# IMPLICATIONS OF TEACHER EFFICACY: ELEMENTARY AND MIDDLE-LEVEL MATHEMATICS

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ABSTRACT

Because math teacher self-efficacy is believed to be connected to outcome expectancy and the amount of effort an individual exerts in the face of difficulty, math teachers who demonstrate higher levels of teaching efficacy are desired to maximize potential student learning and positive academic efficacy development. Chapter One outlines the rationale and motivating questions informing this research. Chapter Two outlines the historical basis for the "Math Wars," beginning with Dewey and Thorndike. The mechanized education and international educational competition pervasive around the Cold War and Sputnik is discussed in relation to the development of Social Learning Theories, the debate of computation versus mathematical thinking, issues of detracking, and ability theories. Chapter Three documents relationships between teacher efficacy and student achievement, the pervasive gender issue with math self-efficacy found as early as elementary school, methods which have shown positive increases in both the preservice and inservice teaching populations, and leadership styles paired with school-wide reform that increase the collective efficacy of a professional educational community. Chapter Four addresses major findings in each of the studies, their applicability to use in the classroom, and suggestions for further research.

CONTENTS

# CHAPTER ONE: INTRODUCTION

## Introduction

Mathematics is a psychologically taxing subject for many students, yet it is one which must be mastered in order to fulfill the stated goals of the State and Presidency, namely that students must be able to pass grade-level appropriate standardized tests and compete globally. In order to meet this goal, students need teachers who can use Best Practices to aid students in comprehending increasingly in-depth mathematics standards. In my research, I have found that a significant contributor to competent teaching has to do with teacher beliefs that they can help students learn, namely teachers' efficacy. Because of the impact teachers have on students' psychological states, what are the methods teachers can use to improve their sense of efficacy so as to improve the efficacy of their students? As stated by Bandura in a 1997 essay on efficacy as an exercise of control: "A capability is only as good as its execution. The self-assurance with which people approach and manage difficult tasks determines whether they make good or poor use of their capabilities. Insidious self-doubts can easily overrule the best of skills" (Hoy & Spero, 2005, p. 344). As a woman entering the field of education with the intent to teach both elementary and middle-level mathematics, I want to know how does teaching efficacy develop, what is its impact on student achievement, and what methods have been found to increase low perceptions of competence? I will invest time in professional development to learn how to best instruct my students and help them to learn, but I want to know how to best take care of myself as a professional to prevent the insidious self-doubt that can lead to burnout or eventual departure from the profession.

## Rationale

The school environment, inside the classroom and school-wide, has an impact on the individual and collective efficacy of teachers. "The task of creating environments conducive to learning rests heavily on the talents and self-efficacy of teachers. Evidence indicates that classroom atmospheres are partly determined by teachers' beliefs in their instructional efficacy" (Bandura 1993, p. 140). That said, rather than focusing purely on individual teachers, it is important to examine larger systems of education as well. "Teachers operate collectively within an interactive social system rather than as isolates. The belief systems of staffs create school cultures that can have vitalizing or demoralizing effects on how well schools function as a social system" (Bandura, 1993, p. 141).

Several of the studies critiqued in Chapter Three demonstrate that teachers with higher levels of self-efficacy are more likely to use teaching practices correlated with higher student comprehension and achievement. Teachers who have higher self-efficacy tend to work harder with their students and genuinely believe that they can positively impact student learning. "Teacher expectancies and beliefs have been shown to influence student motivation and achievement both directly through observable teacher behaviors and indirectly through more subtle forms of communication" (Eccles, et.al, 1989, p. 247). It seems logical to make the connection that teachers who project the belief that they can help students learn math would help to develop students who also believed that they were able to learn. Elementary and middle-level mathematics are very important in establishing the academic future beliefs of students and poor experiences early on will greatly impact future mastery expectations or the lack thereof. As models for students,

teachers need to exhibit confidence in math and project a sense of authentic efficacy so as to encourage their students to do the same. "There are three principle ways in which perceived efficacy operates as an important contributor to academic development: students' beliefs in their efficacy to regulate their own learning and to master different subject matters, individual teachers' beliefs in their efficacy to motivate and promote learning in their students and staffs' collective sense of efficacy that their schools can accomplish significant academic progress" (Bandura, 1993, p. 135). What are ways that improving teacher beliefs can translate to lowered student math anxiety, higher comprehension levels, more confidence, and more positive views of math? What are teaching methods or development opportunities which will help to promote more general and personal efficacy in teachers and students? What school-wide reforms help to improve collective efficacy and promote significant academic progress?

