked, “What if you don’t understand something in the problem, Taylor?” The student’s response was, “You can read it over again.” Donna told her class, “You know I have to sometimes read problems two or three times before I can figure out what they are trying to tell you.”
If Donna errs in speed of knowledge acquisition at all, it is possibly in that she tends to take too much time to explain concepts. “I think that I repeated things too much. I went over and over it again. I do that a lot in math - to repeat it over and over, and maybe that’s ok, but I think they are like yea, yea, yea, we already got it.” There were a couple of times that I observed that most of the students did grasp the concepts being taught, effectively solved problems, and became bored more quickly than Donna expected. It appeared that her own lack of self-efficacy for mathematics (described later in the profile) may have held her back from teaching at a more appropriate pace of learning for her students.

Source of Knowledge

Donna expressed mixed beliefs about the source of knowledge. At first glance, it would appear that she gave her students autonomy. She had all of the children explain to their partners how they obtained answers to multi-digit subtraction problems using counters. She also asked them to create a problem for their partner to solve. However, on three occasions when she had asked students to solve or explain a problem to the class, she interrupted and walked them through the solution, before they had an opportunity to solve it on their own. Her statement to a student she called up to the overhead to explain a problem revealed Donna’s true belief. “You are going to kind of be the teacher. She then proceeded to ask the girl, “What is the first thing you have to do to subtract 18?”
Discussing how she had taught multi-digit addition, Donna admitted,

What I would have liked to have done and maybe some day I’ll get to that, is that they figure out how to add, *without me telling them* here’s another way. I tried to do it that way, but they were just like well, you have got to regroup! Cause that’s what we learned in second grade is that we regroup – they called it carrying. I said well you know that there are different ways to do this. I am just going to show you one way you can do it, which is front end addition.

Despite her tendency to tell her students how to solve problems, Donna does not always set herself up as the expert in the classroom. She willingly admits her own confusion with problems and even purposefully makes common mistakes to see if her students will catch them. For example, when Donna was adding 10s, “just to make sure that they understood it, I’d ask at different times, ‘we’re just adding one plus four plus one?’ and they’d say, ‘No, Mrs. Davis, that’s one 10 plus four 10s plus one 10,’ and so they’ll explain that to me.” Thus, Donna appears to have a moderately sophisticated level of epistemological beliefs about the source of knowledge.

**Mathematics Teaching Efficacy: Analysis of the Teaching Task**

As teachers analyze the mathematics teaching task, they consider their abilities to effectively accomplish three primary teaching responsibilities: student engagement, classroom management and instructional strategies. Each of these major facets of teaching mathematics is comprised of more specific tasks that uniquely impact a teacher’s mathematics teaching efficacy. Donna’s judgment of her efficacy to teach mathematics is discussed in terms of her analysis of these various tasks.

*Efficacy for Student Engagement*

Donna expressed a relatively high level of efficacy for student engagement through her beliefs about her abilities to accomplish two student engagement teaching
tasks that are identified in the TSES: to get students to believe they can do well in mathematics and motivate students who show low interest in mathematics. Donna did not directly discuss the tasks of helping students value learning or assisting families in helping their children do well in mathematics. An additional factor that appeared to have a powerful impact on student engagement was Donna’s ability to develop positive relationships with her students.

When I asked Donna what impacts her confidence to teach mathematics, her first response related to her efficacy for getting students to believe they can do well in mathematics. “If the kids freak out, that bothers me.” Donna explained,

One student in particular has been struggling in all areas, but especially in mathematics. We worked on [multidigit addition], and he has a tutor for it. I think he is getting it, but I don’t think he believes he can get it. I think that is his biggest problem.

One way Donna has tried to get her students to believe they can do well is by teaching those who are struggling a concept before she teaches the rest of the class.

I taught them first, and then I told them they were going to teach it to the class. They were thrilled to be able to do that. I don’t want them to think “I’m no good at math.” I think it’s hard to get away from that even if you try your hardest. I try to do heterogeneous groups at times and then homogenous groups so they never feel like, “Well I’m in the top group or I’m in the low group”…I try to not do that if I can.

However, Donna clearly lacked self-efficacy as she discussed teaching multi-digit subtraction. “It’s just going to be more daunting – I don’t know that a lot of them are going to be able to think that way right now. And that scares them.” Thus, it is evident
that as Donna analyzes the student engagement teaching task of getting her students to believe they can do well in mathematics, her mathematics teaching efficacy is usually negatively impacted.

**Although** Donna did not directly express any efficacy beliefs about her ability to help students value mathematics learning, her students were obviously enthusiastic about learning mathematics. However, Donna still **acknowledged the need to motivate her** students to learn mathematics. When I asked her to consider what additional factors impacted her confidence to teach mathematics, Donna responded,

> Mostly it is the students. Besides the fact that they get it, that they seem interested in what we are doing. I mean I know that 100% of the kids are not going to be interested 100% of the time. If the majority seem engaged and on task, that impacts. If they are visiting and staring off into space or just going “duh,” then that impacts.

Thus although Donna appeared fairly confident in her ability to motivate students who show low interest in mathematics, she acknowledged that when students are not interested, it negatively impacted her self-efficacy.

**An additional aspect of the teaching task of student engagement that impacts Donna’s efficacy judgments is her ability to relate to students.** Donna has a very affirming and caring relationship with her students; she even seemed a bit maternal toward them. She explained that her own negative mathematics experiences help her to be empathetic with her students’ struggles.

> When I see a student going, “I don’t get this,” I know what that feels like, and so I know that frustration. And so I think I identified with it and instead of getting frustrated with them I’m able to just say, “Okay, let’s just step back. And I’ve told the kids before, “Okay, if you don’t get it right now, it’s okay.”
Donna’s encouraging interactions with her students interestingly appear to have a mixed impact on her mathematics teaching efficacy, perhaps reminding her of her own mathematics insecurities.

**Efficacy for Classroom Management**

Donna’s efficacy for classroom management is primarily observed in her analysis of the teaching tasks of getting children to follow classroom rules and establishing a classroom management system. When I commented on how well behaved her students were Donna said that she forgets how good she has it. She acknowledged that behavior management is less challenging than during her student teaching experience in an urban school.

There are still some serious family problems I have to deal with here, but they are not on the same scale. Here there are just a few where the family life is unstable, where the parents are not properly… [Donna’s voice trailed off] So it’s much different.

It is evident that Donna perceives the root issue of misbehavior originates in the family. However, the few minor misbehavior incidents I observed in her classroom were dealt with confidently. Because Donna rarely has to deal with disruptive behavior, analysis of classroom management aspects of the teaching task do not appear to have much of a negative impact on Donna’s teaching efficacy.

There seemed to be an understanding established between Donna and her students that they were expected to listen and obey what she said. If students were distracted all she needed to do was to say, “Eyes up here” and they would redirect their attention quickly. Donna also tried to use fun instructions to monitor her students’ work. “When you have modeled that number, I want you to take your right hand and touch your left
ear.” The children happily followed her directions. Her students’ respect for classroom rules appeared to positively impact Donna’s teaching efficacy.

One example of Donna’s effective classroom management system is evident during transitions to new activities. She made cleaning up a game by setting a timer and putting a marble in their special jar if they successfully beat the clock. When their special jar is filled with marbles, they all get a reward (Canter, 1989). When I commented to Donna that she seemed to create a safe environment for her students to learn, her response was

I try to, and something where they know, so it is not unpredictable. So they are not like, “I am in trouble, but I don’t know why I am in trouble.” Or, “We did it this way this day, and we are doing it another way and I am confused. I don’t know why we are doing that.” I want them to know why we do what we do. And I think it’s worked really well.

As Donna analyzes the teaching tasks of establishing a classroom management system and getting students to follow rules, her efficacy for classroom management is positively impacted.

**Efficacy for Instructional Strategies**

Donna expressed a relatively high level of efficacy for instructional strategies through her beliefs about her abilities to accomplish three of the four instructional strategies teaching tasks that are identified in the TSES: using a variety of assessment strategies, providing alternative explanations when students are confused, and implementing alternative strategies. Donna did not discuss her ability to craft good mathematics questions. Three additional teaching tasks that appeared to have a powerful
impact on efficacy for instructional strategies were identified: understanding mathematics content knowledge, managing instructional time, and meeting students’ individual needs.

When I inquired about assessment, Donna’s response not only revealed her confidence for using a variety of assessment strategies, but also her epistemological beliefs about structure of knowledge.

I assess by homework – what they hand in. I informally assess by what they tell me, why they are doing what they are doing. And then I assess by the rubric – how much they seem to understand what to do in the problem - that they were going about it in a way that was effective. Not so much the right way, but an effective way for them, and that they got to an answer that might not have been right, but was on the right track.

Although Donna did not make a direct efficacy statement about her ability to use assessment strategies, how she discussed her knowledge and use of a variety of approaches suggested that she had high self-efficacy in the task of assessment.

However, Donna expressed mixed beliefs about her self-efficacy to assist children who are struggling with mathematics. With a heavy sigh she admitted

*I don’t know that I have the ability yet* to work with kids that are really stuck and try to figure out where they are stuck and help them out with that. The other thing is trying to communicate how to do something. *That’s hard in math for me*. I know why you do it, sometimes I just don’t have a very good way to articulate that. I think it has been better this year, but I think I can do better at that. I feel that right now the methods, it’s not that I don’t believe in traditional methods, but I think that I would like to get away from that and more into where they figure out why they are doing it. I don’t think that we do enough of that.

However, as Donna discussed her decision to wait until later in the school year to teach mathematics problem solving this second year of teaching, she expressed,
I feel now that I am a little more confident, being able to help them with the barriers they run into. It’s not so much that they are older – well, last year’s class could have benefited if I would have waited. Instead I kind of abandoned it. And this year I kind of waited and waited and realized they are old enough to handle this. I mean I think kids all the way to kindergarten can handle it. It’s just that I guess my confidence was not sure enough for me to be able to do it! (laughing)

Teaching experience and the level of student confusion appear to influence Donna’s self-efficacy to provide mathematics explanations.

When I asked Donna how her teaching experience had impacted her views of mathematics, her response revealed her efficacy for implementing alternative strategies.

I don’t think [my views of mathematics have] changed over the past year as it did when I started grad school. I had a vision of mathematics as the teacher at the blackboard, the kids doing the problems, sitting down, or coming up and doing the problems, then getting the homework and doing it all over again the next day; that there’s one way to do it. And that changed a lot when I went to grad school. It has pretty much stayed that way since I started teaching. It’s a lot harder than I thought, well it actually isn’t a lot harder than I thought it was, it is just hard for me to do personally. [It’s hard] trying to figure out where the kids are and what they need, giving them the experiences.

Furthermore, when her students do not understand what she is teaching, she has low efficacy to implement alternative strategies.

I don’t know why, because if they freak out in other things, I don’t get panicked. But math, because I just don’t, I feel like okay, I can do this in my head, but to explain it sometimes, I don’t feel like I have all the tools to try different things if they are not getting it... I try to think of different things, but I don’t always feel like I have those tools, and I think that’s going to take time. You know, probably taking other math classes and learning different methods and stuff like that. I’d like to take some more math methods classes.

Thus, as Donna considers the instructional strategies teaching tasks of using a variety of assessment strategies, providing alternative explanations when students are confused, and implementing alternative strategies, her mathematics teaching efficacy appears to be somewhat negatively impacted.
Efficacy for Understanding Mathematics Content Knowledge

When I asked what factors impact Donna’s confidence to teach mathematics

Donna said:

I think how much I understand what it is I am teaching – the whys of it. If I don’t understand why I am doing it, I do not really teach it very well. And in the math book, they had some things last year I would teach and I am just going, I don’t understand why I am doing this. It doesn’t make any sense to me, and I did not teach it well.

When I asked to what extent she had incorporated strategies for understanding in her mathematics teaching, Donna’s response was,

Not very much. I would really like to. We worked a little bit on problem solving, but I don’t, (heavy sigh) that’s the one thing - I was not good at math and I think am a lot better at it, but teaching kids the different ways of problem solving, I don’t feel as comfortable.

Donna’s own mathematics learning experiences have had a negative effect on her self-efficacy to teach mathematics. She explained,

In math I did well until about 7th grade, and then things started falling apart because I did not have a conceptual understanding. And I swore I would never be a teacher – Never, Ever! It was all traditional; it was all the teacher at the front of the room as the expert, worksheets all the time. And I thought my experience was so boring, and I never really got anything out of it. I could do what they were telling me to do, but I didn’t understand why I was doing it.

When I asked how these frustrating learning experiences specifically impacted her mathematics teaching, Donna replied, “Well first of all, I don’t feel as confident. When people, when kids throw me questions and I’m going, you know, how do we deal with this? Cause you’re dealing with both methodology and your actual knowledge of it.”
Donna further explained,

I think my hesitancy in knowing that a problem’s right will impact my confidence at times…I’m a little bit slow with computation, not very sure if I’m right on a lot of times. And that will make me hesitate and makes me think about that instead of what the problem is we’re supposed to be working on. So that’s a concern. It’s something that will impact me at times, just how much knowledge I have about what I am doing.

I observed an example of this concern as Donna was guiding her students through using counters to subtract 18 from 35.

How many ones do we have, Patrick? [Seven.] We have seven. 1, 2, 3, 4, 5, 6, 7 (Donna counts them on the overhead). How many tens do we have left? McKala? [Six.] No we had three…[One] You know I think we should actually have two. (Donna is momentarily confused.) No. So we have one ten and seven ones. That is really confusing, isn’t it?

It appears that Donna’s lack of self-efficacy for doing mathematics impacts her self-efficacy to teach mathematics, sometimes to the extent of preventing her from teaching. Donna explained, “I put off problem solving until I felt more comfortable and got into a pace with math. And then I realized these guys can probably handle this.”

Furthermore, when I asked Donna to consider all of the subjects she teaches and rate mathematics in terms of enjoyment, she rated it last. Donna also rated her confidence to teach mathematics as last as compared to other subjects.

Efficacy for Time Management and for Addressing Students’ Different Levels of Mathematics Understanding

Donna’s analysis of the mathematics teaching tasks of managing instructional time and meeting students’ individual needs were consistently discussed in relation to one another. When I initially asked Donna how mathematics teaching had been, her assessment was that
I realize this year that I take too long in going over the basics. I spent time at the beginning of the year going over the addition and subtraction basics so they are ready for when we get to multidigit addition and subtraction. And next year I am definitely not going to spend that much time on it.

When I inquired as to how she came to that conclusion, Donna explained,

It kind of depends on each class. I just felt that I was too slow, my pace was not there, I could tell. Last year’s class just had so much trouble with math - half of them just really freaked out about everything in math. And this year’s class doesn’t. So I think I just kind of assumed that they were going to have trouble too. I have learned that every class is different. Duh. But you don’t realize it.

Curricular time constraints also affect Donna’s mathematics teaching efficacy.

In math I do feel that pressure to get things done. I mean they have to know things that are necessary for fourth and fifth and on. I mean they learn multi-digit addition, multi-digit subtraction and multiplication and division in my class. That’s a lot of basics. If they don’t get it, they’re just going to have a lot of trouble.

Donna further explained,

I have to stuff so much in, and I don’t like that… there is not enough time - in the day and in the year. In their grade all the skills and basic things that I have got to teach them, it’s just like whipping through it. Either that or you don’t get to it. And that upsets the next teacher and the whole chain of things.

When I asked Donna, “Do you think you can teach mathematics to any child no matter what their background is?” her response was, “If in the setting that I am now, no, I do not.” She explained that despite having only 15 students, the time limits and her students’ need for attention were currently prohibitive for her.

There are certain students that I do not think that I could teach math to effectively. If I were one on one and had a lot of time, I think I could…I would like to believe that there will be a point where I could do that.

Moreover, when I initially asked, “how do you perceive yourself as a mathematics teacher right now?” Donna said, “Not that good.” With a heavy sigh Donna admitted,
“I don’t know that I have the ability yet to work with kids that are really stuck and try to figure out where they are stuck and help them out with that.”

*Relationship Between Epistemological Beliefs and Efficacy to Teach Mathematics*

The influence of mathematics epistemological beliefs on mathematics teaching efficacy will be discussed in greater detail in Chapter 5. However, for Donna the relationship between these two constructs is perhaps most evident in her discussion of her efficacy for instructional strategies. Donna clearly expressed a desire to teach so that her students to have a conceptual understanding of mathematics. However she said, “I am just not sure how to get there yet. I think in a few years I might have a better idea.” When I asked Donna if she had implemented the strategy of having her students write about how they solved problems, her response was, “I want to, but I haven’t gotten to that quite yet. I am just terrible about journaling. Just period. Writing, journaling. I started at the beginning of the year, and we just got off of it. I’d like to do that, but I haven’t.”

When I asked Donna to describe how mathematics is best taught, she exclaimed,  

*Boy, I don’t know! I think that the more real life you can put into it, contextual experience, I think that is really important. Hands-on. I think finding ways to help kids, and I think this goes for everything, but helping them find their own meaning. Trying to figure out, make the connections they need to so it makes sense to them. I think that is probably the most important thing.*

Donna strives to “teach the way I would want to be taught.” Thus she strives to help her students learn mathematics with understanding. She attempts to get them to the point where they think that math is not just, “Here it is and this is the way you do it.” But rather, “I can solve this on my own. With a little bit of guidance, I can do this.” However,
Donna laments, “how to get from here to there is where I’m trying to figure out how to do it. It’s easy if the whole class starts kindergarten and the whole school’s doing that, it makes it easier.” Donna concluded,

    So I mean I don’t think I’m a bad teacher in math; I just think that there’s a lot of improvement that could be done. And from a traditional perspective, I think I do okay. I think I could do better in just the critical thinking aspect of it. So that’s what I’d like to work on.

Thus, it appears that Donna has some fairly sophisticated epistemological beliefs about the structure of knowledge and form of knowing mathematics, however, her lack of self-efficacy to implement those beliefs into her mathematic teaching has a powerful impact on her analysis of the teaching task.
Connie: Attempting to Bridge the Gap

Mathematics Teaching Efficacy: Analysis of the Teaching Context

As part of the process of making efficacy judgments about their abilities to teach mathematics, teachers analyze the context in which they work. In this section I describe Marie’s school and classroom environment, her students’ behavior and their academic performance. For each of these aspects of the mathematics teaching context I present Connie’s belief statements that reveal her efficacy for teaching mathematics within this context.

School and Classroom Environment

Connie is a White teacher in a public city school that serves one of the more affluent neighborhoods in the district. Prior to her M.Ed., Connie obtained an M.B.A. and created her own social service organization that obtained computers for the disadvantaged. Connie is married with three children. Two of Connie’s sons attend her elementary school, which she describes as “not quite suburban.” She lives two blocks from the school.

Approximately 35% of the students are on free or reduced lunch. The school has a fairly large special education and mentally disabled population. It also has a literacy collaborative reading program that is based out of the nearby state university. Connie stated that the proficiency scores were about 75% in each area. She describes the staff as highly motivated and hard working. Connie sees her principal as “very supportive.” Although she did not have an official mentor teacher her first year, she has had a very
close working relationship with the other third grade teacher. Connie said that this woman, who has taught for about 25 years, has been like a mentor for Connie. “We get along very well, and we do a lot of things together.”

There are two well kept older buildings on the school property that are separated by a playground. Connie’s classroom is located on the second floor of the smaller building. The room is bright and welcoming. As you enter the only door, there is a carpeted area with an easel and poster board where Connie gathers her students on the floor for discussion times. The room has many windows, a terrarium with live creatures, four computers, and many informational posters, maps and examples of students’ work hanging on the walls. The desks are grouped in twos and sixes, with no apparent “front” of the room. Connie’s desk is in the far right corner, along with her blue drop box for completed work, and several shelves of books and geoboards that the kids can access when they finish their work early.

The first time I observed, I was impressed by Connie’s ability to create a positive and safe learning environment in which the students truly enjoyed learning mathematics. Her 22 students – 10 White and two Black boys, along with five White, three Black and two Hispanic girls - were on task and very engaged in the learning process. Each observed lesson had an exploration aspect to it. The first one involved the students building a dream house out of the geometric shapes they were learning; the second lesson on probability included a dice game. The general atmosphere in Connie’s classroom was fun, creative, and industrious.
**Student Behavior**

When I asked Connie what she had enjoyed the most about teaching, her response was her students. “I love the kids.” She explained that her school over all does not have a lot of behavior problems. You know the biggest behavior problem is kids talking when we are on the carpet. There are some other issues - this year I have quite a challenge. I have one boy who is being assessed for SED (severely emotionally disabled; the boy was later diagnosed as bipolar). So he has been in the room all this year and that’s been a huge challenge.

When I asked how the other students responded to this situation, Connie said,

They’re pretty good, they usually know to just stop and wait until we get it taken care of. They are always quick to alert me when something is brewing; so eager to tell on each other.

As I observed Connie’s students I was struck by how engaged they were in the problem solving and exploration activities. Although they were a bit rambunctious, the students worked well together and most of their conversations were surprisingly focused on the task at hand. Even the one challenging boy, who was working independently, was engrossed in creating his dream house. They were noisy in the transition from the carpet to seat work, but they responded well to Connie’s redirecting. Connie’s simple statement, “I have such a good class” captured the effect of her students’ behavior on her analysis of teaching context.

**Student Academic Performance**

Because many of the students who struggled in mathematics were falling further and further behind, Connie and the other third grade teacher decided to group all of their
students according to mathematics ability for the second half of the year. So Connie is now responsible for 22 intermediate students. Connie said,

It is great! I know there is so much against grouping and everything, but I feel it serves the kids’ needs. I don’t think those kids who go into the other [lower level] room mind at all because they have all this one on one assistance, and they are getting stuff, and it is just for math.

However, Connie is still challenged by some of her intermediate students’ mathematics skills. She explained that her son who is in kindergarten had played the probability dice game and was able to add the dice up by just looking at them. However, several of her third graders were still unable to do this.

I can’t believe some kids are still counting…One girl has become very dependent on her fingers. So I have encouraged her to sit on her hands and try to think about it and get a picture of a number line in her head.