This issue is additionally important to the academic community because of the issue of teacher burnout. "The [2003] National Commission on Teaching and America's Future reported that one-third of new teachers leave the profession within three years and that many more people leave than enter the teaching field" (Rimm-Kaufman & Sawyer, 2004, p. 321). If teachers are to stay in the field of education, it seems necessary to make sure that they are supported in doing so. Burnout is described as a crisis of efficacy (Brouwers & Tomic, 2000), and as such should be preventable, yet "Over 30% of new entrants do not make it to their second year; by their fifth or sixth year, another 20-30% of the same cohort have defected" (Rosenholtz, 1989, p. 422). Upon my entry into a profession which is emotionally taxing, while I anticipate dealing with policy decisions outside the realm of my immediate control, I want to know what I can do to make sure

that I am helping to create and support an environment of renewal rather than apathy and discouragement. "It requires a strong sense of efficacy to remain task oriented in the face of pressing situational demand and failures that have social repercussions" (Bandura 1993, p. 120). I believe that conditions teachers face, especially in today's economy, make examining the issue of efficacy all the more important. I want to have the realistic conviction that teaching outcomes are the result of actions within my locus of control.

Teacher's perceived levels of control over their environment also impact their sense of efficacy and Bandura outlined two aspects of control in his 1993 article on efficacy, stating: "The first concerns the level and strength of personal efficacy to produce changes by perseverant effort and creative use of capabilities and resources. The second aspect concerns the modifiability of the environment" (Bandura, 1993, p. 125). Low efficacy beliefs are therefore related to the development of academic anxiety, a common issue with students of mathematics which is exacerbated by a perceived lack of environmental and academic control.

## Limitations

While there is a large body of academic research to support the need to increase the self-efficacy of teachers, opponents call to reason the idea that teachers with total confidence in their abilities are assumedly less likely to independently affect change or be receptive to policy that would have them modify classroom practice. Thus, there is logic to the idea that "persistent high efficacy in the face of poor performance can produce avoidance rather than positive action" (Hoy & Spero, 2005, p. 345). Yet, in spite of this assertion, I choose to trust research that focuses on the idea of outcome expectancies as related to self efficacy beliefs, such that "Self-efficacy beliefs contribute to motivation in

several ways: They determine the goals people set for themselves, how much effort they expend, how long they persevere in the face of difficulties, and their resilience to failures" (Bandura, 1993, p. 131). If an individual believes that they are capable of investing effort into a task and that their effort will affect a particular result, they are more likely to set ambitious goals and in doing so, achieve. If a teacher with low efficacy does not believe that they are capable of teaching a student how to think mathematically, they will not have as much success as someone with more belief in their abilities and expectations of success.

## Summary

Chapter One outlined the motivating questions for research to be investigated in Chapter Three. Because efficacy is believed to be connected to outcome expectancy and the amount of effort an individual exerts in the face of difficulty, math teachers who demonstrate higher levels of teaching efficacy are desired to maximize potential student learning and positive academic efficacy development. This paper will explore documented relationship between teacher efficacy and student achievement, the pervasive gender issue with math self-efficacy found as early as elementary school, methods which have shown positive increases in both the preservice and inservice teaching populations, and leadership styles paired with school-wide reform that increase the collective efficacy of a professional educational community.

Chapter Two outlines the historical basis for the "Math Wars," beginning with Dewey and Thorndike. The mechanized education and international educational competition pervasive post-Sputnik is discussed in relation to the development of Social Learning Theories, the debate of computation versus mathematical thinking, issues of

detracking, and ability theories. Chapter Three groups research studies to provide an academic basis for the assertions made in synthesis in Chapter Four.

# CHAPTER TWO: HISTORY

## Introduction

Beginning with the philosophical debates of Dewey and Thorndike, the argument of computational math education versus mathematical thinking is grounded in a deep educational history. Because high math teacher self-efficacy challenges computational proficiency in the current swing of the math war pendulum, it is important to understand the basis for the argument and to recognize that there have been two predominant arguments in dialogue for over a century. The need to balance desire for high student achievement on standardized testing with academic arguments for students to learn to think mathematically is something that all math teachers will encounter.

## From Dewey to Thorndike

John Dewey was a visionary educator at the turn of the 20th century who created the Laboratory School "to develop methods that would demonstrate to the student the social value of knowledge and the interdependence of society…[such as] the development of social imagination through cooperative group activities" (Spring, 2005, p. 273). He believed in social learning over order and that students should learn applicable rather than abstract ideals, with opportunities to actively test relationships rather than arbitrarily learn ideas with no concrete basis in a community. Dewey had high ethical expectations of education, that it would promote experience and relationship over industry and order (p. 274). Active engagement was a part of the promotion of societal interdependence, a microcosm of an idealized community-based urban America, one which imparted the "intellectual and social meaning of the work" (p. 275). His focus on the development of critical thinking through action-based learning serves as the basis

for the argument for mathematical reasoning over computation practice detailed later in this chapter.

Edward Thorndike, by contrast, promoted basic instruction that was mechanical, a "situation and response" (Spring, 2005, p. 278) around the time of World War I. He viewed education "as a science concerned with the control of human behavior…giving and withholding stimuli with the result of producing and preventing certain responses" (p. 279). He had a strong emphasis on the scientific over the social, promoting scientific measurement of quantified student achievement. The purpose of education was not to mimic and support a relevant community ideal, as with Dewey, but to crate an "ideal social organization…in which people are scientifically selected for their social roles through testing" (p. 279), and to "select individuals for their places in the meritocracy and to provide an education that prepares individuals to live in a society ruled by merit and intelligence" (p. 301). This was directly in contrast to Dewey's philosophies of education and serves as the basis for the argument of computation over mathematical thinking detailed below. Thorndike intended this to promote a more efficient and mechanized society which matched the ability of the individual with the needs of the state. Thorndike helped to develop intelligence tests to quantify the intelligence of individuals for the purpose of scientific sorting (p. 279). "For Thorndike, the person who tries to act independently of expert opinion is a public danger and at the mercy of clever charlatans" (p. 301). Thorndike's belief in *natural* intelligence over increment theory (where individuals could develop thinking ability through education and proper mentorship, in an adequate *environment*) helped to justify a meritocratic view of racial difference based on inherited intelligence (Spring, 2004, p. 279).

Just as urban industrialization sparked social change which further stratified society, so did educational education change. "Scientific management [in the workplace] promised to replace the unsystematic actions of workers with a planned and controlled work environment" (Spring, 2004, p. 294) and the educational philosophies espoused by Thorndike supported this shift. This contrasted strongly with Dewey's comparatively agrarian ideal of a community-based, critically thinking society. The melding of education with a business model will be repeated in the following subsections in similar ways. Former President Clinton's "Goals 2000 Educate America Act again linked education to the needs of big business by emphasizing the importance of educating workers for competition in international trade" (Spring, 2004, p. 456). This same ideal has been re-introduced as educational "reform" by both Former President Bush and President Obama.