Nevertheless, student academic performance does not appear to hold Connie back from using the CGI model to teach mathematics. During my first observation, Connie began the mathematics lesson with a time on the carpet where the students worked in their journals to determine the pattern of a list of numbers. She wrote “2, 3, 5, 9, __, 33, 65; the rule is…” on the easel. Most students eagerly raised their hands to respond and several were selected to share their answer and give an explanation of how they determined their solution. When one boy figured out the pattern and effectively explained the answer for the missing number, his joyful response was, “This is so cool!”

After the mathematics lesson in which the students worked on their dream houses made out of geometric shapes, they had a 15 minute recess. However, four boys were enjoying the project so much they decided to stay in and keep working. When Connie
asked them to clean up near the end of recess time, one boy said, “Oh yea, we’re at school.” He was so engrossed in the project he lost track of where he was! Thus, although some of Connie’s students’ struggle academically, the majority appears to sincerely enjoy mathematics and actively engage in the learning process. Thus, student academic performance seems to have a positive impact on her analysis of the teaching context.

**Epistemological Beliefs**

*Structure of Knowledge*

Connie explained that her conception of mathematics was “being able to understand numbers and how they work in your life.” When I asked her to define mathematics she responded with “the study of numbers. That’s not all of it; I mean it is so huge. But everything in math goes to numbers. Even in geometry, everything related to numbers. That just seems very shallow for what it actually is.” I further inquired how her perceptions of mathematics had changed since her M.Ed. program, Connie said, “Math is much bigger than I thought it was. There is much more to it, and I see that it needs to be a bigger part of the day than I probably thought it would have before.” Thus, although Connie struggled to define mathematics, she expressed relatively sophisticated beliefs about the structure of mathematical knowledge. She recognized that it is complex and that different aspects of mathematical knowledge are interrelated with one another and everyday life.

However, when I asked Connie, “How beneficial is it for your students to work on mathematics problems that do not have a clear cut answer?” a question on the SEQ that reveals structure of knowledge beliefs, she responded,
I don’t know. I really struggle with that, because they want an answer. They’re not satisfied if they do not know the answer at the end. I don’t know if it’s just them getting use to that kind of thing. I really struggle with working on a problem, do we say this is the right answer or not, cause they want to know. You know, a lot of books will say, let them come to it themselves. But they want to know what the right answer is, and they want that right answer on their paper! And so maybe I am like that too, what is the right answer at the end? And kids don’t see in grey. Kids are black and white still. I don’t know if that is part of their development, or that’s only what we have allowed them to do.

Connie’s insight on the possibility that her own beliefs could be limiting children’s beliefs about mathematics is evidence she recognizes the importance of communicating a more complex structure of mathematics knowledge, but she is struggling with implementing a changing belief.

Regarding the importance of students learning “math facts,” Connie explained,

I think math facts are actually important because everything else gets harder if you can’t do those quickly. As math moves up the chain – math facts are just being able to move numbers in your head. If you have an understanding of those and can do those quickly, everything else you do in math is going to be easier for you.

However, Connie emphasized the import of obtaining conceptual understanding.

I think math facts, if you master them without the conceptual understanding first, they do not mean anything. Once you have the conceptual understanding of what multiplication is, then its simple memorization.

Thus instead of seeing mathematics simply as isolated bits of knowledge, Connie values the integration of mathematics skills and understanding.

*Form of Knowing*

Whereas the dimension of structure of knowledge captures an individual’s beliefs about the constitution of mathematical knowledge, form of knowing focuses on the means through which one knows mathematics (i.e., procedural or conceptual;
mechanistic or problem solving). Connie shared how she wanted her students to have “some very specific skills.” “I don’t mean just computation skills, but problem solving skills, knowing how to try different things to figure it out.” She believes that children need to “have to have a chance to explore and fool around with it and then they have to have a chance to share their ideas – to talk among the class about what other people came up with.”

Connie also expects her students to be able to explain and give the rationale for their answers in writing. “That’s what we focus on. They have to be able to explain it in words. They have to be able to write down why. That’s what we do all year.” Further, Connie expressed that it was not important for students to follow established or correct steps in solving a problem. “I don’t care if they do whatever algorithm, just as long as they understand what they are doing and can explain their answer.” Thus, Connie’s emphasis on her students being able to problem solve and provide explanations that reveal conceptual understanding indicate a relatively sophisticated level of epistemological beliefs about form of knowing.

**Stability of Knowledge**

During a lesson on probability in which students gave examples of different levels of likelihood, one little girl said “I will be rich and famous” should be put in the category of likely to happen. Several of her classmates reacted, calling out that it should not go there. Connie’s response, “Not everyone agrees where everything goes, ok?” showed her relative view of knowledge. Even so, when asked, “Do you think what is known in the discipline of mathematics will be different ten years from now?” Connie said,
I don’t have any idea. I mean 3+2 is always going to be five, otherwise I am out of here! (laughing) I don’t know. How we use math will change obviously because just like with technology and what we need to get along in the world will change. But Pascal’s triangle will always be Pascal’s triangle.

When I inquired, “Will there be new information in mathematics?” Connie humorously said,

Probably! I’ll probably have to go back to school! I am sure there will be new ways of thinking on what is the best way to teach it. There will be evolution about what is the current thought about best practices.

But then she concluded, “I don’t know!” admitting a lack of awareness of how knowledge in the field of mathematics expands and changes.

*Ability to Learn*

Connie believes that “students do come with varying abilities to learn mathematics. For some kids it is really easy, and they just go with it. And for some kids they really struggle.” However, she clarified,

Not to say they can’t learn it, but it’s a different road they have to take. I had kids at the beginning of third grade who still did not have a good idea of the number line and still were struggling with simple addition and subtraction problems. They had not developed any number sense. Until you have a number sense, you can’t skip around and do more complicated things.

When asked, “Does effort help in mathematics learning?” Connie responded, “Yes. I think it does for some kids. For really high kids, they don’t have to put a lot of effort into it sometimes. But yea, I think effort does help.” And when I inquired, “Are there some kids who just aren’t going to get math?” Connie insightfully replied,

Well it depends on what you mean by “aren’t going to get math.” There are some kids who might not be able to pass the fourth grade proficiency test, but that does not necessarily mean that they do not get math. I mean I think they will get math, but they might not get it to the level of other kids in the class room. And that is just kids – they are all at different levels of understanding things.
Connie expressed an awareness of how different definitions of mathematics knowledge and understanding can impact one’s belief about students’ abilities to learn.

**Speed of Knowledge Acquisition**

In my two observations, Connie consistently gave students a lot of time to solve problems and respond to her questions. Connie was so patient that in a couple of instances other kids appeared bored while waiting for their classmate to figure out how to explain his or her answer. Moreover, in the context of a graded quiz, Connie encouraged her students to not rush, “I want you to take your time and not to get tricked by not answering the question all of the way.” When I solicited her reaction to the statement, “If a student cannot understand something in a mathematics lesson quickly, it usually means he or she will never understand it,” Connie emphatically said,

I don’t believe that at all because I had some kids who I tutored after school a couple times a week. We got an instructional assistant and with extra help and extra support, they did get things. It just took a long time.

Thus, Connie’s epistemological beliefs about the speed of mathematics knowledge acquisition are rather sophisticated.

**Source of Knowledge**

When asked how students gain mathematics knowledge, Connie interestingly did not refer to herself or to teachers in general. “I would say through experience, like we gain knowledge about everything. Either doing, reading about it, experiencing, however they’re involved with it.” When I inquired if she saw herself as the mathematics expert in the classroom, Connie responded,
I don’t know if it is that I see myself as that, as the kids do. Because their favorite
game is stump the teacher. They spend the whole year trying to develop a
problem that I can not solve…That’s just the way kids look at you. I do not want
to promote seeing me as the expert at all. A lot of times when one kid is finished
with his work and other groups are still working, those kids then get up and help
the other groups.

Furthermore, Connie readily admits to her students that she is not all-knowing. As she
had her students describe geometric shapes, one boy pointed out that she had written
labels on the different sides of the triangular prism. Connie’s reply was, “I did write them
on there. You know why I did that? Last year I could not remember.”

Connie also encourages student autonomy in knowledge acquisition through how
she designs her lessons. For example, she begins her mathematics lessons with discussion
time in which she structures problems that build students’ reasoning skills and solicits
students’ explanations of mathematical ideas. Connie also provides opportunities for
students to see themselves as the source of mathematics knowledge through exploration
activities such as the geometric dream houses and probability game. Thus, although she
admits her fallibility and promotes student autonomy, it appears that Connie struggles
with how to help her students to believe she is not the source of mathematics knowledge.

Mathematics Teaching Efficacy: Analysis of The Teaching Task

As teachers analyze the mathematics teaching task, they consider their abilities to
effectively accomplish three primary teaching responsibilities: student engagement,
classroom management and instructional strategies. Each of these major facets of
teaching mathematics is comprised of more specific tasks that uniquely impact a
teacher’s mathematics teaching efficacy. Connie’s judgment of her efficacy to teach
mathematics is discussed in terms of her analysis of these various tasks.
**Efficacy for Student Engagement**

Connie expressed a relatively high level of efficacy for student engagement through her beliefs about her abilities to accomplish the four student engagement teaching tasks that are identified in the TSES: to get students to believe they can do well in mathematics, help students value learning mathematics, motivate students who show low interest in mathematics and assist families in helping their children do well in mathematics. An additional factor that appeared to have a powerful impact on student engagement was Connie’s ability to develop positive relationships with her students.

When asked to what extent she could get her students to believe they can do well in mathematics? Connie responded:

I think a teacher can impact that obviously – in the way you lead kids through activities and try to make sure that everybody has the concept before you move on, which is always really hard. Spending a long time on the problem so every kid gets it. I would like to say that I did that all the time, but sometimes you’ve got kids who are not getting it, but you’ve got 22 others who are bored out of their mind. It is always that balancing act between wanting to continually challenge the kids who get it and moving on. But I do think that a teacher can impact that in how you plan your activities, how your discussions go. And you have to be cognizant of kids who are not getting it as quickly and make sure that they have areas of success.

Connie demonstrated her **efficacy for getting student to believe they can do well in mathematics** by often praising students’ mathematics thinking and bringing attention to excellent work. As her students were building the geometric sections of their dream houses, Connie held up different examples of student’s projects to show the class and provide helpful ideas. Connie was also consistently very patient when kids would struggle in asking questions or explaining their solutions. She verbally affirmed their
abilities to do well on a quiz. “Make sure you read the question all the way because you guys obviously all know this stuff because you all answered it [in the review].

Connie also believes teachers can “do a ton” to help students value learning, “in how we present math, how we talk about it, how it is like everyday life, how important it is, giving concrete examples. I think teachers can impact that a huge amount.” When I asked her for a specific incident this past year in which she helped her students value mathematics, without delay she explained:

We did a store for social studies where we made products and the whole school came by and bought stuff. At the end of the day we counted all the money and divided it among the kids. They all got to keep it. It wasn’t a fund raiser; it was an entrepreneurship thing. So in terms of money, that is always the first thing in terms of how math affects your life. But there were a lot of math things involved in that – there was problem solving, computation of multiplication and division, all sorts of different things.

The enthusiasm for learning mathematics that I witnessed in Connie and her students during both observations was vivid evidence of her strong sense of efficacy to help students value learning mathematics.

However, Connie was realistic in her efficacy beliefs to motivate students who show low interest in mathematics. Her response to my inquiry about this teaching task was, “I would not say every single day they were motivated for math, but certain activities you can do definitely motivates kids.” She proceeded to describe how her students were motivated by the Mars fraction hunt in which they were challenged to find a hidden candy bar by solving mathematics codes. When I asked her about her ability to stimulate internal motivation, Connie explained,
There are kids who are internally motivated – they want to do well, they want to be the first to get the answer. There are others who are motivated because they want to get it done and they are more persnickety about their school work. There are some kids who school is not their first love of life. I mean I have one of them at home. Sometimes the internal motivation is harder to come by with them, but I think all people can be motivated.

In response to the TSES question, “How much can you assist families in helping their children do well [in mathematics or] in school in general?” Connie said,

I think you can assist them, maybe not every single family because you do not have an opportunity to meet every family, but in the types of projects that you send where the parents have to be involved to help the kid with it; just how open you are about parents coming into your classroom; calling parents. I tried to call parents last year of some kids who had a lot of behavioral problems, I’d try to call them when their kids did something really good. Just because you are always calling about something else.

Another teaching task related to student engagement that is not considered in the TSES is the ability to develop positive relationships with students. Connie expressed her efficacy for developing positive relationships with her current students as she said, “I love the kids.” As the students worked on their dream houses, they would excitedly tell Connie about what they were making as she walked around the classroom. She was very affirming and encouraging; students obviously enjoyed talking with her. She also modeled respect toward her students. When a student hesitated with answering a question and other students would want to be called on, Connie would say, “Put your hands down, let’s listen to Rob.” As a result, it was evident that her students felt comfortable being creative, taking risks, and fully engaging in the learning process.

**Efficacy for Classroom Management**

Connie’s ability to create an atmosphere of enjoyment, safety, and respect forms a solid foundation for her classroom management. Although some teachers might have felt
things were too out of control noise- and activity-wise in Connie’s classroom, she readily had the ability to settle her students when they got too rambunctious. Connie explains, “I am not that strict of a person so sometimes I feel like there is a little too much going on. I would like to rein things in a little bit more, but it’s not really my personality, so I am trying to find the balance in that.” Connie expressed a relatively high level of efficacy for classroom management through her beliefs about her abilities to accomplish the four classroom management teaching tasks that are identified in the TSES: control disruptive behavior, get children to follow classroom rules, calm a student who is disruptive or noisy, and establish a classroom management system.

Although Connie has a high threshold in terms of noise and activity, when she reaches her limit she is able to control disruptive behavior relatively effectively. For example, after already being asked once to settle down, a student, Jake, was talking into the fan. Connie told him, “You know Jake, I am just about to send you back to Mrs. Bell’s room. Make your choice. Do you want to stay in here, or do you need to go back?” [Stay here] “Ok, well you have got to act like you want to stay here.” Jake was attentive for the rest of the lesson.

When I directly asked Connie, How much can you do to control disruptive behavior in your classroom? She responded, “I think you can do a lot… With the more regular, or cases within the norm, I think you can control it.” However, with extreme situations, as with her bipolar student, Connie said, “Eventually, they can just be out of the room if all else fails.”
At one point in my second observation as Connie was asking the students to think of examples of different levels of likelihood to qualitatively explore probability, some of the students were distracted. Connie said,

Listen to what we are going to do. Hey Jarrod come have a seat on the carpet. Alecia, turn around and face forward. Jarrod, sit right here... Put your hands down. Ok, boys and girls, I am extremely disappointed right now. [All became quiet.] Ok. You guys are much too smart for this, we should have been able to buzz right through this with a lot less reminders. OK. What we are going to do right now is an experiment with dice. But I am not quite sure you are ready to handle it today. Ok. What do you some of the rules might be for doing something with dice? Jake?
Jake: No throwing.
Connie: No throwing. That’s a good one. There were some dice that were thrown yesterday.

Connie’s response to my inquiry about her feelings about whether she was able to get children to follow classroom rules was,

With lots of reminders. Some kids follow them all the time and some kids forget them at the drop of a hat….staying in their seat when they are supposed to be in their seat – when they are doing quiet work and they’re supposed to be in their seat some kids, a couple of little boys – it was just hard for them. I have three boys at home, so I am sympathetic to the energy side of things.

In the above classroom incident Connie had students establish appropriate rules for the dice game, demonstrating her belief in her ability to use effective strategies to get children to follow classroom rules.

Even though Connie has a high tolerance of noise, when students disrupt the learning process or are disrespectful, she will intervene. When Connie asked a question of a student, Joe, several kids loudly responded. Connie humorously asked them, Ok, who’s name is Joe? When they continued to excitedly yell out answers, she told them, “I am not going to call on you if you keep calling out.” They raised their hands and waved
them around, but most quieted down. Later in that lesson three boys were talking as
Connie gave instructions for the next activity. She said, “Hold on a second. You three
come see me at 2:45. I am not sitting up here saying please be quiet for my health. All
three of you stay in at 2:45.” The boys stopped talking.

When I asked Connie, “Were there any points over the past year where you felt
like it was out of control and you were totally frustrated with your kids?” she honestly
confessed,

Yea, there were times when I was extremely frustrated with everyone and I would
say things like no one is going out for recess – you know, stupid things. But I
would make them come in for five minutes and then send them out for recess.
That was part of the human – it wasn’t necessarily anything they were doing, I
was just tired or frustrated.

In general Connie had moderately high efficacy to be able to calm disruptive students,
but she also struggled with the consequences of the solutions to which she sometimes
resorted.

When I asked Connie about her efficacy to establish an effective classroom
management system, Connie openly admitted,

I felt like I had a system, but I am not the most consistent person in the world. I
am kind of lax myself, so that is just my style. I am not rigid, so I don’t think that
always lends itself to classroom management where everything is like this
(perfectly calm). The kids have to remind me of stuff.

Perhaps because I have a similar approach to classroom management, I found Connie’s
easy-going “system” to work well with her students. It seemed that Connie knew she
could calm her students whenever it was necessary to ensure a positive learning
environment.
**Efficacy for Instructional Strategies**

Connie expressed a moderate level of efficacy for instructional strategies through her beliefs about her abilities to accomplish the four instructional strategies teaching tasks that are identified in the TSES: use a variety of assessment strategies, provide an alternative explanation or example when students are confused, craft good questions, and implement alternative strategies. Three additional factors appeared to impact Connie’s efficacy for instructional strategies: mathematics content knowledge, management of instructional time, and addressing students’ different levels of mathematics understanding.

One teaching task through which Connie’s efficacy for instructional strategies was observed was her use of a variety of assessment strategies. During my second observation Connie gave a multiple choice quiz on geometric shapes, however, she also required her students to write explanations for each answer. However, when asked to what extent she was able to use a variety of mathematics assessment strategies, Connie responded,

Not as much as I would like. I would really like to do one-on-one oral assessments with kids to talk with them and see what they are understanding. And the only time that I have made myself find the time to do that is with face value discussions… Their math journals give me a lot of assessment because I can go through those and see what they have been doing in their daily work. And then I do do tests. I don’t necessarily, as a grade and I would like to do this, assess their group work and how they are functioning within a group and how their group is understanding, those sorts of things–more anecdotal assessments – some day!
Connie also expressed efficacy beliefs as she explained, “One of the things that I don’t do as well is sometimes understanding why kids can’t get certain stuff when it seems so obvious.” But later when I specifically asked, “How able are you to provide an alternative explanation or example when students are confused in mathematics?” Connie responded,

I think I can usually do that, and if I run out of ideas, or even before I run out of ideas, you get the kids to explain things in different ways. I have a pretty good handle on math, so I am not uncomfortable with that.

Connie demonstrated efficacy for crafting good questions as she consistently encouraged student autonomy by responding to their questions with questions that helped them to solve problems themselves. For example, when one boy told Connie, “I can’t remember what perpendicular is,” Connie asked him, “What kind of angles do perpendicular angles make?” When he responded, “Right angles?” She said, “Yes, so do you know what perpendicular looks like?” He said yes and continued working on the problem. When I asked Connie about her ability to craft good mathematics questions, she explained,

The questions I think are best are the questions you make up yourself or that you put your name in them or that you put the kids’ names. They love that…I do make up my own questions a lot, but I often get them from other areas and just adjust them for the classroom. It’s funny how they will enjoy it so much more if you put a twist in it. Like we have to do those in/out boxes – you put a 12 in and a 17 comes out… We were doing those one day and I said, “Actually, these are candy making machines. If you put five pieces of candy in you’ll get 10 out.” Then all of a sudden, they love it! It just never occurred to me at first to say something silly like that. They are like, “Ok, let’s put in a 1000 pieces of candy in and see what we get!”
Although Connie defined good questions in terms of situational interest instead of quality mathematics inquiry, her strategies seem to be effective in engaging her students in mathematics learning, resulting in high efficacy for this teaching task.

In response to my question, “How well can you implement alternative mathematics teaching strategies in your classroom?” Connie’s emphatic response was,

That’s what we do all the time. We do do worksheets because they need the paper practice in order to be able to take the tests that they have to take. And we do do silent work sometimes. My math class is a combination of whole group instruction on the carpet where they are coming up with and solving problems, individual work, … and group [work]…And then they will come up and try to present their case. So I think we do a lot of different things to just kind of keep it interesting.

Although Connie explained that she had to follow the district’s curriculum guide, she did not feel too restricted by it.

We do not have to do every activity. We can pick activities and do activities on our own. I use the internet a lot for getting lesson ideas and worksheet and activities. But we have to follow the sequencing in the curriculum guide because of how the kids are tested.

Although Connie expressed only a moderate level of efficacy for instructional strategies overall, her responses, as well as my classroom observations, revealed adept skills in using assessment strategies, providing explanations when students are confused, crafting good questions, and implementing alternative strategies. However, there were three additional factors that also impacted Connie’s analysis of the teaching task of instructional strategies.

The first was her beliefs about her knowledge of the mathematics content. When asked about her beliefs about her abilities to teach mathematics, Connie’s very first response addressed her content knowledge of mathematics. “I would say that I
understand all of the concepts that I have to teach. My own math abilities are good.” She went on to explain that she did didn’t like mathematics until she went to graduate school for the first time. “I always thought I was horrible in math until that program.” Connie described how during her M.B.A. program, “I just got it. I mean I don’t think I didn’t have the ability to get it before, I just think I didn’t care about math. I just had that attitude.”

In our final interview I wanted to see what teaching tasks impacted her efficacy beliefs about the mathematics teaching planning process, so I asked Connie, “As you are preparing a lesson, what all is required of you?” Her first reply was “I think understanding the (mathematics) concept obviously - which in third grade is fine.” It appears mathematics content knowledge plays a primary role in Connie’s analysis of the teaching task and her efficacy for it appears moderately high.

The second additional factor that appears to often impact Connie’s efficacy for instructional strategies in mathematic teaching is management of instructional time. In our first conversation she admitted, “I am really frustrated teaching math. I don’t want to say it’s frustrating, but it’s hard to get everything done in the time I have to teach it.” Connie also said the past year and a half of teaching has “Overwhelming! Challenging. Hard to keep up with.” When I inquired, “What has been the most difficult?” Connie exclaimed, “Having the time necessary to plan well!” When asked what she did not expect about teaching, Connie responded, I did not expect to be as overwhelmed as I was...It’s like, you can’t ever catch up with the paper work. You can’t ever catch up with the grading, the planning. I never feel like I start the day with everything caught up to how I want it to be.
Again, in response to “What impacts your confidence to teach mathematics?” Connie’s immediate reply was, “having time to adequately prepare lessons so that you have good lessons prepared so you know you have time to think about where you are going and what you want to teach.” In our second post-observation interview Connie commented on the mathematics lesson.