## The Cold War and Sputnik

Due in part to the race to space and American disappointment in the Russian Sputnik's success, the American government again looked to the mechanization of education to improve student output. Rao (1990) wrote: "The 1960s witnessed intense activity and increasing concern for educational technology to help improve effectiveness of instruction and promotion of learning efficiency. The implication was to find efficient methods of manipulation of the learning situation to obtain [globally competitive students]" (p. 29). As stated by Spring (2004), "The Cold War between the United States and the Soviet Union spawned demands for more academic courses in the schools and a greater emphasis on science and mathematics as a means of winning the weapons race with the Soviet Union…[generating] demands by government and industry that the

schools educate more scientists and engineers" (p. 375). While situated in different historical times, the professed national goal of education to create globally competitive students has carried from the 1960s to today. Because of the sociocultural and community influences presently recognized as influencing student's identity cognition, paying heed to the emotional connection to learning should hinge from student self-perception. As such, teacher cognition is also important to consider given that classroom learning is facilitated by teachers. In viewing the American educational system through a social cognitive lens, utilizing the work of Bandura seems a logical connection situated in the history of psychology.

## Bandura and Social Learning Theory

Social learning theory officially began in the 1930's at Yale University in an attempt to puzzle through people's common emotional ailments and the basis of personality. Influenced by Freud, Mark May, and Clark Hull, such theories were initially published in books such as Social Learning and Imitation, published in 1941 (Pajares, 2004). These psychologists were key influences in the formation of Albert Bandura's education and subsequent theories, many of which dealt with issues of self-perception and identity. Bandura was instrumental in defining efficacy in terms of general, collective, and self. In 1977, Bandura defined teacher efficacy as "a type of self-efficacy – a cognitive process in which people construct beliefs about their capacity to perform at a given level of attainment" (Hoy, Hoy & Tschannen-Moran, 1998, p. 203). He stated that such beliefs determined the amount of effort that teachers put into changing student beliefs and the confidence that they have the capacity to influence student learning. This social cognitive theory looked to view how self-referenced thought can mediate personal

action. For instance, if a teacher is faced with a classroom containing a high proportion of students with special needs, how long will she work to meet those needs before referring students outside the class for additional aid? The teacher's self-efficacy is believed to influence such factors. Bandura has published both articles and books on this topic since the late 1970s and continues to expand on his definitions and implications of efficacy on academic life.

Bandura was not the only researcher investigating issues of efficacy in the 1970s. In 1966, Rotter published a paper about cognitive learning theory in which internal control signifies that the individual feels that they can have control over their environment versus external control where the environment is outside of their control. "Beliefs about one's capacity to produce certain actions (perceived self-efficacy) are not the same as beliefs about whether actions affect outcomes (locus of control)" (Hoy, Hoy, & Goddard, 2000, p. 481). Put in the context of a classroom, whether a student feels that studying will impact their learning of mathematics is different from the individual's belief that it is possible for them to achieve understanding of specific concepts. Bandura's theory is more focused on specific, rather than general, outcome.

The RAND Corporation, a think-tank focused on research and analysis to aid in better policymaking, inspired by Rotter and Bandura, did a study on teacher efficacy in 1976 which found that "Teachers' sense of efficacy had a strong positive effect not only on student performance but the percentage of project goals achieved, on the amount of teacher change, and on the continued use of project methods and materials after the project ended" (Hoy, Hoy & Tschannen-Moran, 1998, p. 204). This study helped to define the importance of the issue thanks to its implications on student learning.

However, it did not offer specific ways in which to improve efficacy, simply to measure it based on an elaborate self-answered questionnaire. Hoy et al (1998) analyzed this method in relation to other teacher efficacy measurements and found that its limited scope could not be relied on as a "global measure" (Hoy, et al, 1995, p. 205). Efficacy measurement was taken through responses to two prompts, scored with a 5-point Likert scale:

> (a) "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," and
>
> (b) "If I try really hard, I can get through to even the most difficult or unmotivated students" (Hoy & Spero, 2005, p. 347).

Further research allowed for the creation of more specific surveys and questionnaires which focused on different types of efficacy beliefs. Personal, professional, general, and collective efficacy can be tested to look at both the beliefs of individuals about their capabilities and their belief in greater systems' abilities to affect change. This is significant in relation to teaching because it allows researchers to focus on what aspects of environments affect efficacy and what aspects of efficacy in turn affect environments. For instance, are the collective efficacy beliefs of a school influenced by individual teaching efficacy? And, assuming that teacher efficacy influences student achievement, what school-wide reforms can be conducted to better increase the efficacy of individual teachers?