It was way too much to do in one day. We have to get so much in. We want to use every minute so we don’t have enough time to let the kids have fun. Like sitting on the carpet, they were really getting into thinking of things that were most likely to happen, but I am sitting there thinking, “Oh I want to get through this activity so we can start with fairness.

Connie further commented on the impact of time on how much teachers should be involved in students’ development of conceptual understanding,

You don’t know how much to guide them and how much to let them – it’s like there is not enough time to let them develop all of these understandings on their own almost. Like with investigations – that math program- it is great, but man, we would have to teach mathematics all day long in order to do investigations.

In our final interview I raised the fact that Connie had often referred to time. She explained,

That is an issue for me, perhaps more so than for other people. But with my three children at home, I can’t stay until eight o’clock every night making sure I have the perfect math lesson. Even though I would like to.

Thus it is evident that Connie’s inability to effectively manage instructional time to the degree she desires has a strong negative impact on her analysis of the teaching task.

The third factor that influences Connie’s analysis of the instructional strategies teaching task is addressing students’ different levels of mathematics understanding. In response to my question about how she felt about her mathematics teaching, Connie said laughing, “Oh, mediocre. Because it is just so hard to address everything for the kids.”
She further explained that a “huge challenge has been the wide variation in where kids are at…Where to teach to and more how to come up with activities where they can take them. Activities and things that will be supportive of all the kids learning.” Effectively reaching kids with different levels of mathematics understanding seemed to have a powerful impact on her analysis of the teaching task.

I like teaching math. It’s more challenging because of all the divergent ways kids learn. For some kids the part about writing about it, just does not come as easy…Kids who can move numbers in their head are so better off than the kids who just do not have this kind of internalized numeration system…I don’t know what the difference is and how you address that with the kids who really struggle to learn math.

In our final interview I asked Connie what was required of her in planning effective mathematics lessons. After her initial response about understanding the mathematics concepts she said,

Probably the more important thing is trying to figure out where the kids are at and how they are going to react to a lesson, although you can’t always do that. And what sort of support they might need and making sure that it is at the appropriate level for them.

Initially, it appeared that Connie’s students’ mathematics abilities did not have much effect on her efficacy beliefs. However a closer look has revealed that despite having the intermediate students, the wide range of abilities negatively impacts her efficacy beliefs about her instructional strategy abilities.

Moreover, when I asked Connie how her confidence in her abilities to teach mathematics had changed since her M.Ed. program, she laughed and explained,
I am probably less confident now that I realize how hard it is! The more you know, the more you realize you don’t know. And the more you know and the more you learn about kids and teaching in a classroom environment, the more you realize how important it is that they get it… I mean, if my kids are not getting it, I am blaming myself... You think, “If I just could have figured out a different way to teach that... What am I doing? Why aren’t they getting it?”

Connie’s desire for her students’ to have a conceptual understanding of mathematics is a clear example of how her epistemological beliefs about mathematics impact her efficacy to teach mathematics.

Relationship Between Epistemological And Efficacy Beliefs

The influence of mathematics epistemological beliefs on mathematics teaching efficacy will be discussed in greater detail in Chapter 5. However, for Connie the relationship between these two constructs is perhaps most evident in her discussion of the disjuncture between the district’s curriculum and what her students must know for tests.

The biggest thing that has been challenging for me is to move the kids from the hands on manipulative type activities to proficiency they need for proficiency type questions. I am having a hard time finding the bridge between those two things, because you might do all of the manipulative things with them and they understand them, but it doesn’t necessarily help them respond to written type questions… The curriculum guide, I think doesn’t… There’s not the bridge. The curriculum guide is a whole host of activities, but the activities do not help the kids answer the proficiency like questions to go with the activities… There just seems to be a disconnect somewhere between the materials we are given to teach math and what they have to know on those tests.

Further, when asked how she prepares an effective mathematics lesson, Connie said,

I think about whatever problem they were going to have to solve, about what the activity is and how that activity will move them toward the concept I want them to understand. And I think about following the activity what I will do to have them demonstrate or take it one step farther – the bridge. A problem I always have is the bridge between the activity and writing about it, thinking about it, and taking it to the next level of understanding.
When I asked her how she makes the connection, Connie’s reply was,

   It mainly goes back to the math journals and trying to write about it and having
the kids share. All the kids share with each other what they have done, what they
have learned, how they have gotten it. That is probably the main thing we do in
writing activities to try to bridge that and try and get the kids to think about what
they are doing.

The positive analogy of “bridging” the disconnect between mathematics activities and
understanding is a powerful illustration of how Connie’s epistemological beliefs about
mathematics impact her efficacy beliefs about her instructional strategies abilities.
Because she seeks to teach in a way that promotes conceptual understanding instead of a
mere procedural or mechanistic form of knowing, the way she defines the teaching task is
more challenging. Although she has attempted to use the instructional strategy of having
her students write and explain their solutions, her efficacy to teach mathematics in a
manner that is consistent with her epistemological beliefs and equips her students to test
successfully is still developing.

   Epilogue to the Profiles

   The three profiles explored each teacher’s analysis of the mathematics teaching
context, mathematics epistemological beliefs, and analysis of the mathematics teaching
task. The impact their mathematics epistemological beliefs had on their mathematics
teaching efficacy was also briefly considered. In Chapter 5, after first presenting the
quantitative findings and implications, I will reexamine each construct across all three
teachers. A more in-depth discussion of the effect of the different dimensions of
epistemological beliefs on the teachers’ mathematics teaching efficacy will also be
presented.
CHAPTER 5

FINDINGS, IMPLICATIONS, AND RECOMMENDATIONS

In this chapter I present the findings of this study as they relate to the research questions about preservice and novice teachers’ epistemological beliefs about mathematics, their efficacy to teach mathematics, and the relationships between the two constructs. I first address the quantitative findings and discuss plausible explanations in relation to prior research. I next consider the qualitative findings about the three novice teachers in this study. I then look at the relationships between the quantitative and qualitative findings. This is followed by an exploration of the theoretical, measurement and practical implications of the findings. Finally, I provide recommendations for further research and conclusions of this study.

Quantitative Findings

The three quantitative research questions addressed the relationships among teacher efficacy, mathematics teaching efficacy, mathematics epistemological beliefs, mathematics self-efficacy, and mathematics performance, as well as the influence of teacher education and a student teaching experience (comprised in the variable of time) had on those constructs. Specifically, I sought to understand whether teacher efficacy,
mathematics self-efficacy and mathematics knowledge would predict mathematics teaching efficacy. I also explored how epistemological and self-efficacy beliefs would change as a result of a mathematics methods course and a student-teaching experience. Finally, I wanted to understand the influence that different levels of sophistication of epistemological beliefs had on changes in efficacy beliefs. A discussion of the findings from the three quantitative questions is presented below along with a comparison to the existing literature.

**Predicting Mathematics Teaching Efficacy**

The first research question was:

*To what extent do teacher efficacy, mathematics self-efficacy, and mathematics knowledge predict mathematics teaching efficacy?*

I posited that teachers’ efficacy for teaching and for doing mathematics, as well as their knowledge of basic arithmetic, algebra, and geometry mathematics problems, (which are necessary content knowledge requirements for the K-8 mathematics teaching task), would predict their mathematics teaching efficacy. The analysis of the linear regression revealed that the three independent variables accounted for only 22% of the variance in mathematics teaching efficacy. Moreover, teacher efficacy was the only statistically significant predictor of mathematics teaching efficacy. It is not surprising that teacher efficacy was a significant predictor of mathematics teaching efficacy because the MTEBI was developed from the STEBI, which was based on Gibson and Dembo’s (1986) TES. Woolfolk and Hoy’s (1990) adapted version of the TES was used to measure teacher efficacy in this study.
Although Schoon and Boone (1998) found that preservice teachers who performed well on a science principles test also had higher levels of science teaching efficacy, mathematics content knowledge as indicated by performance on a mathematics test was not a predictor of mathematics teaching efficacy in the current study. There are several possible explanations as to why mathematics knowledge and mathematics self-efficacy were not significant predictors of mathematics teaching efficacy. The mathematics problem-solving instrument that was used to measure both mathematics self-efficacy and mathematics knowledge may not have reflected the level or type of mathematics that the elementary teachers believed they would be responsible to teach. Another conceivable explanation is that the teachers did not take the mathematics test seriously or simply wanted to finish quickly, and thus the results do not accurately reflect their actual mathematics knowledge. The very poor performance scores (means of 68% and 60%) likely support this explanation. Yet it is possible that the participants truly tried to answer the mathematics questions, however, their lack of content knowledge resulted in poor performance.

As will be later revealed in the qualitative findings, it appears that teachers’ mathematics content knowledge powerfully impacts their sense of efficacy to teach mathematics. However, the MTEBI does not address teachers’ beliefs about their abilities for mathematics content knowledge. Thus the findings of this first question may inadvertently support the argument that teacher efficacy instruments for a particular content area need to include items that measure beliefs about their content knowledge abilities (e.g., I am able to clearly explain why \( \frac{3}{4} \) divided by \( \frac{1}{2} \) is \( 1\frac{1}{2} \)), or at least about
very specific pedagogical content knowledge and skills (I am able to teach division of fractions so that my students have a conceptual understanding).

Changes During Pre-service Training

The second research question was:

*How do preservice teachers’ overall teacher efficacy, mathematics teaching efficacy, mathematics self-efficacy, and epistemological beliefs about mathematics change during preservice training?*

Preservice training refers to the time from the beginning of the third quarter of a M.Ed. program that involved a second mathematics methods course (middle school level) to the end of the fourth quarter that was comprised of a student teaching experience. A repeated measures MANOVA and a follow-up univariate analysis of variance revealed that both teacher efficacy and mathematics teaching efficacy had significant changes. No significant change in mathematical epistemological beliefs was observed. Further, a t test indicated a significant increase in mathematics self-efficacy between the first and final data collections.

Consistent with the findings of Huinker and Madison (1995, 1997), post hoc analyses indicated that mathematics teaching efficacy significantly increased from a mean of 3.39 to 3.54 (on a 6-point scale ranging from zero (lowest) to five (highest)) over the period of time in which the teachers were enrolled in a mathematics methods course. Furthermore, consistent with Woolfolk Hoy’s (2000) findings, teacher efficacy significantly increased during the same period of time from a mean of 3.20 to a mean of 3.41. As both prior studies acknowledged, the students were simultaneously obtaining...
clinical experience and thus it is unlikely that the mathematics methods course alone was responsible for the increases in efficacy. Although the timing of this study was not optimal in that the students had already had an elementary mathematics methods course, there was still a significant increase in mathematics teaching efficacy over the period of time in which they had their second (middle school level) mathematics methods course. Further, because of the way the mathematics methods courses were taught, students learned that whether or not they know the mathematics, they can learn it. So it makes sense that mathematics teaching efficacy would increase.

Nevertheless, in contrast to the findings of Wingfield et al. (2000) whose participants’ mathematics teaching efficacy increased during a field-based experience, the slight increase in mathematics teaching efficacy for participants in the current study during their student teaching experience was not significant. Efficacy beliefs are most powerfully impacted by mastery experiences, however, the participants in this study taught varying amounts of mathematics both prior to and during their student teaching. If a student did not teach mathematics, her or his mathematics teaching efficacy would be expected to remain the same or change consistently with their overall teaching efficacy.

In contrast to the findings of Woolfolk Hoy (2000) whose participants’ teacher efficacy scores increased during a student teaching experience, the preservice teachers in this study experienced a significant decrease in their teacher efficacy from a mean of 3.41 to 2.98. It is possible that these participants perceived their student teaching contexts and/or tasks to be especially challenging or that they naively held an overestimation of teacher efficacy prior to student teaching. The fact that the net result was no significant
difference in teacher efficacy between the initial and final data collections may indicate that the efficacy the preservice teachers lost during student teaching may have been the efficacy they had gained during the methods course. Perhaps because it was based in more observational and persuasive sources of efficacy, and not actual mastery experience through teaching, the gained teacher efficacy was not as enduring. This explanation would need further research to evaluate its validity.

Possible explanations for the increase in mathematics self-efficacy include the influence of the participants’ experiences in the mathematics methods course, required mathematics courses for elementary teachers, and the student teaching experience. Also, the teachers had evaluated and solved similar problems on the mathematics self-efficacy and mathematics performance test during the first data collection. Moreover, following the first data collection, several students informed the researcher that when they completed the mathematics self-efficacy measure, they did not realize that multiple choice answers would be provided. This gained awareness more than likely resulted in higher mathematics self-efficacy to solve the problems in the final data collection.

Although Perry (1970) observed epistemological development across the college years and Schommer’s (1997) longitudinal study demonstrated epistemological development in the high school years, no significant changes in mathematics epistemological beliefs occurred among preservice teachers over two quarters involving a mathematics methods course and the student teaching experience. The time was too short, the mathematics methods course too infrequent, and many participants did not teach significant amounts of mathematics in their student teaching experiences to have their
deeply-seated epistemological beliefs impacted. Further, the preservice teachers had already completed one conceptually-based mathematics methods course during the quarter prior to the research. Also, Perry’s work was with undergraduates, so it is possible changes in epistemological beliefs had already occurred for these participants before they entered this graduate program.

Effect of Mathematics Epistemological Beliefs

The third quantitative research question was:

*How do mathematics epistemological beliefs influence the changes in mathematics self-efficacy and mathematics teaching efficacy during preservice training?*

The initial Pearson correlation analyses established that there were significant relationships of mathematics epistemological beliefs to mathematics self efficacy and mathematics teaching efficacy. Overall, those teachers with more sophisticated epistemological beliefs also had higher mathematics self efficacy and mathematics teaching efficacy. Perhaps sophistication of epistemological beliefs may in some way reflect teachers’ command of mathematics content knowledge. This finding will later be considered in relation to the observational findings.

To answer the third research question, the participants were grouped according to their mathematics epistemological beliefs scores into low (21 participants), moderate (20 participants), and high (21 participants) level of sophistication groups. A repeated measures MANOVA revealed that mathematics epistemological belief sophistication levels and time had a significant effect on at least one of the dependent variables.
Consistent with question two, further analyses showed that time had a significant effect on both mathematics self-efficacy and mathematics teaching efficacy. However, mathematics epistemological beliefs levels had a significant effect only on mathematics teaching efficacy, and not on mathematics self-efficacy. When follow-up analyses were conducted, however, the ANOVA with mathematics epistemological beliefs level of sophistication as the independent variable and change in mathematics teaching efficacy as the dependent variable, the findings were not significant.

The results of the initial analysis provide support for the argument that the higher a pre-service teacher’s mathematics epistemological belief level of sophistication, the higher his or her mathematics teaching efficacy. In regards to the third research question, however, the mathematics epistemological beliefs of the pre-service teachers in this study did not influence the changes in their mathematics self-efficacy or mathematics teaching efficacy during two quarters involving a mathematics methods course and a student teaching experience.

Teacher efficacy is theorized to change in response to four sources of self-efficacy: mastery experience, vicarious experience, verbal persuasion, and physiological response. The lack of impact of epistemological beliefs on change in mathematics teaching efficacy may indicate that just because teachers’ have more sophisticated beliefs about a subject, this does not equip them with resources to more effectively process the four sources of teacher efficacy. Further research is necessary to explore the influence of epistemological beliefs on teachers’ processing of sources of efficacy. Although, as I argue in the qualitative discussion, epistemological beliefs may influence teachers’
definitions of the teaching context and task, as well as their definitions of what it means
to teach mathematics successfully, they do not appear to influence the changes in
mathematics teaching efficacy over two quarters of a teacher training program. This
helps to clarify where in the integrated teacher efficacy model (Tschannen-Moran, et al.,
1998) epistemological beliefs may have an influence.

The lack of effect of level of mathematics epistemological beliefs on mathematics
self-efficacy may reflect the unfortunate fact that individuals can be confident of their
abilities to procedurally do a mathematics problem without having conceptual
understanding. As will be revealed in the qualitative findings, the teachers expressed that
they knew they could solve a mathematics problem, but they had difficulty explaining it,
revealing their lack of a conceptual form of knowing.

Summary of Quantitative Findings

The quantitative findings of this study provided insights into how teacher efficacy
and mathematics epistemological beliefs predicted 60 preservice elementary teachers’
mathematics teaching efficacy. It was determined that neither mathematics self-efficacy
nor content knowledge as indicated by performance on a mathematics test, predicted
mathematics teaching efficacy. One reason may be that the MTEBI was not developed to
assess teachers’ beliefs about their abilities to do mathematics. Doing mathematics is an
integral part of teaching mathematics. I argue that content knowledge of mathematics
impacts teachers’ efficacy to teach mathematics, thus in addition to pedagogical and
pedagogical content knowledge, it should be included in assessment measures.
The second quantitative question explored how teacher efficacy, mathematics teaching efficacy, mathematics epistemological beliefs, and mathematics self-efficacy changed during a quarter in which the students completed a second mathematics methods course and also during a quarter of student teaching experience. During the quarter that included a mathematics methods course, both teacher efficacy and mathematics teaching efficacy significantly increased. However, during the student teaching experience, mathematics teaching efficacy increased slightly, but not significantly, and teacher efficacy actually decreased.

Finally, the third quantitative research question considered the influence that teachers’ epistemological belief levels had on the changes in mathematics teaching efficacy and mathematics self-efficacy. Although overall, teachers who have more complex beliefs of how mathematics is known appear to have more efficacious beliefs about their abilities to effectively teach mathematics, epistemological beliefs did not influence the changes in mathematics self-efficacy and mathematics teaching efficacy in this study.

Qualitative Findings and Discussion

At the completion of the quantitative portion of this study, I still wanted a deeper understanding of the teachers’ mathematics teaching efficacy, epistemological beliefs, and the relationship between the two constructs. Through interviewing three teachers and observing them in their classrooms, I sought to gain a thicker description of the constructs that I had measured quantitatively. I followed three of the prior participants during their second year of teaching, interviewing them and observing them in their
classrooms. The three qualitative questions of this study explored mathematics epistemological beliefs, contextual and task factors that influenced mathematics teaching efficacy, and the influence that epistemological beliefs had on the teacher efficacy of three of the novice elementary teachers who had participated in the quantitative portion of this study.

The teachers were purposefully selected based on their mathematics teaching efficacy scores at the end of their M.Ed. program. Marie’s score on the MTEBI was in the middle third of the scores, Donna scored in the upper third, while Connie was among the lowest third of teachers’ scores on the MTEBI. Highlights of the findings from interviews and observations in these three teachers’ classrooms are presented and discussed in relation to the existing literature.

**Mathematics Epistemological Beliefs**

The first qualitative research question was:

*What are the mathematics epistemological beliefs of the three novice elementary teachers in this study?*

To address this question the six dimensions of mathematics epistemological beliefs identified in the literature review – structure of knowledge, form of knowing, stability of knowledge, ability to acquire knowledge, speed of knowledge acquisition, and source of knowledge - were used as a framework to analyze each teacher’s epistemological beliefs about mathematics. In this section the three teachers’ epistemological beliefs are presented, compared and contrasted with one another and with the existing literature for each dimension.
**Structure of knowledge.** A teacher’s epistemological beliefs about structure of knowledge can be described on a continuum from understanding knowledge as isolated bits and pieces of information to comprehending knowledge as interrelated networks of concepts. Simple knowledge in the epistemological literature corresponds to compartmentalized mathematics facts and rules in the mathematics beliefs literature, whereas complex knowledge corresponds to connected or integrated conceptual understanding (Schommer, 1991; Thompson, 1992).

One way that teachers’ epistemological beliefs about the structure of knowledge was explored in this study was through their definitions of mathematics. Marie simply said, “Math is problem solving using numbers and communicating with numbers.” Donna explained, mathematics “is a lot of things. The things that come to mind are trying to find order and pattern in things... Just the everyday things that make life work between measurement, money, problem solving. Connie defined mathematics as “the study of numbers,” but clarified, “that’s not all of it; I mean it is so huge. But everything in math goes to numbers. Even in geometry, everything is related to numbers.” Connie expounded that mathematics is about “being able to understand numbers and how they work in your life...being able to problem solve.” Donna and Connie’s definitions involved complexity and interrelatedness that were not as apparent in Marie’s.

Marie’s compartmentalized structure of mathematics knowledge was also evident in her belief that hands-on activities were not an integral part of mathematics, which she explained must involve some form of computation. Furthermore, her beliefs about
mathematics knowledge structure as isolated bits and pieces were revealed in her explanations about her students’ struggles: “The fractions themselves are not particularly the problem. It is the math.”

In comparison, Donna expressed an integrated conceptual mathematics understanding as she discussed how she taught addition. “When we reviewed basic facts at the beginning of the year, I worked a lot with counting on and missing addends. Or I talked to them like it was algebra, that ten minus six equals four is the same as four plus six equals ten.” In contrast, as Marie explained why a students’ answer of 3x7=21 was incorrect she said,

I couldn’t let him use the seven the way he wanted to use it. The only numbers given in the problem were three and 21. So he had to come up with a way to get to that seven. And that’s where the math thinking took place.

Marie’s explanation revealed her lack of conceptual understanding and her beliefs about the simple structure of mathematics.

The three teachers’ differing views on “math facts” also disclosed their beliefs about mathematics knowledge structure. Marie repeatedly emphasized how strongly she believed in the import of her students knowing mathematics facts. Donna also said, “I do believe that there are certain facts that they need.” However, she emphasized the importance of students learning “the process of how to get that information.” Donna expounded, “They are not going to know those facts engrained until they have used them a lot. So I don’t feel like they need to know every single fact.” Connie explained, “Math facts are just being able to move numbers in your head. If you have an understanding of those and can do those quickly, everything else you do in math is going to be easier for
you.” However, she emphasized the import of obtaining conceptual understanding. “I think math facts, if you master them without the conceptual understanding first, do not mean anything. Once you have the conceptual understanding of what multiplication is, then it is simple memorization.”

Both Donna and Connie are still in the process of incorporating their espoused beliefs about the integration of mathematics facts and conceptual understanding. However what they expressed about the interconnectedness of mathematics knowledge structure was not apparent in Marie’s statements. Thus, the teachers’ definitions of mathematics, their understanding of its integrated nature as revealed in their teaching, as well as their views on mathematics facts all revealed their beliefs about the structure of mathematics knowledge.

*Form of knowing.* Whereas the dimension of structure of knowledge captures an individual’s beliefs about the constitution of mathematical knowledge, form of knowing focuses on the means through which one knows mathematics (i.e., procedural or conceptual; mechanistic or problem solving). The three teachers’ beliefs about form of knowing mathematics are consistent with those discussed in the mathematics beliefs literature.

For example, as Battista (1994) described a teacher he had observed, he stated, “Because of her conception of the nature of mathematics she did not understand why making sense of the problem should be part of the instructional activity” (p. 466). Likewise, Marie’s similar beliefs about the form of knowing mathematics were evident as she explained, “You have to actually do it on the paper; you have to put the
manipulatives aside… At some point, you have to teach the skill and not worry about why you’re doing it.” Moreover, Marie’s beliefs about the form of knowing mathematics are like those of the teachers in Putnam et al.’s (1992) study who held that understanding was important, but because learning is seen as a rigidly sequential, hierarchical process, understanding must wait until the arithmetic basics are first mastered. Marie said, “My kids want to ask why all the time, but you don’t have to know why. Learn how and then you can start figuring out why. Skills first right now, and the how will follow.” It is clear that Marie’s unsophisticated epistemological beliefs about the form of knowing have a powerful negative influence on how her students are directed to learn mathematics.

Although Donna’s epistemological beliefs about the form of knowing mathematics were more sophisticated than Marie’s, like the teachers Schoenfeld observed, Donna’s use of “word problem key word procedures subverts understanding by teaching how without why.” Donna explained that one of the objectives of the lesson I was about to observe was “to figure out the language that tells you that it is a pattern – to find the clues that tell you that this is the kind of problem that you can use a pattern to solve.” However, she also stated her second objective was to get her students to be able to express how to solve a problem. Yet, she explained, “I like the idea of problem solving, but I don’t think it works for everything.”

Even so, Donna was not like Putnam et al.’s (1992) teachers who saw problem solving as merely “applying well-practiced computational skills in particular situations, rather than opportunities to figure out what is reasonable and sensible in those situations” (p. 222). Instead, Donna wants her students to learn to “think in a mathematical or
scientific way…It’s that logic, that making sense of things.” She said, “If you don’t understand why you do it then it’s pointless.” For example, when a student suggested an unusual solution to a problem, Donna asked her class, “Is that ok to do?” Donna gave the students opportunity to express their concerns and asked the student to demonstrate on the overhead how he had solved the problem. These examples of Donna’s beliefs about the form of knowing mathematics reveal that she is attempting to implement more sophisticated epistemological beliefs in her teaching practice.

Similarly, Connie stressed the importance of problem solving. Consistent with Thompson’s (1985) emphasis on sense-making and discovery of mathematics properties and relationships through personal inquiry, Connie wanted her students to have the opportunity to explore mathematical concepts and to discuss their ideas with their classmates. She focused on developing conceptual understanding by having her students explain the rationale for their answers verbally and in writing. Connie also encouraged students to question, guess, theorized and not fear being wrong (Thompson, 1985). She did not want her students to merely do computations or manipulate symbols, but instead structured her lessons to develop argumentation and justification. Of the three, Connie demonstrated the most sophisticated beliefs about the form of knowing.

Stability of knowledge. Accessing the teachers’ beliefs about the dimension of stability of knowledge proved to be more challenging. Teacher beliefs about the stability or certainty of knowledge is primarily discussed in the literature in terms of a continuum concerning the nature of the body of mathematics knowledge ranging from unchanging, static and standard, to evolving and dynamic. Thompson (1985) explained that
elementary teachers do not tend to see mathematics as a developing scientific discipline, but rather as a fixed product to be assimilated. Marie’s twelve references to “math facts” in our discussions and my observations of her teaching suggest she was inclined to perceive mathematics as a certain or standard body of knowledge consisting of facts and procedures that teachers must get students to master (Schoenfeld, 1985).

On the other hand, Donna’s statement, “I want you to explain to me how you got the answer. Ok? And it is ok if the way you got the answer is different from the way other people got the answer” indicates a more dynamic belief about the certainty of mathematics knowledge. Connie expressed a similar non-static belief about the stability of knowledge when she explained in a probability lesson that “Not everyone agrees where everything goes, ok?”

However, when I specifically asked Connie about mathematics problems that do not have a clear cut answer, she explained that her students always want to know the right answer. She discussed her struggle to discern her own beliefs about the certainty of mathematics knowledge and how it impacts her students’ beliefs. “They want to know what the right answer is, and they want that right answer on their paper!...So maybe I am like that too, ‘What is the right answer at the end?’...And kids don’t see in grey. Kids are black and white still. I don’t know if that is part of their development, or that’s only what we have allowed them to do.” Connie’s concern is a lucid illustration of how teachers’ epistemological beliefs can limit students’ mathematics epistemological beliefs. Her insight also reveals how awareness of one’s beliefs (or lack there of) and instructional
practices are not always aligned. Her comments demonstrate how beliefs are fragile. Connie thinks she believes in one way, but she really is not certain.

One aspect of the dimension of the stability of mathematics knowledge for which none of the teachers expressed awareness was how mathematics knowledge changes and expands. Consistent with Lampert’s findings, none of their responses to my inquiries revealed an understanding of how mathematicians “zigzag” between revising their conclusions and assumptions in the process of coming to know, how they submit their work for review by their colleagues, or how overtime mathematics conclusions that were unquestioned in the past are reconsidered (Lampert, 1990).

*Ability to learn.* Teachers’ epistemological beliefs about the dimension of malleability of learning ability range on a continuum from fixed ability to the ability to learn. None of the teachers directly expressed the belief that to be good at mathematics you need a mathematical mind (Carter & Norwood, 1997), but all acknowledge their belief that their students had varying mathematics ability levels. Marie said, “The kids are not able to think through the activities they have given me to do with them. They have trouble with the application end of the math. And that might just be my kids and their particular level that they are at – their reasoning levels.”

Marie expressed the erroneous belief that young children do not have the abstract thinking abilities necessary for problem solving. Putnam et al. (1992) found that teachers believed students should sometimes just learn the procedures and then later, when their minds are more mature, they can understand. Similarly, while discussing her students’ poor problem solving abilities, Marie said, “They are just not developmentally ready.”
From my observations of Marie’s students reasoning through problems, it appeared to me that some did have the ability to learn the level of material required by the curriculum guide. Mary simply did not have the ability to teach it, and so she placed the blame on her students’ apparent lack of ability. Her exasperating mastery experiences of teaching mathematics to her current students have apparently contributed to a more fixed view of ability to acquire knowledge.

In contrast, Donna communicated more sophisticated beliefs about her students’ abilities to learn. “If they don’t get it right now, in time they will get it. I mean I talk a lot to the kids about how there are things that I didn’t get for a long time, but eventually it all made sense… I really do believe that eventually most kids will get it. It’s just a matter of clicking. It’s that everything coming together to make sense…it just takes time and experience and practice.”

Likewise, Connie explained that not all of her students have the same mathematics abilities, but clarified, “Not to say they can’t learn it, but it’s a different road they have to take.” When asked if some students simply aren’t going to get math, she insightfully responded,

Well it depends on what you mean by “aren’t going to get math.” There are some kids who might not be able to pass the fourth grade proficiency test, but that does not necessarily mean that they do not get math.

Connie displayed an awareness of how different definitions of mathematics knowledge and understanding can impact one’s belief about students’ abilities to learn. Thus compared with Marie, Donna and Connie expressed more sophisticated beliefs about ability to learn.
**Speed of knowledge acquisition.** Teachers’ beliefs about the dimension of speed of knowledge acquisition lie on a continuum from quick learning or not at all to gradual learning. Despite her emphasis on quick recall of mathematics facts, Marie differentiated between speed in problem solving and the importance of understanding. “I could take my calculator and figure this out *real quick*. The hard part is what those words say and how I am going to work things.”

Even so, consistent with Schoenfeld’s (1988) finding that students believed it should only take 2.2 minutes to answer a typical mathematics homework problem, Marie unintentionally reinforced the importance of speed in problem solving by requiring a timed mathematics facts quiz every Friday and by giving her students insufficient time to work on word problems in class. Furthermore, Marie reasoned if her students did not grasp a mathematics concept in her classroom, she knew that they would encounter it again the following year. However Putnam et al. (1992) point out this belief subtly undermines reformers’ efforts to focus mathematics instruction on understanding and problem solving because teachers can fall back on “they’ll see it again” when students do not comprehend.

In comparison, Donna discussed the challenge of not reinforcing quickness in the mathematics classroom. “It is hard because one of the rewards you give a child when they are done is that they get to do something that they enjoy cause you are trying to wait for everyone to finish.” Yet Donna also communicated her own need to work through mathematics problems slowly to her students. “You know I have to sometimes read problems two or three times before I can figure out what they are trying to tell you.”

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Moreover, she tended to give her students more time than they appeared to need in order to walk around and make sure each pair of students understood the problem. It appears that Donna has a sophisticated level of belief about the dimension of speed of knowledge acquisition, but struggles with appropriately implementing it at times.

Connie also gave students a lot of time to solve problems and respond to her questions. She encouraged them to take their time and not to get tricked by not answering the questions all of the way on a quiz. Moreover, when asked to respond to the belief, “If a student cannot understand something in a mathematics lesson quickly, it usually means he or she will never understand it,” Connie emphatically said, “I don’t believe that at all!” She went on to explain how extra tutoring and support has significantly helped several of her students grasp concepts they had difficulty with in class. Thus, once again, Donna and Connie appeared to have more sophisticated beliefs than Marie about the dimension of knowledge acquisition.

**Source of knowledge.** Orton, Ball, and Cooney (1995) described one extreme of teachers’ beliefs about the dimension of source of knowledge as the teacher as master and judge who validates correct answers and tells students what to do. All three teachers appeared to struggle with not being the mathematics expert in the classroom. Marie’s statement, however, “they really can’t go off on their own and do it themselves” is clearly consistent with Stodolsky et al.’s (1991) findings that when teachers believe students cannot learn mathematics on their own, they foster reliance on the “all-knowing” teacher to tell the “helpless” students what to do.
Marie’s students’ obvious frustration with her students, who all struggle in the mathematics learning process, may partially result from this dynamic. As Pea (1987) explains, “Students see themselves as recipients of the inert mathematics knowledge that others possess, not as mathematics thinkers – so teachers think they have engaged the students’ learning commitment, but students rarely see significance in the learning because it is someone else’s math. Thus problems are approached with someone else’s knowledge and reasoning” (p. 118). Furthermore, Marie’s dependence on the textbook and curriculum guide modeled dependence on an external source for her students. This is consistent with Lampert’s (1990) findings that in conventional mathematics classes students believe that the teacher knows the correct answer, and the teacher believes that the right answer can be found by using rules in the textbook (Lampert, 1990).

In comparison, Connie is struggling with her beliefs about the dimension of the source of knowledge. She explained that she did not want to promote herself as the expert, nevertheless, her students saw her as such. She tried to counter this belief by promoting student autonomy in exploration activities and having students who finish early on projects help others who are still working. Yet it appears that Connie inadvertently reinforced her role as expert through her “stump the teacher game” in which students were encouraged to give her problems they thought she would not be able to solve.

The sophisticated end of the source of knowledge dimension’s continuum includes student autonomy in the proposal of problems and validation of solutions. Donna portrays herself as a mathematics learner, almost equal with the students as they
discover mathematics knowledge together (Orton, Ball, & Cooney, 1995). Donna had her students create problems for their partners and explain how they developed solutions. Yet she revealed that she is still developing the belief in students being the source of mathematics knowledge as she explained, “What I would have liked to have done and maybe some day I’ll get to that, is that they figure out how to add, without me telling them here’s another way.” Whereas Marie displayed a strong need to appear the mathematics expert, both Donna and Connie willingly admitted their fallibility and demonstrated more sophisticated beliefs about the dimension of source of knowledge.

Summary of Findings on Mathematics Epistemological Beliefs

Marie, Donna and Connie displayed much of the range of the continuums for each of the six dimensions of epistemological beliefs. Of the three, Marie definitely had the most naïve epistemological beliefs, often exemplifying the negative examples provided in prior research. Donna held more mature epistemological beliefs, but struggled to implement them in her classroom. Connie overall tended to have the most sophisticated epistemological beliefs of the three, but still has much room for growth. However, it is important to point out that within each of the teachers’ epistemological belief systems, different dimensions of epistemological beliefs exist at differing levels of development.

Qualitative analysis of the teachers’ epistemological beliefs has served to flesh out their espoused and enacted beliefs about the six dimensions and has provided a rich description with specific examples that quantitative measures are not able to ascertain. However, one issue that has arisen in the analysis process is a concern that is inherent in qualitative research. As I considered the teachers’ statements about mathematics, I was
specifically looking for epistemological belief statements. In a sense, I used the lens of epistemological beliefs for analysis. In doing so, I acknowledge that some of the mathematical statements that I interpreted as being unsophisticated epistemological beliefs may instead have simply been expressions of lack of content knowledge. For example, when Donna said, “I like the idea of problem solving, but I don’t think it works for everything,” she may have just been revealing her lack of content knowledge. When a teacher does not know the content well, he or she will be unable to pose the appropriate questions to facilitate student learning. Nevertheless, it still appears that teachers’ epistemological beliefs about mathematics create a boundary within which their conceptual understanding of their current quantity of knowledge develops.

Mathematics Teaching Efficacy

The second qualitative research question was:

What aspects of the teaching context and task influence three novice elementary teachers’ efficacy judgments for teaching mathematics?

To explore this question the three novice teachers’ analyses of their teaching context and task as theorized in Tschannen-Moran, et al.’s (1998) integrated model are presented and discussed in relation to findings of previous qualitative studies on teacher efficacy.

Tschannen-Moran and Woolfolk Hoy (2001) have explained that as teachers analyze the teaching task and its context, they weigh the relative importance of factors that make teaching difficult or act as constraints against an assessment of the resources available that facilitate learning. As teachers make judgments about self-efficacy, they
“must assess what will be required of them in the anticipated teaching situation. This analysis produces inferences about the difficulty of the task and what it would take for a person to be successful in this context” (p. 228).

For teaching context, the teachers’ school and classroom environment, student behavior and student mathematics performance are considered in this discussion. To examine the teacher’s analysis of the teaching task, efficacy for student engagement, classroom management, and instructional strategies are taken into account. Furthermore, findings on four additional factors not considered in the TSES that influenced the teachers’ analyses of the teaching task are presented and discussed. As part of student engagement, efficacy for developing positive relationships with students was identified. And impacting teacher efficacy for mathematics instructional strategies were the tasks of managing instructional time, understanding mathematics content knowledge, and meeting the diverse needs of students with different mathematics knowledge and skills.

Assessment of the teaching context. The contexts in which Marie, Donna, and Connie taught varied greatly, as did their assessments of those contexts. Marie by far had the most challenging teaching context of the three. Her public city school is comprised of about 95% socio-economically disadvantaged students who are ethnically and culturally very different from Marie. This cultural mismatch was evident in her interactions with her students. When I attempted to discuss the issue, Marie appeared unaware or unwilling to discuss how cultural issues were influencing her mathematics teaching efficacy.
Although Marie described her principal and colleagues as very supportive, she did not have a mentor teacher. Marie’s eight mathematics students all performed on a third grade level or lower, yet Marie was still required to follow the fifth grade district mandated curriculum guide. Her students’ inability to recall addition or multiplication facts and their very low reading comprehension skills limited their understanding of mathematics problems. These contextual factors related to student academic performance had a strong negative effect on Marie’s mathematics teaching efficacy.

Perhaps due to the cultural mismatch or to the frustration resulting from Marie’s inability to facilitate mathematics learning, her students’ classroom behaviors were extremely disruptive. Marie believed, however, that their poor classroom behavior was a result of coming from rough family backgrounds. Irregardless of the cause, when her students talked back, refused to follow her directions, or even started fighting, their behavior had a negative effect on her analysis of the teaching context, thereby impacting mathematics teaching efficacy.

Overall, Marie’s assessment of her teaching context appeared to have a negative bearing on her mathematics teaching efficacy judgments. She described her classroom as a zoo and repeatedly expressed low efficacy for overcoming her students’ unruly behavior. “It’s really discouraging to try to expect them to learn and try to teach them when they are doing stupid stuff.” Marie’s defeated attitude toward her students’ low academic performance also revealed how her teaching context negatively impacted her
efficacy. She described her students as “idiots,” saying “They are not operating at a normal fifth grade level. That’s for sure. On any level, reading, math, maturity – any of those levels.”

Donna’s teaching context was quite different. She taught third grade in a small rural Catholic school where spirituality and an emphasis on the development of moral character powerfully impact the teaching context. Donna’s principal was very supportive, however, her relationship with one of her colleagues had a negative influence on her analysis of the teaching context. She expressed frustration over the fourth grade teacher’s emphasis on mechanistic approaches to teaching mathematics and the effect that has on how she prepares her students for the future.

In terms of student behavior, Donna perceived her class as caring and well-behaved. Her students were polite and obediently followed directions. They work well with one another and were actively engaged in the learning process. Donna did mention two students that appeared to impact her analysis of the teaching context. The first was a boy who was being tested for learning disabilities due to lack of focus. The second student had some challenging home problems that appeared to impact her classroom behavior. In regards to student academic performance, Donna described her students as being “mostly above average” and believed they could grasp the mathematics concepts she was teaching. Donna did express frustration over her students’ lack of number sense and problem solving skills, but appeared confident that she could address these issues. Overall, Donna’s analysis of her teaching context appeared to have a primarily positive influence on her mathematics teaching efficacy judgments.
Although Connie taught third grade in the same public city district as Marie, her school served one of the more affluent areas and had a comparatively lower percentage of socio-economically disadvantaged students. Further, the majority of students were from cultural backgrounds similar to Connie’s. Connie not only had a very supportive principal, but she is the only one of the three participants who had a very close mentoring relationship with an experienced teacher. This relationship appeared to have very positive effect on her analysis of her teaching context. Connie’s positive interactions with her students and the fun atmosphere in her classroom were evidence that classroom environment also had a favorable influence on her analysis of the teaching context.

In terms of student behavior, Connie stated that her school “overall does not have a lot of behavior problems…the biggest behavior problem is kids talking.” Connie did express concern and frustration over one boy who was diagnosed as bipolar: “that’s been a huge challenge.” Connie’s relaxed classroom environment allowed for a lot of student talking, but they were intently engaged in the learning process and their discussions were primarily on task. Student behavior appeared to have a positive effect on Connie’s analysis of the teaching context: “I have such a good class.” Although Connie expressed frustration over some of her students’ mathematics abilities, especially in terms of number sense, the majority of her 22 intermediate level students appeared to comprehend and enjoy the mathematics they were learning. After solving a pattern problem, one even expressed, “This is so cool!” Thus it appeared that teaching context had a primarily positive influence on Connie’s mathematics teaching efficacy judgments.
Several key issues rose to the surface as I analyzed the factors the teachers considered as they assessed their teaching context. The first is the belief that the background in which their students live is the main source of their poor behavior and academic performance. Marie especially expressed the challenge of dealing with students who come from difficult home environments. However, Donna also discussed how one girl’s parents’ conflicts were negatively impacting her behavior and thus Donna’s assessment of the classroom context. This issue is foundational to teachers’ self-efficacy beliefs. In fact, one of the original RAND questions was “When it comes right down to it, a teacher really can’t do much – most of a student’s motivation and performance depends on is or her home environment.”

Another factor that all of the teachers mentioned as they assessed their teaching context was the struggle of effectively dealing with special needs students. As they identified factors that impacted their mathematics teaching efficacy, Marie repeatedly referred to the fact that two of her students were on IEPs, Donna discussed her plan to test one boy who appeared to not be able to grasp mathematics concepts, and Connie acknowledged her frustration over her bipolar student. Students with exceptional academic and emotional needs negatively impacted all of their assessments of the teaching context. Identification of this factor as an influence on mathematics teaching efficacy is consistent with the original RAND teacher efficacy item, “If I try really hard, I can get through to even the most difficult or unmotivated students.”

Another contextual factor that appeared to influence all three teachers’ analysis of the teaching context was whether they had the resource of a mentor teacher. Each
expressed that their principals were supportive, but only Connie identified someone she
could turn to for guidance and encouragement in her mathematics instruction. Connie’s
regular interactions with the other third grade teacher who had taught for 25 years led to
their decision to regroup the students to more effectively meet their mathematics needs.
Connie’s mentor provided emotional support and instructional insights unavailable to the
other two teachers. In fact, Marie agreed to participate in this study because she looked
forward to the opportunity to discuss her mathematics teaching, “I’m open to any and all
suggestions because I’ve really been struggling here.” Donna also specifically said that
she struggled because she had no one with whom to discuss mathematics instructional
concerns.

An additional contextual factor that impacted the assessment of the teaching
context of the two teachers in the city public schools, Marie and Connie, was their
district’s mandated curriculum guide. Connie seemed a bit overwhelmed by its extensive
requirements. “Between all the curriculum guides there is just so much!...It’s amazing!
We have to follow the guide pretty much.” Marie expressed low efficacy as she explained
how the curriculum guide dictated the scope of her mathematics teaching, “I follow the
curriculum guide because that’s what the school district wants me to do… I teach from
the curriculum guide. That way if they do not do well, I can say, well I did what you told
me to do.” The powerful impact of the mandated curriculum guide on both
epistemological and mathematics teaching efficacy beliefs will be later discussed in
greater detail.
Finally, in terms of student academic performance, it is interesting that both third grade teachers, Donna and Connie, indicated that their students’ lack of number sense impacted their analysis of their teaching context. Donna said, “Oh my gosh, my kids have no numbers sense – it drives me nuts!” She and Connie discussed how their students had not learned number sense in prior grades and how that affected subsequent mathematics learning. Connie’s comment, “Until you have a number sense, you can’t skip around and do more complicated things” revealed how the contextual factor of student academic abilities impact teachers’ analysis of the teaching task. Moreover, it illustrates how Connie’s epistemological beliefs about mathematics influenced her definition of the teaching task.