## Computation versus Mathematical Thinking

In the two mathematics methods courses I took at Evergreen State College as part of my Master in Teaching program, I learned that one aspect of the politics of teaching math which has come into prominence recently is the idea of basic computation versus critical thinking as the more effective mode of math instruction. It is possible that this dichotomous argument came about as a result of the push to create more internationally competitive students in the post-Sputnik educational environment or as a continuation of the philosophical arguments posed by Dewey and Thorndike. Whereas some institutions believe that it is most important to help students quickly and efficiently "plug and chug" series of problems where they insert numbers into formulaic or routinized patterns for problem completion, others desire more transferrable math learning which focuses on problem-solving based mathematical thinking. In our methods courses at Evergreen, taught by Anita Lenges and Lisa Rollins, we discussed that the benefit to the computational system of education is that it can be simple to replicate and thus require less time to teach. It also can prove useful on standardized testing which focuses more on the correct computation of numbers and formulas than the critical thinking necessary in conceptually-based mathematics instruction. Some students, including some with certain learning disabilities (as with ADHD), benefit from more computation-based instruction and it tends to be more favored by teachers more comfortable with traditional teaching styles. These teachers often assume that the role of the teacher is to stand at the front of the classroom and instruct students on procedures which they then replicate at their desks several times for practice.

The other and arguably more controversial method of math instruction which has gained prominence of late is the idea that students need to understand mathematical relationships more than they need to use rote memorization to plug numbers into computation patterns and formulae. This was the mode emphasized and extensively discussed in our methods courses as being preferable because of the belief that through inquiry-based, student centered learning, math skills will be learned with students thinking critically about the *how*s and *why*s of math rather than simply the *what* of computation-based learning. The debate centers around which method will better prepare students to take standardized tests as proof of learning and which is best for conceptual understanding which can then be transferred to other mathematical concepts. Additionally, there is debate that forcing teachers to learn how to use a critical approach to mathematics will make them feel less competent about their ability to teach and student achievement will suffer as a result. Other arguments claim that teachers with higher efficacy tend to rely less on traditional teaching techniques and thus they are more likely to teach in alternate and more experimental ways to try to help every student in their classroom learn mathematics (Hoy, Hoy, & Tschannen-Moran, 1998, p. 214). Again, this argument can directly be tied to the opposing notions of Dewey and Thorndike.

## Detracking

Another issue in the history of education pertinent to this research has to do with the issue of detracking as outlined in Ross, McKeiver, and Hogaboam-Gray (1997). Mathematics education, starting at the middle school level, has traditionally been conducted through like-ability grouping such that some students go into an advanced

track, some to an average track, and the remainder in a remedial track. School districts are increasingly “detracking” these systems of math education because of new research which suggests that students show greater achievement gains across all ability levels when they are all grouped together in heterogeneous, versus homogenous, ability groupings. Additionally, there were disproportionate numbers of minority students in the lower-level courses, suggesting that tracking contributes to later segregation of schools which prevents minority student from taking the college-preparation math courses that non-minority peers have had access to since middle school.

The historical argument has been that teachers with more homogenous groupings, ability-wise, are able to teach more effectively to the needs of their students. They also have an easier job in that the mathematical curriculum content of their classes does not have to be adjusted for differing ability levels. Teachers can allegedly go more in depth with the students who need help and can focus one mathematical concept at a time, better keeping track of the pace of student learning. While this argument is convincing from the perspective of the teacher, schools who are trying to bring all students up to math standards often believe that tracking systems perpetuate the problem that students who fall behind, stay behind their peers and state-mandated standards. Heterogeneous classrooms, while more difficult for teachers initially, have been linked to greater achievement gains and better cooperative learning opportunities than schools who keep the tracking system (Ross, McKeiver, & Hogaboam-Gray, 1997). The issue with regard to efficacy beliefs is that teachers who are unsure of their ability to adapt curriculum to the diverse needs of learners in a heterogeneous classroom are more likely to be lower, at least for a time, than the teacher efficacy beliefs of teachers in traditionally tracked

classrooms. This has been an argument against math education reform in the past and sometimes holds in preventing reform which could potentially meet the needs of more students. This argument will be examined more closely in Chapter Three through an analysis of Ross, McKeiver and Hogaboam-Gray's (1997) study about the change in efficacy beliefs of a group of teachers who undergo school-wide detracking reform.