Assessment of the teaching task. To examine the teacher’s analysis of the teaching task, their efficacy for student engagement, classroom management, and instructional strategies are taken into account. Furthermore, findings on additional factors that influenced the teachers’ analyses of the teaching task are presented and discussed. Once again, the questions from the short version of the TSES that were used as a framework in the teacher profiles, will guide the discussion of findings. However, I also return to conclusions from prior qualitative teacher efficacy research, which were presented in Chapter 2 to support the analysis of the teaching task findings.

Efficacy for student engagement. As I considered teachers’ analysis of the task of student engagement, I focused on their abilities to accomplish the four student engagement teaching tasks that are identified in the TSES: (1) get students to believe they
can do well in mathematics, (2) help students value learning mathematics, (3) motivate students who show low interest in mathematics and (4) assist families in helping their children do well in mathematics.

Marie’s self-efficacy for student engagement appeared to be very low. At one point as she struggled to keep her students involved in the learning process, she said, “I am not going to do this…There is no point. The level of cooperation is nonexistent, and the problems are too hard.” It was evident that she did not believe that her students could do well in mathematics, thus she did not have the efficacy to get them to believe they could do well. “They weren’t capable of doing the work, so they couldn’t do it…I just have to do one problem at a time or they can’t figure it out.” Marie was so frustrated by students’ disinterest and related misbehavior that she regularly appeared to simply stop mathematics lessons. These observations are consistent with those of Ashton and Webb (1986) who found that low efficacy teachers were unable to spark student interest in academic work and unwilling to challenge students or closely monitor their academic progress. Further, Marie expressed her low efficacy regarding assisting families as she discussed her students’ poor academic performance and behavior: “Actually, they are reflecting their parents, and there is not a whole lot that you can do about that.”

In contrast, Donna had developed effective strategies for promoting student engagement, thus her efficacy for this teaching task was greater than Marie’s. Although she admitted, “If the kids freak out, that bothers me,” one way Donna has tried to get her students to believe they can do well in mathematics is by first teaching those who are struggling in mathematics so they could teach it to the rest of the class. Donna also
expressed that she based her efficacy to engage students in mathematics on how motivated they were to learn. “I know that 100% of the kids are not going to be interested 100% of the time, but if the majority seem engaged and on task, that impacts.” My classroom observations of her students’ enthusiastic participation supported Donna’s high efficacy for the tasks of motivating students and helping them value learning mathematics. Donna has a very affirming and caring relationship with her students; she even seemed a bit maternal toward them. She explained that her own negative mathematics experiences help her to be empathetic with her students’ struggles.

When I see a student going, “I don’t get this,” I know what that feels like, and so I know that frustration. And so I think I identified with it and instead of getting frustrated with them I’m able to just say, “Okay, let’s just step back. And I’ve told the kids before, “If you don’t get it right now, it’s okay.”

Donna’s encouraging interactions with her students interestingly appear to have a mixed impact on her mathematics teaching efficacy, perhaps reminding her of her own mathematics insecurities. This finding is consistent with that of Ramey-Gassert, Shroyer and Stave (1996) who found that low efficacy teachers’ own prior lack of success in science often led to empathy for students, thereby reinforcing beliefs that their students would not be able to understand science.

Connie expressed a relatively high level of efficacy for student engagement through her beliefs about her abilities to get her students to believe they can do well in mathematics. She said she attempts to accomplish this through trying to make sure as many students as possible understand a mathematical concept.
It is always that balancing act between wanting to continually challenge the kids who get it and moving on. But I do think that a teacher can impact that [helping students believe they can do well] in how you plan your activities, how your discussions go. And you have to be cognizant of kids who are not getting it as quickly and make sure that they have areas of success.

Her beliefs are similar to those of the high efficacy teachers in Ashton and Webb’s (1986) study who exhibited a “with-it-ness” and awareness of student comprehension.

Connie was realistic in her efficacy beliefs to motivate students who show low interest in mathematics. “I would not say every single day they were motivated for math, but certain activities you can do definitely motivates kids.” She also believed that she could assist parents to help their students do well, however, “maybe not every single family because you do not have an opportunity to meet every family, but in the types of projects that you send where the parents have to be involved to help the kid with it; just how open you are about parents coming into your classroom.” She also calls parents when their kids perform or behave especially well.

The contrasts between Marie’s assessment of the teaching task of student engagement and those of Donna and Connie are strikingly similar to the findings of Czerniak and Shriver (1994). How Donna and Connie defined what was necessary for success in terms of student engagement parallels the high efficacy teachers in Czerniak and Shriver’s study whose assessment of success was in terms of children’s interest, evidence of learning, on-task behavior, and active participation. Their high efficacy teacher participants, like Donna and Connie, focused on providing students opportunities to make choices and independently discover the concepts being taught. In contrast, low
efficacy teacher participants, like Marie, tended to assess their teaching success through concrete examples of the students’ actual work or correct answers, and in terms of their ability to maintain step-by-step control.

A teaching task related to student engagement that is not considered in the TSES was identified in the analysis: the ability to develop positive relationships with students. As Donna and Connie discussed what impacted their teaching efficacy they both referred to their warm and caring relationships with their current students. “I love the kids.” This supports prior findings that high efficacy teachers had positive relationships with their students and expressed a willingness to teach all students and a determination to help all students succeed (Hebert et al., 1998; Milner & Woolfolk, 2001; Ashton and Webb, 1986). However in sharp contrast, Marie’s relationships with her students appeared to have a negative impact on her analysis of the teaching task of student engagement. “I had a hard class last year, but this particular group [of students] is just really challenging.” “They just are not nice to me or to each other.” Soon after I observed two female students mock Marie saying, “Don’t you get smart with me,” she soon afterwards simply stopped the mathematics lesson, appearing extremely discouraged.

Efficacy for classroom management. As I considered the teachers’ analyses of the task of classroom management, I focused on their abilities to accomplish the four classroom management teaching tasks that are identified in the TSES: (1) control disruptive behavior, (2) get children to follow classroom rules, (3) calm a student who is disruptive or noisy, and (4) establish a classroom management system.
Although not stated in a future tense, I interpreted Marie’s honest admittance, “I’m struggling with behavior…It’s been very hard” to indicate a low level of efficacy for classroom management. She expressed how her inability to control disruptive behavior has a negative impact on her teacher efficacy as she said, “For all the time and energy and money that I invested for this, it is not worth it. I can take bad attitudes, acting out, etcetera, but it is hard when they defiantly talk back to you. These kids just are not nice.” Like the low efficacy teachers in Ashton and Webb’s (1986) study, Marie was frustrated by a constant threat of disorder and tended to define the classroom situation in terms of conflict. “It is a very very very challenging class and they are way behind and you can see why. And being so far behind makes the behavior worse, and sometimes the behavior causes them to be so far behind.”

Also consistent with Ashton and Webb’s (1986) findings on low efficacy teachers, Marie was apt to use public embarrassment of students who misbehaved and often separated them from their classmates. For example, Marie repeatedly sent students to PEAK and in her classroom management system, those students who did not have any pretend money at the end of the week due to poor behavior or not completing assignments had to sit and do mathematics problems while students who had reward money get to play games on the computer. However, unlike the low efficacy teachers in Czerniak and Shriver’s (1994) study, she did take blame for classroom management problems and mentioned personal mistakes. “I have not done a very good job of teaching them how to get in and out of groups. So that may have been part of the group problem this morning. I am working on that.”
When I commented on how well behaved Donna’s students were, she responded that she forgets how good she has it. Because Donna rarely had to deal with disruptive behavior, analysis of classroom management aspects of the teaching task do not appear to have much of an impact on Donna’s teaching efficacy. Like the high efficacy teachers in Ashton and Webb’s (1986) study, both Donna and Connie’s warm relationships with their students have strengthened their authority and made classroom management easier. There appeared to be an understanding established between Donna and her students so that they happily listened to and obeyed what she said. If students were distracted, all she needed to say was, “Eyes up here” and they would quickly redirect their attention. Donna made her classroom management system fun by using Canter’s (1989) approach of putting marbles in a special jar when the students successfully beat the clock while they were cleaning up. When I commented to Donna that she seemed to create a safe environment for her students to learn, her confident response “I want them to know why we do what we do, and I think it’s worked really well” revealed her high efficacy for the task of classroom management.

Connie is similar to the high efficacy teachers in Czerniak and Shriver’s (1994) study who did not seem concerned with classroom control or noise. She has a high threshold in terms of student talking and activity, yet when she reaches her limit or if it interferes with the learning process, she is able to control disruptive behavior relatively effectively. Connie said she can control “regular, or cases within the norm.” However, with extreme situations, as with her bipolar student, she admitted, “Eventually, they can
just be out of the room if all else fails.” It is apparent that the three teachers’ self-efficacy for classroom management was significantly impacted by their context of teaching.

**Efficacy for instructional strategies.** As I considered the teachers’ analyses of the task of appropriate use of instructional strategies, I focused on their abilities to accomplish the four instructional strategies tasks that are identified in the TSES: (1) use a variety of assessment strategies, (2) provide an alternative explanation or example when students are confused, (3) craft good questions, and (4) implement alternative strategies. Consistent with prior research, analysis of the teaching task of using appropriate instructional strategies was dependent on how the teachers defined the teaching task.

De Laat and Watters (1995) found that low efficacy teachers expressed a desire for prescriptive materials that provided step-by-step guidance and answers to problems. Similarly, Marie said,

*I know how to do it, but I don’t know how to teach it.* And this was not in the curriculum guide. There was nothing in the curriculum guide that taught…specifically how to carry and how to borrow. So I used the textbook a lot because the lessons were laid out right there.

Marie’s statement supports Czerniak and Shriver’s (1994) finding that low efficacy teachers used more teacher-centered strategies that emphasized factual knowledge (e.g., lecture, text book reading).

It is important to emphasize that Marie’s efficacy for instructional strategies was greatly impacted by her low performing students. She said, “I don’t think I lack confidence at all. I keep trying things until something works. They just have no problem solving skills.” However, it was apparent from the observations that Marie was unable to effectively provide alternative explanations when her students were confused. Although
several students said, “I don’t get this” or commented on the lesson being “confusing” or “hating” it, Marie’s only response was “This is a hard one. Draw a picture.” After the students struggled with a problem for several minutes, Marie simply solved the problem on the board, without asking the students for ideas or encouraging them to ask questions. Moreover, she gave the students no explanation of how she set up the problem.

On another occasion when I asked Marie if there was any other way she could explain the relationship between division and multiplication for her students, she resignedly said, “I am out of ideas.” Marie later stated, “I really like that cognitively guided instruction, and I would always be striving in that direction where students are trying to solve these problems on their own. BUT like I say, in this particular setting, that doesn’t always work.” Thus, Marie’s efficacy for implementing effective mathematics instructional strategies in this context is very low.

Although Donna expressed low efficacy for implementing effective mathematics instruction, in contrast to Marie, she recognized the strategies she needed to develop and believed that she could do so in the future. Discussing her self-efficacy to assist children who are struggling with mathematics, she admitted

*I don’t know that I have the ability yet* to work with kids that are really stuck and try to figure out where they are stuck and help them out with that. The other thing is trying to communicate how to do something. *That’s hard in math for me*. I know why you do it, sometimes I just don’t have a very good way to articulate that. I think it has been better this year, but I think I can do better at that.
Donna also discussed her low efficacy to implement alternative strategies in mathematics.

I don’t know why, because if they freak out in other things, I don’t get panicked. But math, because I just don’t, I feel like okay, I can do this in my head, but to explain it sometimes, I don’t feel like I have all the tools to try different things if they are not getting it… I try to think of different things, but I don’t always feel like I have those tools, and I think that’s going to take time.

Consistent with the high efficacy teachers in De Laat and Watters study (1995), however, both Donna and Connie sought to develop students’ problem solving and logical thinking skills for real life situations, used themes to integrate math into other subjects, and emphasized hands-on math experiences. Furthermore, similar to Czerniak and Shriver’s (1994) high efficacy teachers, Connie and Donna selected student-centered strategies (e.g., learning centers) that emphasized student conceptual understanding, autonomy, and higher-level thinking and problem solving skills. In response to my question, “How well can you implement alternative mathematics teaching strategies in your classroom?” Connie’s emphatic response was, “That’s what we do all the time!” However, Connie admitted, “One of the things that I don’t do as well is sometimes understanding why kids can’t get certain stuff when it seems so obvious.” Yet, Connie expressed that she usually could provide alternative explanations, “And if I run out of ideas, or even before I run out of ideas, you get the kids to explain things in different ways. I have a pretty good handle on math, so I am not uncomfortable with that.”

Moreover, Connie expressed a desire to grow in her use of mathematics assessment strategies: “I would really like to do one-on-one oral assessments with kids to talk with them and see what they are understanding.” Moreover, like the previously mentioned high efficacy teachers, Connie did not depend solely on the district’s
mandated curriculum guide, but rather developed her own curriculum lesson plans. This is in stark contrast to Marie’s low-efficacy dependency on the curriculum guide for instructional strategies.

Three additional factors that are not addressed on the TSES appeared to impact analysis of the teaching task and therefore the teachers’ self-efficacy for instructional strategies: mathematics content knowledge, management of instructional time, and meeting students’ individual mathematics needs. When I asked what impacted their confidence to teach mathematics, all three of the teachers’ first response related to their mathematics content knowledge. Marie said, “I think my own past because I was not a good math student.” Donna explained,

> I think how much I understand what it is I am teaching – the whys of it. If I don’t understand why I am doing it, I do not really teach it very well… I was not good at math and I think am a lot better at it, but teaching kids the different ways of problem solving, I don’t feel as comfortable.

In fact, it appeared that Donna’s current low efficacy for mathematics content knowledge resulted in a high need to maintain control, thereby slowing down the learning process for her students.

In contrast, when asked I asked Connie about her beliefs about her abilities to teach mathematics, she responded, “I would say that I understand all of the concepts that I have to teach. My own math abilities are good.” These findings on mathematics content knowledge impacting mathematics teaching efficacy are consistent with those of Hebert et al.’s (1998) whose teacher participants cited their confidence in their knowledge as the number one reason they rated themselves as high in teaching efficacy. Furthermore, Ramey-Gassert et al. (1996) found that low efficacy teachers articulated negative prior
science experiences and poor science backgrounds. In contrast, high efficacy teachers spoke of strong science backgrounds at home and through coursework as well as high interest in science.

All three teachers also often alluded to the issue of time as they discussed their efficacy to teach mathematics. Marie repeatedly mentioned the pressure she felt to keep up with the time schedule of the district curriculum guide.

This curriculum guide really moves through pretty fast, about four or five days per section, and in my opinion they need more time than that. But I don’t have that kind of time, so I try to go through it as fast as they want me to run through it. It would be a lot better if I had time to develop it more.

Curricular time constraints also affect Donna’s analysis of the mathematics teaching task.

“In math I do feel that pressure to get things done.” Donna further explained,

I have to stuff so much in, and I don’t like that… there is not enough time - in the day and in the year. In their grade all the skills and basic things that I have got to teach them, it’s just like whipping through it. Either that or you don’t get to it. And that upsets the next teacher and the whole chain of things.

Likewise, Connie stated, “I am really frustrated teaching math. I don’t want to say it’s frustrating, but it’s hard to get everything done in the time I have to teach it.” She explained that “having time to adequately prepare lessons so that you have good lessons prepared so you know you have time to think about where you are going and what you want to teach” impacted her efficacy to teach mathematics. “We have to get so much in. We want to use every minute so we don’t have enough time to let the kids have fun.”

Therefore, it appears that the task of managing instructional time has a powerful impact on the teachers’ analysis of the mathematics teaching task.
Finally, Donna and Connie both identified a third additional task that impacted their mathematics teaching efficacy. When I asked Donna, “Do you think you can teach mathematics to any child no matter what their background is?” her response was, “If in the setting that I am now, no, I do not.” She explained that despite having only 15 students, the time limits and the difficulty of meeting her students’ individual mathematics needs were currently prohibitive for her. Similarly, Connie expressed, “It is just so hard to address everything for the kids.” She elucidated that a “huge challenge has been the wide variation in where kids are at…Where to teach to and more how to come up with activities where they can take them. Activities and things that will be supportive of all the kids learning.” Effectively reaching kids with different levels of mathematics understanding seemed to have a powerful impact on her analysis of the teaching task.

Probably the more important thing is trying to figure out where the kids are at and how they are going to react to a lesson, although you can’t always do that. And what sort of support they might need and making sure that it is at the appropriate level for them.

Thus, the task of meeting students’ individual mathematics needs significantly influenced two of the teachers’ analysis of the instructional strategies teaching task. It seemed that Marie perceived her students to all be low performing, so this issue did not arise.

_Influence of Epistemological Beliefs on Mathematics Teaching Efficacy_

The third qualitative question was:

_How do the mathematics epistemological beliefs of the three novice elementary teachers in this study influence their analysis of the mathematics teaching context and task in the cyclical model of teacher efficacy?_
Through this question I sought to understand how teachers’ epistemological beliefs about mathematics impact their mathematics teaching efficacy. It was conceived that epistemological beliefs would in a sense form the parameters in which the teacher defines the mathematics teaching context and task. Consistent with Bandura’s conception of self-efficacy as being situation-specific, Ashton and Webb (1986) found that teacher efficacy beliefs “can be expected to have different relationships to different subject matter, depending on teachers’ beliefs about the subject being taught” (p. 139). The following quotes and observations of the three teachers reveal how each of the six dimensions of their mathematics epistemological beliefs influenced their mathematics teaching efficacy judgments. I will present the findings regarding each dimension of mathematics epistemological beliefs in the same order that they were considered in the first qualitative question. However, there were no data that indicated that the teachers’ beliefs about the stability of knowledge impacted their mathematics teaching efficacy. Therefore it is not discussed in this section.

Structure of knowledge. A teacher’s epistemological beliefs about structure of knowledge can be described on a continuum from understanding knowledge as compartmentalized facts and information to comprehending knowledge as interconnected webs of concepts. An example of the influence of structure of knowledge on efficacy beliefs was seen in Marie’s frustration over her perception of a disconnect between her district’s curriculum guide and the mathematics knowledge her students were expected to learn for testing. She described a “big gap” between working with manipulatives and what she called the “actual math.” Marie’s beliefs about the structure of mathematics
knowledge did not involve an integration of different facets of mathematics knowledge. When I asked Marie if she had thought of any ideas on how to bridge the “big gap” of her students’ inability to translate from the hands-on activities to the level of problem solving required on the quizzes. Her response revealed her disjointed conception of mathematics. “I saw that [the manipulatives] were not carrying through to the math part, where the numbers – how do you work the numbers? What do you do with those numbers?” The frustrating lack of transfer and “big gap” are graphic analogies of how Marie’s epistemological beliefs about the disjointed structure of mathematics knowledge negatively impact her efficacy to teach mathematics.

In addition to lacking mathematics content knowledge, her lack of an integrated understanding of mathematics knowledge prevents her from perceiving that the activities provided in the curriculum guide are actually mathematics. Moreover, Marie’s mechanistic form of knowing mathematics prohibits her from developing a strategy that would connect the activities to an understanding of mathematics that would enable her and her students to know what to do with the numbers. Thus, as she analyzes the teaching task of developing effective instructional strategies, Marie’s epistemological beliefs about the structure and form of knowing have a powerful and negative effect on her mathematics teaching efficacy judgments.

In contrast, Connie’s epistemological beliefs about the complex and interrelated nature of the structure of mathematics knowledge have a positive impact on her efficacy for student engagement. When I asked Connie how much she could do to help her students value mathematics learning, she confidently responded, “I think teachers can do
a ton - in how we present math, how we talk about it, how it is like everyday life, how important it is, giving concrete examples.” She then described a social studies project that incorporated mathematics problem solving, thereby illustrating her integrated networks of knowledge structure. Thus, depending where on the continuum from isolated bits and pieces to complex interrelated networks they stand, teachers’ beliefs about the dimension of the structure of knowledge have been demonstrated to affect their analysis of the teaching tasks of appropriate use of instructional strategies and student engagement, thereby impacting their efficacy to teach mathematics.

*Form of knowing.* The proposed epistemological belief dimension termed form of knowing is characterized by a continuum of beliefs that range from an emphasis on procedural and computational ways of knowing mathematics to a more sophisticated conceptual understanding of mathematics that involves creativity, argumentation, and justification in problem solving. An example of the impact of beliefs about form of knowing on efficacy beliefs was observed in Connie’s views about the required curriculum. Like Marie, Connie struggled with her district’s mandated curriculum guide and also referred to a disconnect between the activities and mathematics knowledge necessary for testing. “A problem I always have is the bridge between the activity and writing about it, thinking about it, and taking it to the next level of understanding.” However, in contrast to Marie whose descriptions of her frustrations with the curriculum guide reflected her structure of mathematics knowledge, Connie discussed her concerns
about the curriculum guide in terms of the form of knowing. When I asked her how she makes the connection between the curriculum guide’s activities and the understanding that is needed for testing, Connie’s reply was,

> It mainly goes back to the math journals and trying to write about it and having the kids share…what they have learned, how they have gotten it. That is probably the main thing we do in writing activities to try to bridge that and try and get the kids to think about what they are doing.

The positive analogy of “bridging” the disconnect between mathematics activities and understanding is a powerful illustration of how Connie’s epistemological beliefs about the form of knowing mathematics impact her efficacy beliefs about her instructional strategies abilities. Because she seeks to teach in a way that promotes conceptual understanding instead of a mere procedural or mechanistic form of knowing, the way she defines the teaching task is more challenging. Although she has attempted to use the instructional strategy of having her students write and explain their solutions, her efficacy to teach mathematics in a manner that is consistent with her epistemological beliefs and equips her students to test successfully is still developing.

Further, Connie described how her expanding knowledge and mastery experience have actually resulted in a decrease in her mathematics teaching efficacy, influenced by her epistemological beliefs about the form of knowing she wants for her students. “The more you know, the more you realize you don’t know. And the more you know and the more you learn about kids and teaching in a classroom environment, the more you realize how important it is that they get it.” Connie’s desire for her students’ to have a conceptual understanding of mathematics shapes how she defines the teaching task. This
is an excellent example of how her epistemological beliefs about the form of knowing mathematics impacted her analysis of the teaching task, and therefore her efficacy to teach mathematics.

Donna also indicated that her epistemological beliefs about the form of knowing impacted her mathematics teaching efficacy. She realized that she needed conceptual understanding in order to believe that she could teach effectively. “If I don’t understand why I am doing it, I do not really teach it very well…I have to own it, or I am not going to teach it well.” Further, as she discussed her desire to teach so that her students developed beliefs about the form of knowing mathematics as problem solving with conceptual understanding also, she admitted, “I am just not sure how to get there yet. I think in a few years I might have a better idea.”

Like Connie, Donna’s definition of the teaching task is formed by her sophisticated epistemological beliefs. However, Donna lacked knowledge of the necessary instructional strategies to effectively teach as she would like, thus her mathematics efficacy was negatively impacted. Even so, Donna’s positive statement about the future is consistent with Wheatley’s (2002) proposal that inefficacy can be construed as beneficial if the teacher believes she has the ability to learn a task in the future. Donna recognizes her need to grow and this awareness appears to result in her striving to teach more effectively.

*Ability to learn.* Teachers’ epistemological beliefs about the dimension of malleability of learning ability range on a continuum from fixed to incremental. As Marie described her beliefs about her students’ ability to learn, she also conveyed how they
negatively impacted her efficacy mathematics instructional strategies. “People who I expected to get something out of it, did and the others may at some time. So there was mathematical thinking going on by some and others were lost. *I just can’t do it all.*” Marie does not take responsibility for facilitating learning by making the mathematics accessible to her students. This characteristic is consistent with Czerniak and Shriver’s (1994) findings on low efficacy teachers. Marie further explained her views on student ability to learn and her efficacy to teach mathematics as she explained, “you’ve got a bell curve.” Some students are going to be at the low end, many will be in the middle, and some will be at the high end, “no matter what you are doing.”

Marie’s epistemological beliefs about her students’ ability to learn also influenced her analysis of the teaching task of student engagement. Following a discouraging mathematics lesson, Marie explained, “They weren’t capable of doing the work, so they couldn’t do it…I just have to do one problem at a time or they can’t figure it out.” Thus, Marie’s unsophisticated epistemological beliefs about her students’ ability to learn negatively impacted her efficacy for the tasks of using appropriate instructional strategies and student engagement.

Donna’s beliefs about her students’ ability to learn appeared to influence her efficacy for the instructional strategies task of providing alternative explanations when students are confused. Donna explained that at first she questioned her students’ ability to learn problem solving strategies because last year’s class had really struggled with it. However, she later realized that she should not allow her own resulting lack of self-efficacy to limit her students’ learning.
**Speed of knowledge acquisition.** Teachers’ beliefs about the dimension of speed of knowledge acquisition lie on a continuum from quick learning or not at all to gradual learning that takes time and experience. While analyzing her students’ academic abilities and the limited time she has to teach mathematics, Marie demonstrated how her unsophisticated beliefs about the speed of knowledge acquisition impacted her efficacy for instructional strategies. “My students don’t catch on real quickly so they need more practice than I can usually give them.” Rather than taking responsibility for more effectively facilitating mathematics lessons for greater student understanding, Marie instead blamed her lack of self-efficacy for the tasks of implementing instructional strategies and efficient use of instructional time on her students’ inability to learn quickly.

As Connie expressed her beliefs about her ability to accomplish the task of getting her students to believe they can do well in mathematics, her assessment was based on her sophisticated epistemological beliefs about the speed of knowledge acquisition. She explained that to get students to believe they can do well in mathematics, teachers can “lead kids through activities and try to make sure that everybody has the concept before you move on - *which is always really hard* – [teachers can] spend a long time on the problem so every kid gets it.” Connie also revealed how her beliefs about the speed of knowledge acquisition impacted her efficacy for the instructional strategies task of efficiently managing instructional time. “You don’t know how much to guide them and how much to let them [learn on their own] – it’s like there is not enough time to let them develop all of these understandings on their own almost.” Thus, it appears that teachers’
epistemological beliefs about the speed of knowledge acquisition bear heavily on their
teacher efficacy judgments about the tasks of implementing effective instructional
strategies and managing instructional time.

*Source of knowledge.* Teachers beliefs about the source of mathematics
knowledge range on a continuum from seeing themselves as the expert and sole
authoritative source of mathematics knowledge to believing in student autonomy in the
solving of problems and validation of solutions. Donna attempts to get her students to
perceive that learning mathematics is not just, “Here it is and this is the way you do it.”
But rather, “I can solve this on my own. With a little bit of guidance, I can do this.”
However, Donna laments, “how to get from here to there is where I’m trying to figure out
how to do it. It’s easy if the whole class starts in kindergarten and the whole school’s
doing that, it makes it easier.” Donna’s developing beliefs about her students being
autonomous sources of mathematics knowledge expands her definition of the teaching
task thereby impacting her efficacy to implement mathematics instructional strategies that
will support her students’ learning.

*Conclusions about influence of epistemological beliefs.* Teaching mathematics
was challenging for Marie, Donna, and Connie, however, what made the task difficult
was different for each teacher. Their epistemological beliefs about mathematics
influenced their definition of the teaching task. In a sense, the teachers’ epistemological
beliefs informed them as to what was difficult about teaching mathematics. Marie’s
simple and certain epistemological beliefs about mathematics resulted in her defining
success in terms of her students being able to recall mathematics facts or copy her
solutions to problems. When her students were unmotivated to memorize facts or unable to make the knowledge transfer from activities to conceptual understanding, Marie was unsuccessful in accomplishing her teaching task. Consistent with prior studies of low efficacy teachers, she placed the responsibility for failure on the students.

In contrast, Donna and Connie’s more sophisticated mathematics epistemological beliefs resulted in more challenging definitions of the teaching task. Connie sought to teach in a way that promoted conceptual understanding instead of a mere procedural or mechanistic form of knowing. Sophisticated epistemological beliefs about the speed of knowledge acquisition also influenced her instructional strategies. She endeavored to make sure that she provided adequate time for her students to fully understand problems so they believed they could do well in mathematics. However, Connie admitted that implementing these beliefs into her teaching was very challenging; they affected her definition of success in mathematics teaching. For example, although she has attempted to use the instructional strategy of having her students write and explain their solutions, her efficacy to teach mathematics in a manner that is consistent with her epistemological beliefs and equips her students to test successfully is still developing. Likewise, Donna’s developing beliefs about her students being autonomous sources of mathematics knowledge expanded her definition of successfully accomplishing the instructional strategies teaching task, and thereby impacted her mathematics teaching efficacy.

These findings suggest that because epistemological beliefs shape the definition of the teaching task, they have a significant impact on mathematics teaching efficacy beliefs. In the cognitive processing of efficacy information in the integrated model as
theorized by Tschannen-Moran, et al. (1998), it appears epistemological beliefs influence what constitutes successful mathematics teaching. This in turn affects teachers’ analyses of the teaching task and their assessment of whether their personal resources are adequate.

Comparison of Quantitative and Qualitative Findings

The qualitative portion of this study provided rich descriptions of three novice teachers’ mathematics teaching efficacy and epistemological beliefs, and also considered how mathematics epistemological beliefs influenced the teachers’ mathematics teaching efficacy. The questions of the quantitative section were focused on the same constructs of preservice teachers and addressed the effects of a teacher training program. There are some significant relationships between the quantitative and qualitative findings of this study.

Analysis of the first quantitative question revealed that neither mathematics self-efficacy nor mathematics knowledge were predictors of mathematics teaching efficacy. This was perhaps because the teachers did not believe the mathematics test accurately reflected what they needed to teach mathematics. Even so, I suggested that another explanation was that the Mathematics Teaching Efficacy Beliefs Instrument was not constructed to measure a teacher’s efficacy beliefs to “do” mathematics. This is important because the qualitative analysis revealed that the first thing teachers considered when they assessed their efficacy to teach mathematics was their mathematics knowledge and understanding. Thus I argue mathematics, or any subject-specific, teacher efficacy instruments need to include items that measure teacher beliefs about their content
knowledge abilities (e.g., I am able to clearly explain why \( \frac{3}{4} \) divided by \( \frac{1}{2} \) is \( 1\frac{1}{2} \)), or at least about very specific pedagogical content knowledge and skills (I am able to teach division of fractions so that my students have a conceptual understanding).

The second quantitative question considered the change in the constructs under study over a quarter involving a mathematics methods course and a quarter of student teaching experience. Mathematics epistemological beliefs had no significant changes whereas mathematics teaching efficacy increased significantly during the first time period and increased slightly, but not significantly during the student teaching experience. From the qualitative analyses, Connie’s interesting insight about her apparent decrease in mathematics teaching efficacy, “The more you know, the more you realize you don’t know…and the more you learn about kids and teaching in a classroom environment, the more you realize how important it is that they get it” may be the explanation for the observed significant decrease in teacher efficacy during the quantitative participants’ student teaching experience. When Connie began teaching, she realized the complexity of the mathematics teaching task. Her definition of the teaching task expanded, whereas her resources to successfully achieve the more difficult task appeared to not have increased to the same extent. Thus her perceptions of her efficacy to teach mathematics decreased.

The analyses of the third quantitative question revealed that epistemological beliefs did not influence the change in mathematics self-efficacy or mathematics teaching efficacy, however, both constructs were significantly correlated to mathematics epistemological beliefs. The more sophisticated the teacher’s epistemological beliefs, the higher her mathematics teaching efficacy tended to be. This relationship was also evident
among the three participants in the qualitative portion of the study. Marie had the least sophisticated epistemological beliefs about mathematics and also expressed the lowest mathematics teaching efficacy in the interviews and observations. Connie demonstrated the most sophisticated mathematics epistemological beliefs and also communicated the highest mathematics teaching efficacy.

Implications and Recommendations

The findings of this study have multiple theoretical, measurement, and practical implications. These implications, along with related recommendations will be considered in this section.

Theoretical implications

Researchers (e.g., Tschannen-Moran, et al., 1998) have acknowledged that the construct of teacher efficacy has had an arduous path of theoretical development. Both quantitative and qualitative findings in this study indicated the need to further consider how subject specific teacher efficacy is conceptualized. Currently, teacher efficacy measures assess pedagogical and pedagogical content knowledge and beliefs. In the development of the theoretical understanding of subject specific teacher efficacy, researchers have assumed that they could merely adapt measures and models of teacher efficacy to address their specific area of interest. However, teachers’ beliefs about their content knowledge abilities apparently have been overlooked. In this study, each of the teachers’ first response to what affects their sense of efficacy to teach mathematics was
their mathematics content knowledge. It is likely that a theoretical conception of subject specific teacher efficacy needs to include teachers’ self-efficacy for understanding and using content knowledge.

Through the use of the integrated model of teacher efficacy (Tschannen-Moran, et al., 1998), this study has brought further clarity on what teachers consider as they analyze their teaching context and task. The contexts in which Marie, Donna and Connie teach varied greatly. The qualitative profiles made it obvious that school and classroom environment, students’ academic performance and student behavior powerfully impact teachers’ assessment of “what will be required of them in the anticipated teaching situation. This analysis produces inferences about the difficulty of the task and what it would take for a person to be successful in this context” (Tschannen-Moran & Woolfolk Hoy, 2001, p. 228).

The context of a public city school in which all of the students come from low SES backgrounds, are from a different cultural background than the teacher, have what he or she perceives to be disrespectful and violent behavior, and are performing two years below grade-level stands in stark contrast to the context of a rural parochial school in which above-average students eagerly obey the teacher and enjoy learning. It is evident that context must in some concrete way be included in the theoretical understanding and measurement of teacher efficacy. The findings of my second quantitative question addressing changes in teacher efficacy during student teaching also emphasized the importance of knowing the context in which teachers are making their efficacy
judgments. Had I obtained more detailed descriptions of the preservice student teaching contexts, I may have gained insight into what contributed to the unexpected decrease in teacher efficacy.

Another important issue is what comprises context. In the teacher profiles I included classroom and school environment, along with student behavior and academic performance. It can be argued, however, that factors of student behavior and academic performance are considered as context only at the beginning of a school year. Later, after a teacher has worked with the students for some time, their academic achievement and behavior instead become a source of mastery experience to the teachers’ sense of efficacy. Thus in Marie’s case, her inability to take a difficult group of students and overcome the challenges of their behavior and low academic performance negatively informed her efficacy judgments. Further research is needed to explore how contextual factors influence the development of teacher efficacy.

In terms of analysis of the teaching task, this study confirmed that teachers’ beliefs about their abilities in the areas of student engagement, classroom management, and use of instructional strategies influence their assessment of their competence to teach. Several tasks that Tschannen-Moran and Woolfolk Hoy (2001) did not address in their TSES, however, rose to the surface in the qualitative analysis of the data. As teachers analyze their abilities for student engagement, their capacity to develop positive relationships with their students had a significant impact. As the teachers considered their abilities to effectively use instructional strategies, the tasks of instructional time management and effectively meeting the individual mathematics needs of students
influenced their assessment of their competence. Further, teachers’ content knowledge also powerfully impacts their sense of efficacy for teaching a particular subject. Each of these three aspects of the teaching task needs to be included in the theoretical understanding and measurement of teacher efficacy.

This study also has theoretical implications for the study of personal epistemologies. A dimension of epistemological beliefs, form of knowing, has been proposed and explored. This dimension needs to be clarified and empirically validated. Moreover, this study has only initiated the exploration of the influence of teachers’ epistemological beliefs on their efficacy belief judgments. Through the analysis of the teachers’ profiles, I have argued that the nature of teachers’ beliefs about how mathematics is known contribute to how they define the mathematics teaching context and task, as well as how they determine what is successful mathematics teaching. Thus when researchers study teachers’ sense of efficacy for teaching mathematics, it is important to identify upon what task and definition of success teachers are basing their efficacy judgments. Burke-Spero and Woolfolk Hoy (2002) proposed that a cultural lens be included in the integrated model of teacher efficacy. Similarly, to address this concern I propose that an epistemological lens, or perhaps a comprehensive knowledge and beliefs lens, be added to the integrated model.

One additional theoretical implication involves the interpretation of teachers’ sense of efficacy. Wheatley (2002) construed inefficacy as positive if a teacher says, I have a lot to learn, but I can learn it. In this study Donna was a prime example. She repeatedly admitted her lack of immediate ability, but followed it with statements such as
“but I think I can do better in the future.” This finding challenges the understanding that low teacher efficacy automatically implies poor teacher outcomes.

**Measurement implications**

Perhaps the most significant findings of this study regard the measurement of teacher efficacy. As has been mentioned, one implication of this study is that quantitative measures need to address the importance of context. Further, quantitative measures of teacher efficacy also need to include items that access beliefs about abilities for understanding and using content knowledge. The practice of merely adding in “mathematics,” for example, to existing teacher efficacy measures should be discontinued. I have proposed that mathematics teaching efficacy instruments need to include items that measure beliefs about their mathematics content knowledge abilities (e.g., I am able to clearly explain why \( \frac{3}{4} \) divided by \( \frac{1}{2} \) is \( 1\frac{1}{2} \)), or at least about very specific mathematics pedagogical content knowledge and skills (I am able to teach division of fractions so that my students have a conceptual understanding).

In regards to measurement of teacher efficacy, the TSES would more accurately reflect teacher efficacy for student engagement by adding items on teachers’ abilities to develop positive relationships with their students. Items addressing instructional time management and ability to effectively teach to a wide variety of student performance levels would also improve the TSES’s evaluation of teachers’ self-efficacy for instructional strategies. As all of these recommendations flow out of analysis of the qualitative data, it is apparent that qualitative teacher efficacy findings should be used to inform future development of quantitative measures.
The same can be said for the measurement of epistemological beliefs. The field of personal epistemologies began with qualitative studies (e.g., Perry, 1970), and 20 years later Schommer (1991) developed a quantitative measure. In this study I have used qualitative findings to explore the six epistemological dimensions identified in the quantitative literature. I recommend that further qualitative studies be conducted that explore how the dimensions of teachers’ epistemological beliefs are enacted in practice. As with teacher efficacy, findings from these studies could then be used to develop more effectual quantitative measures.

The qualitative portion of this study brought to light the challenge of obtaining teacher efficacy statements using nondirective, open-ended interview questions. In an attempt to allow the teachers to initiate expressions of self-efficacy, my interview protocols initially had the teachers describe their mathematics teaching experiences. I also asked more specific, future-oriented questions such as, “Would you discuss what I am going to see in your mathematics lesson today?” Yet in order to obtain clearer expressions of self-efficacy, as opposed to other self-evaluative constructs, I would now recommend more guided questions that access teacher beliefs about abilities to successfully accomplish certain teaching tasks.

I found that using the items from the TSES (Tschannen-Moran & Woolfolk Hoy, 2001) as interview questions to be extremely beneficial in acquiring explicit teacher efficacy belief statements and explanations about those beliefs for the different aspects of the teaching task. For example, I asked Connie, “To what extent are you able to use a variety of mathematics assessment strategies? Can you give me any examples?” She
responded, “Not as much as I would like.” Connie then defined what success meant to her by explaining a specific type of assessment that she hopes to use in the future. She also described what she currently incorporates in her practice, and shared what she thought was most effective – all without further prompting.

Instead of only obtaining a self-reported Likert-scale response of perhaps a 5, “Some Influence,” on the quantitative TSES measure, I obtained a much richer description of Connie’s self-efficacy beliefs for using mathematics assessments. In response to the same question in interview form, Connie provided an explanation of why she responded as she did and what influences her self-efficacy for that particular task. Yet it is important to mention that this interview in which I used the TSES to explore Connie’s specific mathematics teaching efficacy beliefs was conducted after five prior interviews and two observations in her classroom. What Connie shared may have been based on the relationship I had developed with her through the prior process. Perhaps if it was the first interview I conducted, she may not have given the same depth of responses.

Practical implications

This study has several practical implications for practicing teachers and the preparation of future teachers. Two of the tasks that impacted teachers’ sense of efficacy for effectively using instructional strategies were instructional time management and the skill of effectively addressing students’ different mathematics performance levels. It is recommended that teacher training programs explicitly address these issues with specific
Another practical implication emerged out of the interview data that addressed how context impacted teacher efficacy. Each of the teachers in this study identified family background as a root issue of student misbehavior and poor academic performance. What kids are coming out of is seen as the problem. So the question arises of how you get teachers to see parents as allies, deeply invested in their kids and doing the best that they can. It is possible that if you take away the family as being responsible, or no longer make family the scapegoat for the things that make teaching difficult, teacher efficacy may decrease. But educators can overcome this blaming barrier and learn to take responsibility for their students’ achievement and what transpires in their classrooms. They need to see themselves as on the same team as parents, working together to improve student outcomes. If teachers were able accomplished these challenging tasks, it is likely their teacher efficacy would significantly increase.

Summary and Conclusion

In summary, this study examined pre-service and novice elementary teachers’ mathematics teaching efficacy, mathematics epistemological beliefs, and the relationship between the two constructs. Both quantitative and qualitative methodologies were employed. The quantitative research participants were 60 preservice elementary teachers enrolled in a Master of Education initial certification program at a large state university in the Midwest. Data were collected at three points in the program to determine the
influence of a mathematics methods course and the student teaching experience. Self-report survey measures included teacher efficacy (TES), mathematics self-efficacy, a mathematics performance test, mathematics teaching efficacy (MTEBI) and mathematics epistemological beliefs (DSBQ). In a multiple regression analysis, teacher efficacy predicted mathematics teaching efficacy, however, mathematics self-efficacy and mathematics performance did not.

Changes over time were also considered through a repeated measures MANOVA. Mathematics epistemological beliefs did not change during the study. Teacher efficacy and mathematics teaching efficacy increased significantly over the period of time that the pre-service teachers were enrolled in a mathematics methods course. However, mathematics teacher efficacy did not change and teacher efficacy significantly decreased during student teaching. Mathematics self-efficacy increased from the beginning to the end of the study. Finally, Pearson correlation analyses of the relationship of mathematics epistemological beliefs to mathematics self-efficacy ($r=0.277; p<0.05$) and mathematics teaching efficacy ($r=0.666; p<0.01$) were significant. However, a repeated measures MANOVA revealed that mathematics epistemological beliefs did not influence changes in mathematics self-efficacy or mathematics teaching efficacy.

This study also qualitatively explored three novice teachers’ mathematics epistemological beliefs, their analyses of the contextual and task factors that impact mathematics teaching efficacy, and the influence their epistemological beliefs had on mathematics teaching efficacy. Thematic coding and analyses were conducted with the interviews and classroom observation data to create teacher profiles. The dimensions of
epistemological beliefs (Schommer, SEQ, 1990) were used as a framework to analyze each teacher’s epistemological beliefs about mathematics. The qualitative portion of this research sought to clarify Tschannen-Moran, Woolfolk Hoy and Hoy’s (1998) integrated model of teacher efficacy by probing the factors that impact teachers’ cognitive processing and analysis of the teaching task and context. For analysis of the teaching context, the teachers’ school and classroom environment, student behavior and student mathematics performance were taken into account. To examine the teacher’s analysis of the teaching task, efficacy for student engagement, classroom management, and instructional strategies were considered.

Factors that influenced the teachers’ analysis of the mathematics teaching context included availability of a mentor teacher, a mandated curriculum guide, students’ family backgrounds, mainstreamed special needs students, and students’ lack of number sense. Several factors that are not addressed on the TSES appeared to impact analysis of the mathematics teaching task: teachers’ relationships with students, teachers’ mathematics content knowledge, management of instructional time, and ability to teach to a wide range of students’ mathematics understanding. Teachers’ epistemological beliefs influenced their definitions of the mathematics teaching task and what it meant for them to teach mathematics successfully in their context, thereby impacting mathematics teaching efficacy.

Through analysis of the findings, I have suggested that teachers’ self-efficacy for understanding and using content knowledge needs to be an integral part of the theoretical conception and measurement of subject-specific teacher efficacy. Further empirical study
of the relationship between teachers’ mathematics self-efficacy and mathematics teaching efficacy is necessary. Further, I suggested that teaching context must in some concrete way be included in the measurement of teacher efficacy. Tschannen-Moran, et al.’s (1998) integrated model has provided the theoretical framework for teacher analysis of context and specific task. Further, the TSES was designed to address the three primary teaching tasks. It will be challenging to incorporated sufficient contextual data into a quantitative measure, however, without it, we truly do not know what contextual factors on which teachers are basing their efficacy judgments.