## Ability

The idea that human ability is a fixed entity has also changed in recent history. Rather than looking at the mental capabilities of the child based on birth as emphasized by Thorndike, researchers are beginning to better understand the impact of motivational attributes tied to similar ideals as Dewey. Ability is connected to motivation and environment and "is a generative capability in which cognitive, social, motivational, and behavioral skills must be organized and effectively orchestrated to serve numerous purposes. It also involves skill in managing aversive emotional reactions that can impair the quality of thinking and action" (Bandura, 1993, p. 118-119). While not simply an issue of nature versus nurture, social cognitive theory focuses on the interactions between an individual, the beliefs they have in their ability to achieve a desirable outcome, and the supports in their environment which help them to achieve these goals. Each factor is important to understanding the whole picture of efficacy development regarding specific intellectual pursuits, such as mathematics. If a student believes in a fixed-entity theory of knowledge in which they are born with a certain capability and cannot exceed this ability, they are less likely to put forth effort on problems which are difficult for them. However, if a student believes in a theory of intelligence which is impacted by motivation and a

supportive environment, they are more likely to believe that they can learn even difficult concepts.

The desire for school districts to examine teacher efficacy beliefs as an indirect indicator of the potential for student achievement seems to have come to national attention in the mid-1990s. Arguments were made which asserted that teacher feelings should not determine commitment to student achievement. Yet, people like New York Schools Chancellor Rudy Crew believed that since efficacy beliefs are an indicator of the preconceived beliefs that teachers have about the learning abilities of their students and their ability to impact learning, looking to efficacy reform could help teachers to raise expectations of success and help more students at higher levels ("Changing Teacher Attitudes," 1997). This movement, while occasionally veering too close to feeling-based misconceptions of quack-psychology, focused on more a learned rather than innate view of knowledge formation. This suggests that "with motivation and hard work, any child can perform above grade level" (Richardson, 1995). If teachers believe that students can learn, the assumption is that students' beliefs in their abilities will follow suite and achievement by implication will also improve.

## Summary

The debates Dewey and Thorndike continue to wage through history and the argument of computational math education versus mathematical thinking is unlikely to be resolved in the near future. The Cold War and Sputnik furthered the notion that it is important to produce math-proficient students who can prove international competitors through standardized testing. Despite attempts to pull math education away from

standardization and the mechanization of computation, district desire for high student achievement on standardized testing is something that all math teachers will encounter.

Chapter Three outlines studies that examined the ways in which teacher efficacy beliefs are formed and can be improved in both pre-service and in-service interventions, connecting efficacy to quantifiable student achievement and issues of gender.

# CHAPTER THREE: INTEGRATIVE REVIEW OF THE LITERATURE

## Introduction

This chapter focuses on an analysis thirty studies which researched different aspects of the efficacy of elementary and middle-level preservice and inservice mathematics teachers. First, the issue of a gender difference in math self-cognition is addressed to establish efficacy discrepancies in math self-efficacy and the impact on math performance. Then, studies are critiqued which show a connection between the teacher efficacy in teaching math and the achievement and math-beliefs of students. This section is followed by studies which investigate methods to improve the self-efficacy of preservice and inservice math teachers to prevent burnout and departure from the profession. The final subsection will focus on improving teacher efficacy through community support and professional collaboration as connected to transformational leadership and school-wide reform efforts.