One advantage of qualitative study of teacher efficacy is the ability to gain rich descriptions of how teachers analyze the teaching context and task. The drawback, however, is that obtaining actual self-efficacy belief statements in open-ended, non-directive interviews is problematic. In this study I decided to use the quantitative TSES as the framework for qualitative exploration after I discovered that I had inadequate teacher efficacy data for one of the teachers. My last minute decision had greatly beneficial results. I obtained excellent task-specific teacher efficacy data, along with explanations of how the teacher defined the task and what she perceived to be success. I believe the structure of the TSES worked synergistically with the depth of description accessible through interview methods.

Because self-efficacy is task-specific and distinct from more global assessments of ability such as self-concept, it appears that more structured and directive interview protocols are needed to obtain specificity and correspondence between self-efficacy and performance assessment. Pajares (1997) recognized the methodological weakness of self-
report and recommended that researchers assess both the sources and the effects of self-efficacy through direct observation rather than rely on self-reports. I believe the combination of using structured interviews and classroom observations is the best scenario for exploring teacher’s cognitive processing as the analyze the teaching context and task. This combination has the potential to attain the most complete and accurate evaluations of teacher efficacy. The findings from qualitative teacher efficacy studies can then be used to develop more effectual quantitative instruments for use with larger samples of teachers.

I also qualitatively explored epistemological beliefs using the theoretical framework underlying a quantitative instrument, the SEQ (Schommer, 1990). In the analysis process a concern arose that is inherent to qualitative research. As I considered the teachers’ statements about mathematics, I was specifically searching for epistemological belief statements. I acknowledged that my thematic approach may have resulted in simple lack of content knowledge being misinterpreted as an unsophisticated epistemological beliefs. This highlights that the relationships and distinctions between mathematics content knowledge and mathematics epistemological beliefs need greater elaboration.

The qualitative analyses highlighted the complex nature of teacher efficacy and epistemological beliefs as well as the challenge of appropriately interpreting teachers’ expressions of beliefs. Qualitative analysis, like real life, is “messy.” When a multifaceted construct like mathematics epistemological beliefs is measured with a quantitative instrument, the depth and fragility of beliefs are not easily captured.
Although the findings of this study may have raised more questions than they answered, they challenged current methods of measurement and afforded thick descriptions of teachers’ mathematics teaching efficacy and epistemological beliefs.

This raises a final critical issue of how researcher’s own epistemological beliefs can limit, enhance, or otherwise control the identification, coding, and interpretation of data. Qualitative researchers need to understand how their role as the primary research “instrument” influences the research process. It could prove beneficial for researchers of future qualitative studies to develop profiles of their own mathematics epistemological beliefs and explicitly identify how these beliefs influence their analyses.
APPENDIX A

PRE-SERVICE TEACHER MEASURES

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An Examination of the Relationships between Pre-service Elementary Teachers’ Mathematics Teaching Efficacy, Mathematics Self-efficacy, and Beliefs About Mathematics

BACKGROUND INFORMATION

ID: ______________________

1. Name: ________________________________

2. Age: ______________________

3. Gender: Female _____ Male _____

4. Ethnicity: ________________________________

5. Grade(s) you desire to teach: ______________

6. Your preferred subjects to teach:
   1) __________________ 2) __________________

7. Your least preferred subjects to teach:
   1) __________________ 2) __________________

8. Number of years of high school mathematics: ______

9. Which of the following high school mathematics courses did you complete?
   ___ pre-algebra   ___ algebra   ___ geometry   ___ pre-calculus   ___ calculus

10. Number of university level mathematics courses completed: _______

11. Highest level of university mathematics course completed (list course number and name):
    ________________________________

12. Undergraduate major: ________________________________

13. What occupation did you have prior to starting your Master of Education program?
    ________________________________

14. Briefly describe your feelings about your previous mathematics learning experiences.
    ________________________________

15. Briefly describe your feelings about teaching mathematics.
    ________________________________
Teacher Efficacy Scale

Directions: Read the following statements and rate your answers by filling in the appropriate circle on the scantron sheet. Respond to each item based on what you believe. There are no right or wrong answers.

Use the scale below when responding to each item:

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<tr>
<td>Strongly Disagree</td>
<td>Moderately Disagree</td>
<td>Slightly Disagree</td>
<td>Slightly Agree</td>
<td>Moderately Agree</td>
<td>Strongly Agree</td>
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1. The amount a student can learn is primarily related to family background.

2. If students aren't disciplined at home, they aren't likely to accept any discipline.

3. When I really try, I can get through to most difficult students.

4. A teacher is very limited in what he/she can achieve because a student's home environment is a large influence on his/her achievement.

5. If parents would do more for their children, I could do more.

6. If a student did not remember information I gave in a previous lesson, I would know how to increase his/her retention in the next lesson.

7. If a student in my class becomes disruptive and noisy, I feel assured that I know some techniques to redirect him/her quickly.

8. If one of my students couldn't do a class assignment, I would be able to accurately assess whether the assignment was at the correct level of difficulty.

9. If I really try hard, I can get through to even the most difficult or unmotivated students.

10. When it comes right down to it, a teacher really can't do much because most of a student's motivation and performance depends on his or her home environment.

MTEBI (Pre-service)

Directions: Read the following statements and rate your answers by filling in the appropriate circle on the scantron sheet. Respond to each item based on what you believe. There are no right or wrong answers.

Use the scale below when responding to each item:

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11. When a student does better than usual in mathematics, it is often because the teacher exerted a little extra effort.
12. I will continually find better ways to teach mathematics.
13. Even if I try very hard, I will not teach mathematics as well as I will most subjects.
14. When the mathematics grades of students improve, it is often due to their teacher having found a more effective teaching approach.
15. I know how to teach mathematics concepts effectively.
16. I will not be very effective in monitoring mathematics activities.
17. If students are underachieving in mathematics, it is most likely due to ineffective mathematics teaching.
18. I will generally teach mathematics ineffectively.
19. The inadequacy of a student’s mathematics background can be overcome by good teaching.
20. When a low-achieving child progresses in mathematics, it is usually due to extra attention given by the teacher.
21. I understand mathematics concepts well enough to be effective in teaching elementary mathematics.
22. The teacher is generally responsible for the achievement of students in mathematics.
23. Students' achievement in mathematics is directly related to their teacher's effectiveness in mathematics teaching.
24. If parents comment that their child is showing more interest in mathematics at school, it is probably due to the performance of the child's teacher.
25. I will find it difficult to use manipulatives to explain to students why mathematics works.
26. I will typically be able to answer students’ questions.
27. I wonder if I will have the necessary skills to teach mathematics.
28. Given a choice, I will not invite the principal to evaluate my mathematics teaching.
29. When a student has difficulty understanding a mathematics concept, I will usually be at a loss as to how to help the student understand it better.
30. When teaching mathematics, I will usually welcome student questions.
31. I do not know what to do to turn students on to mathematics.
WHAT DO YOU BELIEVE?

Directions: Read the following statements and rate your answers by filling in the appropriate circle on the scantron sheet. Respond to each item based on what you believe. There are no right or wrong answers.

Use the scale below when responding to each item:

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32. Students who are good at social studies have to work hard.
33. Strategies will help a student learn mathematics.
34. Mathematics is primarily a solitary activity, done by individuals in isolation.
35. A social studies question can be approached in several different ways.
36. Students who understand the mathematics they have studied will be able to solve any assigned problem within a few minutes.
37. How successful students are in social studies is related to how hard they work.
38. There are links between mathematics and other disciplines.
39. Someone can teach a student how to learn mathematics material.
40. Information learned in mathematics is useful outside of school.
41. Strategies will help a student learn social studies.
42. It is a good use of time to work on mathematics problems that have no precise answers.
43. How successful students are in mathematics is related to how hard they work.
44. Only certain people can do well in mathematics.
45. Even if it takes a long time to learn a social studies concept, it is best to keep trying.
46. Social studies relates to day to day life.
47. Reviewing the material discussed in class would help a student learn math.
48. Most people can do well in social studies.
49. There is usually only one correct way to solve a mathematics problem.
50. There is a relationship between the number of hours students study and how well they do in mathematics.
51. Students need to see the material many times to understand mathematics concepts.
52. There are links between social studies and other disciplines.
53. It is important for students to combine new ideas in social studies with what they already know.
54. Exerting effort to try to understand a tough problem in mathematics is a wise use of time.
55. There are methods for learning social studies.
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56. Students who are good at mathematics have to work hard.
57. It is a good use of time to work on social studies questions that have no exact answers.
58. A class in social studies study skills would be valuable.
59. The information learned in social studies is useless outside of school.
60. If a student is not naturally gifted in social studies, they can still learn the class material well.
61. Mathematics relates to day to day life.
62. A class in mathematics study skills would be valuable.
63. Students should understand social studies concepts after one lesson.
64. There is a relationship between the number of hours students study and how well they do in social studies.
65. How successful students are in mathematics has no relationship to how hard they work.
66. Even if it takes a long time to learn a mathematics concept, it is best to keep trying.
67. A mathematics problem can be approached in several different ways.
68. It is a waste of time to work on mathematics problems that have no exact answers.
69. There are methods for learning mathematics.
70. A student should naturally know how to learn social studies material.
71. Reviewing the material discussed in class would help a student learn social studies.
72. It is a waste of time to exert too much effort trying to understand a tough problem in social studies.
73. There is only one way to approach a mathematics problem.
74. If a student is not naturally gifted in mathematics, they can still learn the class material well.
75. Information learned in social studies is useful outside of school.
76. It is important for students to integrate new ideas in mathematics with what they already know.
77. Mathematics is unrelated to day to day life.
78. A class in social studies study skills would be useless.
79. Exerting effort to try to understand a tough problem in social studies is a wise use of time.
80. Most people can do well in mathematics.
81. The number of hours students study is unrelated to how well they do in social studies.
82. Students need to see the material many times to understand social studies concepts.
83. Someone can teach a student how to learn social studies material.
84. If it takes a long time to learn a mathematics concept, it is best to give up.
MATHEMATICS CONFIDENCE - A

How confident are you that you can correctly solve the following mathematics problems? Do not solve the problems now. Instead respond how confident you are that you can solve them. You will be asked to solve similar problems at a later point. Please do not write on this survey. Fill in the scantron number that represents your confidence level using the following scale:

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85. A jet airliner traveling 500 miles per hour makes a trip in 2 hours. With the aid of a tailwind, the plane can make the same flight in \(1 \frac{3}{4}\) hours. If the tailwind is \(x\) miles per hour, then set up the equation to solve for \(x\).

86. Arrange the areas \(P\), \(Q\), and \(R\) of the following shaded regions in increasing order:

\[
P \quad \quad Q \quad \quad R
\]

radius = 1  \quad radius = 2

87. The sum of the angles of a triangle is _____.

88. A certain punch is made by mixing orange juice, lemonade, and soda. Three times as much orange juice as lemonade is to be used, and half as much lemonade as soda is used. If the hostess is making 36 gallons of the punch, how many gallons of soda does she need?

89. Mike needs four pieces of wood \(2 \frac{3}{4}\) feet long for the legs of a table. Boards from which this wood can be cut come in 12-foot lengths. What length board will be left over?

90. Five spelling tests are to be given to John’s class. Each test has a value of 25 points. John’s average for the first four tests is 15. What is the highest possible average he can have on all five tests?

91. Five stations are long a railway. Newton is next to Stanmore, Petersville is next to Lewisburg, Redfern is next to Newton, Stanmore is next to Petersville. Which of the following is true?

- Newton is between Stanmore and Petersville
- Petersville is between Newton and Stanmore
- Redfern is between Stanmore and Newton
- Lewisburg is between Redfern and Newton
- Stanmore is between Newton and Petersville

92. What is the weight of the contents of a large package made up of four packages weighing \(3 \frac{1}{2}\) pounds, \(5 \frac{2}{5}\) pounds, 1 pound, and \(2 \frac{1}{10}\) pounds?
93. Next year Ellen will be three times as old as she was five years ago. How old will she be next year?

94. The two triangles shown below are similar. Thus, the corresponding sides are proportional and \( \frac{AC}{BC} = \frac{XZ}{YZ} \). If \( AC = 1.7 \), \( BC = 2 \), and \( XZ = 5.1 \), find \( YZ \).

95. The sum of two numbers is 90. One of them is 25% more than the other. What is the smaller number?

96. If \( x = \frac{7}{6} y + 42 \) and \( y = 42 \), what does \( x \) equal?

97. Suppose that an operation \( \# \) on any numbers \( a \) and \( b \) is defined by \( a \# b = a + (a \times b) \). Then \( 5 \# 2 \) equals _____.

98. Farmer Brown’s goat grazes in a triangular region. The grazing region is a right triangle. How many yards of fence does Farmer Brown need to replace side \( b \) if \( a = 12 \) yards and \( c = 13 \) yards?

99. Find the smaller of two numbers whose sum is 32 and difference is 14.

100. In the game of archery, the target is a set of five circles with the bull’s eye as the center of them all. These circles are called ___________.

101. \( 8 - 2.46 = \) _____.

102. Which of the following illustrates the distributive principle?

\[
\begin{align*}
2 + 6 &= 6 + 2 \\
(4 + 2) + 6 &= 4 + (2 + 6) \\
(4 \times 2) + 6 &= (2 \times 4) + 6 \\
4 \times (2 \times 6) &= (4 \times 2) \times 6 \\
4 \times (2 + 6) &= (4 \times 2) + (4 \times 6)
\end{align*}
\]
MATHEMATICS ACHIEVEMENT - A

Directions: Solve each of the following mathematics problems and fill in the scantron bubble that corresponds to the correct multiple choice answer. Scrap paper will be provided. Please do not write on this sheet.

103. A jet airliner traveling 500 miles per hour makes a trip in 2 hours. With the aid of a tailwind, the plane can make the same flight in \(1 \frac{3}{4}\) hours. If the tailwind is \(x\) miles per hour, then

a) \(500 - x = \frac{4}{7}(1000)\) 

b) \(2(500 + x) = 1000\) 

c) \(\frac{1}{4}x = 1000\) 

d) \(1000 = \frac{7}{4}(500 + x)\) 

e) \(1000 = \frac{1}{4}(500 - x)\)

104. Arrange the areas \(P\), \(Q\), and \(R\) of the following shaded regions in increasing order:

- a) \(P < Q < R\) 
- b) \(Q < P < R\) 
- c) \(P < R < Q\) 
- d) \(R < P < Q\) 
- e) \(Q < R < P\)

105. The sum of the angles of a triangle is ______.

- a) between 90 and 180 degrees 
- b) 180 degrees 
- c) between 180 and 360 degrees 
- d) 360 degrees 
- e) dependent on the sizes of the angles

106. A certain punch is made by mixing orange juice, lemonade, and soda. Three times as much orange juice as lemonade is to be used, and half as much lemonade as soda is used. If the hostess is making 36 gallons of the punch, how many gallons of soda does she need?

- a) 6 
- b) 10 
- c) 12 
- d) 18 
- e) 22

107. Mike needs four pieces of wood \(2 \frac{3}{4}\) feet long for the legs of a table. Boards from which this wood can be cut come in 12-foot lengths. What length board will be left over?

- a) \(12 - 2 \frac{3}{4}\) 
- b) \(12 + \frac{3}{4}\) 
- c) \((2 \frac{3}{4} \times 4) - 12\) 
- d) \(12 - (2 \frac{3}{4} \times 4)\) 
- e) none of these
MATHEMATICS ACHIEVEMENT – A

108. Five spelling tests are to be given to John’s class. Each test has a value of 25 points. John’s average for the first four tests is 15. What is the highest possible average he can have on all five tests?

a) 15    b) 16    c) 17    d) 20    e) 25

109. Five stations are long a railway. Newton is next to Stanmore, Petersville is next to Lewisburg, Redfern is next to Newton, Stanmore is next to Petersville. Which of the following is true?

a) Newton is between Stanmore and Petersville
b) Petersville is between Newton and Stanmore
c) Redfern is between Stanmore and Newton
d) Lewisburg is between Redfern and Newton
e) Stanmore is between Newton and Petersville

110. What is the weight of the contents of a large package made up of four packages weighing 3 $\frac{2}{5}$ pounds, 5 $\frac{2}{5}$ pounds, 1 pound, and 2 $\frac{1}{5}$ pounds?

a) 11 $\frac{1}{10}$ pounds    d) 12 pounds
b) 11 $\frac{2}{5}$ pounds    e) 12 $\frac{1}{5}$ pounds
c) 11 $\frac{4}{5}$ pounds

111. Next year Ellen will be three times as old as she was five years ago. How old will she be next year?

a) 8    b) 9    c) 11    d) 12    e) 15

112. The two triangles shown below are similar. Thus, the corresponding sides are proportional and $\frac{AC}{BC} = \frac{XZ}{YZ}$. If $AC = 1.7$, $BC = 2$, and $XZ = 5.1$, find $YZ$.

a) 3    b) 3.4    c) 5.4    d) 6    e) 9

113. The sum of two numbers is 90. One of them is 25% more than the other. What is the smaller number?

a) 30    b) 35    c) 40    d) 45    e) none of these
114. If $x = \frac{7}{6}y + 42$ and $y = 42$, what does $x$ equal?

a) 98  b) 91  c) 84  d) 78  e) 0

115. Suppose that an operation $\#$ on any numbers $a$ and $b$ is defined by $a \# b = a + (a \times b)$. Then $5 \# 2$ equals _____.

a) 10  b) 12  c) 15  d) 20  e) 35

116. Farmer Brown’s goat grazes in a triangular region. The grazing region is a right triangle. How many yards of fence does Farmer Brown need to replace side $b$ if $a = 12$ yards and $c = 13$ yards?

a) 1  b) 5  c) 8  d) 10  e) 25

117. Find the smaller of two numbers whose sum is 32 and difference is 14.

a) 7  b) 9  c) 18  d) 20  e) none of these

118. In the game of archery, the target is a set of five circles with the bull’s eye as the center of them all. These circles are called ___________.

a) congruent b) asymmetric  c) concentric  d) corresponding  e) coincident

119. $8 - 2.46 =$

a) 2.35  b) 2.38  c) 5.54  d) 6.46  e) none of these

120. Which of the following illustrates the distributive principle?

a) $2 + 6 = 6 + 2$

b) $(4 + 2) + 6 = 4 + (2 + 6)$

c) $(4 \times 2) + 6 = (2 \times 4) + 6$

d) $4 \times (2 \times 6) = (4 \times 2) \times 6$

e) $4 \times (2 + 6) = (4 \times 2) + (4 \times 6)$

Thank you for your participation in this research.
MATHEMATICS CONFIDENCE - B

How confident are you that you can correctly solve the following mathematics problems? Do not solve the problems now. Instead respond how confident you are that you can solve them. You will be asked to solve similar problems at a later point. Fill in the scantron number that represents your confidence level using the following scale:

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85. \[ \frac{3}{5} - \frac{1}{2} \] _______.

86. The average of three numbers is 30. The fourth number is at least 10. What is the smallest average of the four numbers?

87. Write an equation which expresses the condition that “the product of two numbers R and S is one less than twice their sum.”

88. Set up the problem to find the number asked for in the expression “six less than twice \( 4 \frac{5}{6} \).”

89. In Starville, an operation * on any numbers a and b is defined by \( a * b = a \times (a + b) \). So \( 2 * 3 \) equals _____?

90. A living room set consisting of one sofa and one chair is priced at $200. If the price of the sofa is 50% more than the price of the chair, find the price of the sofa.

91. To construct a table, Michele needs four pieces of wood 2.5 feet long for the legs. She wants to determine how much wood she will need for five tables. She reasons: \( 5 \times (4 \times 2.5) = (5 \times 4) \times 2.5 \). What number principle is she using?

92. Fred’s bill for some household supplies was $13.64. If he paid for the items with a $20 bill, how much change should he receive?

93. On a certain map, \( \frac{7}{8} \) inch represents 200 miles. How far apart are two towns whose distance apart on the map is \( 3 \frac{1}{2} \) inches?

94. Bridget buys a packet containing 9-cent and 13-cent stamps for $2.65. If there are 25 stamps in the packet, how many are 13-cent stamps?

95. If \( 3x - 2 = 16 - 6x \), what does \( x \) equal?

96. There are three numbers. The second is twice the first, and the first is one-third of the other number. Their sum is 48. Find the largest number.

97. The hands of a clock form an obtuse angle at __ o’clock.
98. Sally needs three pieces of poster board for a class project. If the boards are represented by rectangles A, B, and C, arrange their areas in increasing order. (Assume b > a.).

\[\text{A} \quad \text{B} \quad \text{C} \]

\[d \quad a \quad b \quad d + a \quad d - a \quad d + b \quad d - b\]

99. In a certain triangle, the shortest side is 6 inches, the longest side is twice as long as the shortest side, and the third side is 3.4 inches shorter than the longest side. What is the sum of the three sides in inches?

100. Five points are on a line. T is next to G, K is next to H. C is next to T. H is next to G. Determine the relative positions of the points along the line.

101. The opposite angles of a parallelogram are__________.

102. The formula for converting temperature from degrees Centigrade to degrees Fahrenheit is $F = \frac{9}{5}C + 32$. A temperature of 20 degrees Centigrade is how many degrees Fahrenheit?
MATHEMATICS ACHIEVEMENT – B

Directions: Solve each of the following mathematics problems and fill in the scantron bubble that corresponds to the correct multiple choice answer.

103. \( \frac{3}{5} \cdot \frac{1}{2} \) _______.
   a) 2 \( \frac{3}{10} \)  b) 3 \( \frac{3}{10} \)  c) 3 \( \frac{2}{5} \)  d) 3 \( \frac{3}{5} \)  e) none of these

104. The average of three numbers is 30. The fourth number is at least 10. What is the smallest average of the four numbers?
   a) 10  b) 15  c) 20  d) 25  e) 30

105. Write an equation which expresses the condition that “the product of two numbers R and S is one less than twice their sum.”
   a) 2(R X S) – 1 = R + S  d) R X S – 1 = 2(R + S)
   b) R X S = 2(R + S) – 1  e) None of these
   c) R X S = 2(R + S) + 1

106. Set up the problem to find the number asked for in the expression “six less than twice \( \frac{5}{6} \).”
   a) \( (2 \times 4 \frac{5}{6}) – 6 \)  d) 6 - \( \frac{5}{6} \)
   b) \( 6 – (2 \times 4 \frac{5}{6}) \)  e) none of these
   c) \( (6 \times 4 \frac{5}{6}) \) –2

107. In Starville, an operation * on any numbers a and b is defined by a * b = a X (a + b).
    So 2 * 3 = ____?
    a) 6  b) 7  c) 10  d) 12  e) 15

108. A living room set consisting of one sofa and one chair is priced at $200. If the price of the sofa is 50% more than the price of the chair, find the price of the sofa.
    a) $100.  b) $120.  c) $133.50  d) $150.  e) none of these

109. To construct a table, Michele needs four pieces of wood 2.5 feet long for the legs. She wants to determine how much wood she will need for five tables. She reasons: 5 X (4 X 2.5) = (5 X 4) X 2.5. What number principle is she using?
    a) associative  b) commutative  c) cancellation  d) distributive  e) multiplicative identity

110. Fred’s bill for some household supplies was $13.64. If he paid for the items with a $20 bill, how much change should he receive?
    a) $6.56  b) $7.56  c) $7.64  d) $13.44  e) none of these

111. On a certain map, \( \frac{7}{2} \) inch represents 200 miles. How many miles apart are two towns whose distance apart on the map is 3 \( \frac{1}{2} \) inches?
    a) 600  b) 650  c) 678  d) 700  e) 800

112. Bridget buys a packet containing 9-cent and 13-cent stamps for $2.65. If there are 25 stamps in the packet, how many are 13-cent stamps?
    a) 5  b) 10  c) 15  d) 20  e) none of these
113. If \(3x - 2 = 16 - 6x\), what does \(x\) equal?  
   a) \(-6\)  
   b) \(\frac{14}{9}\)  
   c) 2  
   d) 6  
   e) 17

114. There are three numbers. The second is twice the first, and the first is one-third of the other number. Their sum is 48. Find the largest number.  
   a) 8  
   b) 16  
   c) 20  
   d) 24  
   e) 30

115. The hands of a clock form an obtuse angle at \(\_\) o’clock.  
   a) 2  
   b) 3  
   c) 4  
   d) 6  
   e) 12

116. Sally needs three pieces of poster board for a class project. If the boards are represented by rectangles A, B, and C, arrange their areas in increasing order. (Assume \(b > a\)).  
   a) \(A < B < C\)  
   b) \(B < A < C\)  
   c) \(A < C < B\)  
   d) \(C < A < B\)  
   e) \(B < C < A\)

117. In a certain triangle, the shortest side is 6 inches, the longest side is twice as long as the shortest side, and the third side is 3.4 inches shorter than the longest side. What is the sum of the three sides in inches?  
   a) 21.4  
   b) 25  
   c) 26.6  
   d) 27.4  
   e) 27.6

118. Five points are on a line. T is next to G, K is next to H. C is next to T. H is next to G. Determine the relative positions of the points along the line.  
   a) C is between G and T  
   b) H is between T and G  
   c) K is between C and T  
   d) T is between H and G  
   e) G is between H and T

119. The opposite angles of a parallelogram are \(\_\_\_)\).  
   a) congruent  
   b) supplementary  
   c) complementary  
   d) acute  
   e) right

120. The formula for converting temperature from degrees Centigrade to degrees Fahrenheit is  
   \(F = \frac{9}{5}C + 32\). A temperature of 20 degrees Centigrade is how many degrees Fahrenheit?  
   a) 0  
   b) 32  
   c) 46  
   d) 68  
   e) 90
An Examination of the Relationships between Pre-service Elementary Teachers’ Mathematics Teaching Efficacy, Mathematics Self-efficacy, and Beliefs About Mathematics

BACKGROUND / STUDENT TEACHING INFORMATION

65. Your Gender:  a) Male   b) Female
66. Your Age:  a) 22 – 25   b) 26-30   c) 31-35   d) 36-40   e) 41-45   f) 46+
67. Your Ethnicity:  a) African American   b) Asian   c) Caucasian   d) Hispanic   e) Other
68. Preferred subject to teach:  a) Lang Arts/Reading   b) Math   c) Science   d) Social Studies   e) Other
69. Least preferred subject to teach:  a) Lang Arts/Reading   b) Math   c) Science   d) Social Std   e) Other
70. Number of year-long high school math courses completed: a) 0    b) 1     c) 2     d) 3     e) 4     f) 5+
71. Average high school math grade:  a) E     b) D     c) C     d) B     e) A
72. Number of college math courses completed: a) 0    b) 1     c) 2     d) 3-4     e) 5-6     f) 7+
73. Average college math grade:  a) E     b) D     c) C     d) B     e) A
74. Student teaching location:   a) Urban    b) Suburban    c) Rural
75. Grades Taught:   a) K - 2  b) 3 - 5  c) 6 - 8   d) 9-12
76. How many weeks did you student teach full time?  a) less than 4   b) 4   c) 5-6   d) 7-8   e) 9-10   f) 11+

For questions 77 through 81, please use the following scale:

<table>
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<tr>
<th>Very Negative</th>
<th>Moderately Negative</th>
<th>Slightly Negative</th>
<th>Slightly Positive</th>
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</table>

77. How would you evaluate your student teaching experience overall?
78. How would you evaluate your mathematics teaching experience in your student teaching?
79. How would you evaluate your student teaching experience in regards to classroom management / discipline?
80. How would you describe your relationship with your cooperating teacher?
81. What are your feelings about teaching mathematics in the future?
82. Prior to your student teaching, to what extent would you say your cooperating teacher had implemented conceptually-based (NCTM standards) approaches to teaching mathematics in her/his instruction?

<table>
<thead>
<tr>
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<th>Moderate</th>
<th>Above Average</th>
<th>A lot</th>
<th>Completely</th>
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<td>5</td>
<td>6</td>
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</tbody>
</table>

83. To what extent did you attempt to incorporate conceptually-based (NCTM standards) approaches in your teaching of mathematics?

<table>
<thead>
<tr>
<th>Not at All</th>
<th>Very Little</th>
<th>Moderate</th>
<th>Above Average</th>
<th>A lot</th>
<th>Completely</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
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</tbody>
</table>

84. How supportive was your cooperating teacher concerning your implementation of conceptually-based instruction (NCTM standards) in your mathematics teaching?

<table>
<thead>
<tr>
<th>Not at All</th>
<th>Very Little</th>
<th>Moderate</th>
<th>Above Average</th>
<th>A lot</th>
<th>Completely</th>
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<td>2</td>
<td>3</td>
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</table>
WHAT DO YOU BELIEVE? (Phases 2 and 3)

**Directions:** Read the following statements and rate your answers by filling in the appropriate circle on the scantron sheet. Respond to each item based on what you believe. There are no right or wrong answers.

Use the scale below when responding to each item:

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
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<tr>
<td>Strongly Disagree</td>
<td>Moderately Disagree</td>
<td>Slightly Disagree</td>
<td>Slightly Agree</td>
<td>Moderately Agree</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

32. Strategies will help a student learn mathematics.
33. Mathematics is primarily a solitary activity, done by individuals in isolation.
34. Students who understand the math they have studied will be able to solve any assigned problem within a few minutes.
35. There are links between mathematics and other disciplines.
36. Someone can teach a student how to learn math material.
37. Information learned in mathematics is useful outside of school.
38. It is a good use of time to work on math problems that have no precise answers.
39. How successful students are in mathematics is related to how hard they work.
40. Only certain people can do well in mathematics.
41. Reviewing the material discussed in class would help a student learn math.
42. There is usually only one correct way to solve a math problem.
43. There is a relationship between the number of hours students study and how well they do in math.
44. Students need to see the material many times to understand math concepts.
45. Exerting effort to try to understand a tough problem in math is a wise use of time.
46. Students who are good at math have to work hard.
47. Mathematics relates to day to day life.
48. A class in math study skills would be valuable.
49. How successful students are in mathematics has no relationship to how hard they work.
50. Even if it takes a long time to learn a math concept, it is best to keep trying.
51. A math problem can be approached in several different ways.
52. It is a waste of time to work on math problems that have no exact answers.
53. There are methods for learning mathematics.
54. Doing mathematics requires a lot of practice in following rules.
55. If a student is not naturally gifted in mathematics, they can still learn the class material well.
56. It is important for students to integrate new ideas in math with what they already know.
57. Mathematics is unrelated to day to day life.
58. Most people can do well in mathematics.
59. Doing mathematics involves exploration and creativity.
60. If it takes a long time to learn a math concept, it is best to give up.
61. Learning mathematics is mainly about memorizing facts and procedures.
62. Knowing how to solve a problem is as important as getting the solution.
63. There is always a rule to follow in solving math problems.
64. The average math homework problem should not take more than five minutes to solve.
Questions that were asked via email (Columbus cohorts) or at a follow-up session (Newark cohorts):

1) Please indicate whether or not you have completed Math 105 and 106 at OSU:
   a) Neither course
   b) Math 105 only
   c) Math 106 only
   d) Both Math 105 and 106

2) How many days a week and for how long each time did you teach math during your student teaching? (examples: 3 days per week, 45 minutes each day; or never; or every class every day)
APPENDIX B

INTERNAL REVIEW BOARD ACCEPTANCE LETTER AND
RECRUITMENT AND CONSENT LETTERS
TITLE PAGE - APPLICATION FOR EXEMPTION
FROM REVIEW BY THE INSTITUTIONAL REVIEW BOARD
The Ohio State University, Columbus OH 43210

<table>
<thead>
<tr>
<th>Principal Investigator</th>
<th>Name: Diana Erchick</th>
<th>Phone: 292-4093 X 203</th>
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</thead>
<tbody>
<tr>
<td>University Title:</td>
<td></td>
<td></td>
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<tr>
<td>□ Professor</td>
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<tr>
<td>□ Associate Professor</td>
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<tr>
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<td>Department or College:</td>
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<tr>
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<tr>
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<tr>
<td>OSU, Newark</td>
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<tr>
<td>Newark, OH 43055</td>
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<th>Co-Investigator</th>
<th>Name: Elizabeth Esterly</th>
<th>Phone: 263-0299</th>
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<td>□ Graduate Student</td>
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<tr>
<td>2915 Indianola Ave.</td>
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| Protocol Title | An Exploration of Novice Teachers' Perceptions of Mathematics Teaching Efficacy, Epistemological Beliefs, and Their Use of Conceptually-based Mathematics Methodologies |

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<th>Source of Funding</th>
<th>Personal</th>
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For Office Use Only

☐ Approved. ▶ Research has been determined to be exempt under these categories: |
Research may begin as of the date of determination listed below.

☐ Disapproved. ▶ The proposed research does not fall within the categories of exemption. Submit an application to the appropriate Institutional Review Board for review.

Date of determination: 1/3/03
Signature: [Signature]
Office of Research Risks Protection

HSE 1.0 Page 1 Approved by the Policy Coordinating IRB, May 18, 2000

321
Recruitment Email

Dear Teachers Name,

I want to thank you again for participating in my 2001 survey study on teacher confidence to teach mathematics and beliefs about mathematics. Last year I taught 8th grade math and science in SouthWestern City Schools. It was much more challenging than I ever expected! From my own experiences as a math teacher, I decided to conduct a follow-up interview study to gain a better understanding of how teachers can have greater confidence and effectiveness in teaching mathematics.

I would like to get your opinions and insights about teaching math in your classroom.

**Would you be willing to share your experiences and perceptions of teaching math with me?**

There are two options for participation: 1) participate in in-person interviews or 2) fill out an open-ended questionnaire.

1) I would like to interview you and observe you teaching mathematics.

I could come to your school whenever was convenient for you during January or February. The initial interview would last about 50 minutes and I could observe you teaching mathematics following the interview. The second interview of about 30 minutes would simply clarify any outstanding questions and give you an opportunity to give input on my understandings of our first interview. I would once again observe you teaching mathematics that same day.

As an expression of my gratitude for your time and willingness to contribute to the research, I will give you a $30 restaurant gift certificate if you participate in the interviews.

OR

2) I will send you an open-ended questionnaire via email which you can fill out and return to me via email. The four questions should take you about 20 minutes to complete. As an expression of my gratitude for your time and willingness to contribute to the research, I will give you a $5 restaurant gift certificate if you thoughtfully complete the questionnaire.

Please reply to this email, indicating if you would like to participate in the interview or complete the questionnaire.

If it is better to reach you at a different email address or by telephone, please let me know.

I hope to hear from you soon!

Gratefully,

Elizabeth Esterly
Consent for Participation in Social and Behavioral Research

Mathematics Teaching Efficacy, Epistemological Beliefs, and the Use of Conceptual Mathematics Methods

Dear Teacher:

My name is Elizabeth Esterly. I am a doctoral student in the College of Educational Policy and Leadership at the Ohio State University. I am working under the direction of Dr. Diana Erchick. I would like to request your participation in a study that explores the beliefs of teachers. The results of this research will culminate in my dissertation thesis, entitled Mathematics Teaching Efficacy, Epistemological Beliefs, and the Use of Conceptually-based Mathematics Methodologies.

The main purpose of this study is to obtain your perceptions, insights, and experiences of teaching mathematics so as to gain a better understanding of teachers’ beliefs about mathematics and their confidence to teach mathematics. You are being asked to participate in four 30 minute interviews with one possible follow-up interview to clarify any outstanding questions. You are also being asked to have the interviews tape recorded. The audio tapes will be transcribed for analysis and erased at the completion of the study.

You are also being asked for permission to observe you teaching mathematics on two occasions. You will also be asked to complete three brief opinion surveys that should take a total of 15 minutes.

My desire is that this study will result in helping new teachers be more confident and effective in teaching mathematics. I believe this study will be helpful to you as a teacher. I will make a copy of the dissertation available to the participants during autumn quarter 2003. If you would like to receive the general research results or discuss the implications of the findings, you may contact me at the email address listed below. All information will be kept strictly confidential by assigning a participant code number that will substitute for your name on all materials. The completed surveys will be secured in an office at the university for safe-keeping. An alias name will be used in the dissertation thesis.

If you agree to participate, please sign this form. Your participation in this study is voluntary, and you are free to withdraw from participation at any time. If you have any questions related to this study, you can contact me at (614) 263-0299 or esterly.3@osu.edu or Dr. Diana Erchick at (614) 292-4093 ext. 203 or erchick.1@osu.edu. If you have any questions concerning your rights as a participant in this study, you may contact the Office of Research Risks Protection, The Ohio State University at (614) 292-5958.

Sincerely,

Elizabeth J. Esterly

I agree to participate in the research project entitled: Mathematics Teaching Efficacy, Epistemological Beliefs, and the Use of Conceptual Mathematics Methods. Elizabeth J. Esterly or her authorized representative has explained the purpose of the study and the procedures to be followed. I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction. Furthermore, I understand that I am free to withdraw at any time and to discontinue participation in the study without prejudice. Finally, I acknowledge that I have read and fully understand this form. I sign it freely and voluntarily. A copy has been give to me.

Signature: ___________________________ Date: ___________________________
APPENDIX C

INTERVIEW PROTOCOLS
I. First Contact Telephone Interview Protocol (15 minutes)

After reading informed consent script and scheduling the school visits, the following two questions were asked:

1) How has your first year and a half of teaching been?
   - listen for indicators of teacher efficacy for instructional strategies, classroom management, and student engagement through analysis of mastery experiences
   - listen for impact of environmental and demographic factors
   - if these topics are not brought in to the conversation, the researcher will ask directly about them

2) Would you talk to me a bit about what it has been like for you to teach mathematics?
   - listen for indicators of mathematics teaching efficacy through analysis of experiences
   - listen for changes in efficacy
   - listen for factors that have influenced changes
   - if these topics are not brought into the conversation, the researcher will ask directly about them

II. Pre-Observation Interview Protocol (20 minutes)

A. First Classroom Observation

After introductions and signing of consent letter, I will ask the following questions:

1) Would you tell me about your approach to teaching mathematics?
   - listen for talk of how participant feels about content knowledge
   - listen for how participant feels about pedagogical skills
   - listen for how participant implements methods
   - be prepared to ask participant for details of the instructional practice
   - be prepared to ask participant for details of the rationales (theory, etc) undergirding the practice

2) Would you discuss what I am going to see in your mathematics lesson today?
   - listen for bulleted items in question one
   - How do you feel about the lesson?
   - Have you taught it before? Is it new content?
   - Discuss lesson plan objectives and how they will be attained

B. Second Classroom Observation

1) You know that this study focuses on mathematics. Can you talk to me about mathematics, what it is, how it is best taught, and how your perceptions of it have changed or not while you have been teaching?
   - listen for procedural and conceptual understandings
   - listen for impact of teaching experience
   - listen for impact of teacher training
   - if these topics are not addressed, the researcher will ask directly about them
2) Would you tell me about today’s mathematics lesson?
   - listen for how participant feels about content knowledge
   - listen for how participant feels about pedagogical skills
   - listen for how participant implements methods
   - be prepared to ask participant for details of the instructional practice
   - be prepared to ask participant for details of the rationales undergirding the practice
   - Discuss lesson plan objectives and what methods will be used to attain them

III. Post-Observation Interview Protocols

First and Second Classroom Observations
1) How do you feel the mathematics lesson went?
   - listen for indicators of teacher efficacy for instructional strategies, classroom management, and student engagement.
   - listen for how participant perceives effectiveness of methods and instructional practice
   - listen for how participant feels about pedagogical skills
   - listen for how participant perceives effectiveness of methods
   - be prepared to ask participant about details of her instructional practice (e.g., When you did X, what were you thinking?)
   - be prepared to ask participant for details of the rationales (theory, etc) undergirding the practice

Additionally:
First Post-Observation Interview:
2) What do you believe are the factors that influence how you teach mathematics?

Second Post-Observation Interview:
2) What do you perceive are the factors that influence your confidence to teach mathematics?

IV. Clarification Telephone Interview Protocol (15 minutes)

Following First and Second Classroom Observations
1. Conduct an oral member check of interviews, observation, and lesson plan document analysis

2. Clarify any outstanding questions from issues raised in the interviews on efficacy, epistemological beliefs, and use of conceptually-based methods of teaching mathematics.
Follow-up Interview Based on TSES

1. In your opinion, what all is involved in teaching an effective mathematics lesson with your third grade students?

2. How much can you do to help your students value mathematics learning? Can you think of a specific incident this past year where you helped a student value math?

3. If you were preparing a mathematics lesson to teach the next day, when you think about how effective the lesson will be, what types of things do you consider?

4. To what extent can you get your students to believe they can do well in mathematics? Can you give me an example?

5. Do you feel able to motivate students who show low interest in mathematics? Can you think of an incident when you motivated a low-interest student in math?

6. How much can you assist families in helping their children do well in mathematics or in school in general? Was there a specific time when you assisted one of your student’s families to help her or him do well?

7. Turning to classroom management issues, How much can you do to control disruptive behavior in your classroom? How do you handle disruptive behavior?

8. Do you feel you are able to get children to follow classroom rules? Are there any particular rules you are not great at enforcing?

9. How much can you do to calm a particular student who is disruptive or noisy? Can you think of a specific example?

10. How well can you establish a classroom management system that is effective with your students?

11. I am now going to ask you several questions about your beliefs about your use of instructional strategy abilities. How well can you implement alternative mathematics teaching strategies in your classroom? Can you give me an example?

12. To what extent are you able to craft good mathematics questions for your students? Can you think of an example?

13. To what extent are you able to use a variety of mathematics assessment strategies? Can you give me any examples?

14. How able are you to provide an alternative explanation or example when students are confused?

15. I am now going to ask you to describe some of your beliefs about mathematics as it relates to classroom learning. First of all, I would like for you to talk to me about your views on your students’ abilities to learn mathematics. Does it take a mathematical mind to do well in math? Does effort help in mathematics learning? Are there some kids who “just can’t get math?” (ABILITY TO LEARN)

16. If you, as her teacher, were to say that Mary’s mathematics knowledge is good, what does that mean?
17. Could you tell me your views on your role as the teacher and students’ role in the learning of mathematics? To what extent do you believe that what a student gets out of mathematics lessons depends on the quality of the teacher? (SOURCE)

18. How beneficial is it for your students to work on mathematics problems that do not have a clear cut answer? (STRUCTURE)

19. Tell me about your views on the importance of your students learning “math facts.” / Gaining conceptual understanding? (STRUCTURE)

20. How do you feel about the statement, “If a student cannot understand something in a mathematics lesson quickly, it usually means he/she will never understand it?” What do you think about the statement that “Learning mathematics well takes a long time?” (SPEED)

21. What is your response to the statement, “the mathematics facts presented in textbooks will never change.” Do you think what is known in the discipline of mathematics will be different ten years from now? (STABILITY)

22. Is it important for students to follow the established/correct steps in solving a problem? How often would you say that your students can get the correct answer for a problem, but not really understand why it is the correct answer? How do you feel about that? (FORM)
APPENDIX D

TEACHERS’ SENSE OF EFFICACY SCALE
### Teachers’ Sense of Efficacy Scale\(^1\) (short form)

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<tbody>
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</tr>
<tr>
<td>1. How much can you do to control disruptive behavior in the classroom?</td>
<td>(1)</td>
</tr>
<tr>
<td>2. How much can you do to motivate students who show low interest in school work?</td>
<td>(1)</td>
</tr>
<tr>
<td>3. How much can you do to get students to believe they can do well in school work?</td>
<td>(1)</td>
</tr>
<tr>
<td>4. How much can you do to help your students value learning?</td>
<td>(1)</td>
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<td>5. To what extent can you craft good questions for your students?</td>
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<tr>
<td>6. How much can you do to get children to follow classroom rules?</td>
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<tr>
<td>7. How much can you do to calm a student who is disruptive or noisy?</td>
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<td>8. How well can you establish a classroom management system with each group of students?</td>
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<tr>
<td>9. How much can you use a variety of assessment strategies?</td>
<td>(1)</td>
</tr>
<tr>
<td>10. To what extent can you provide an alternative explanation or example when students are confused?</td>
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<tr>
<td>11. How much can you assist families in helping their children do well in school?</td>
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<tr>
<td>12. How well can you implement alternative strategies in your classroom?</td>
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330
LIST OF REFERENCES