## Math Self-Efficacy and Gender

As a woman entering the field of elementary and middle-level mathematics education, it is important to consider possible gender differences in relation to math self-efficacy beliefs. The studies that follow showed gender-based efficacy difference (Newstead, 1998) and focus on the efficacy beliefs of women who have succeeded in math- and technology-based careers (Pajares & Zeldin, 2000). This is necessary to help ground the importance of this topic for a woman entering the profession before establishing the connection between teachers' personal efficacy and that of their students. While Miller and Pajares (1994) did not see significant gender difference in efficacy

beliefs, their results were not typical for most of the studies researched. These that follow are examples of more typical results.

Seegers and Boekaerts (1996) examined the difference between girls and boys math test performance, self-referenced cognitions, task-specific appraisals, and whether there were "differences between boys and girls in the way trait-like self-referenced cognitions and task-specific appraisals determine learning intention and performance on mathematics tasks" (Seegers & Boekaerts, 1996, p. 224). Ninety boys and 96 girls (N = 186; all eighth-graders, ages 11-12) were selected from nine schools in an urban region of Leiden in the Netherlands to participate in this study. It is not mentioned how students were chosen for participation. Two of the schools were from "lower-class" areas, and the rest were from "middle-class" environments. Researchers excluded first-generation immigrants from this study because of their limited command of the Dutch language (Seegers & Boekaerts, 1994, p. 224).

Subjects were given several tests to determine math performance, academic self-concept, goal-orientation, success-attribution, academic motivation, and "intelligence." "Data were collected by advanced students as part of their study requirements" (Seegers & Boekarts, 1996, p. 227). It was unclear as to whether these students were advanced eighth-graders or college research assistants. The math performance test consisted of 104 items of a variety of difficulty, largely composed of released items from a national assessment study conducted by Wijnstra (1988). The assessment of academic self-concept of math ability was a 5-point scale, researcher-designed and tested instrument ($\alpha = .70$). Goal orientation was assessed with a 4-point scale featuring questions about task-orientation ($\alpha = .78$), fear of making mistakes ($\alpha = .66$), ego orientation ($\alpha = .75$), and

how often students hide their mistakes ($\alpha = .73$). The attribution questionnaire was also researcher-designed and focused on reasons for success and failure in relation to math-task performance ($\alpha = .62$-$.64$). The motivation questionnaire focused on relevant aspects of a specific learning task and was partially taken before a task and finished afterward ($\alpha = .72$-$.86$). The "objective measure for intelligence" was taken from the Snijders-Oomen Nonverbal Intelligence test and featured 27 questions on similarities of pairs of related geometrical figures ($\alpha = .76$) (Seegers & Boekaerts, 1996, p. 224-227).[1]

The results from this study which most directly relate to the research question of this paper have to do with the difference boys and girls in this study had when starting math problems. "Our results demonstrated that girls feel less efficacious in doing mathematics than boys. As a group, girls have less favorable beliefs about their mathematics ability" (Seegers & Boekaerts, 1996, p. 235-236). In the context of this study, efficacy beliefs were viewed through the lens of students' belief in their ability to learn, denoted by "learning intention" and "subjective competence." In comparing the average subjective competence scores for boys and girls, the difference in scores was found to be statistically significant ($F$ [1,184] = 13.07; $p < .01$). Additionally, there were significant gender differences in learning intention ($F$ [1,184] = 4.32; $p < .05$) (Seegers & Boekaerts, 1996, p. 231). What this means is that there were gender differences in student beliefs about their ability to complete mathematics problems and these beliefs were found to be the most significant factors in determining why boys subsequently scored higher, on average, than girls on the math tests researchers gave subjects.

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[1] This "objective measure" has obvious problems with measuring "intelligence" because it assumes that there is one type of academic intelligence, in which students can point out visual difference and similarity. There are many different mathematical aptitudes and this is only one of them.

In switching the focus from children to adults, Pajares and Zeldin (2000) published themes from a series of interviews conducted on 15 women in math, science, and technological careers, all of whom rely on extensive use of math or have math as a prerequisite for their career. The goal of the research was to examine the role played by "self-efficacy beliefs in the success of women who selected mathematics-related majors and pursued mathematics-related careers," specifically how these efficacy beliefs developed for such successful women (Pajares & Zeldin, 2000, p. 220). This was a theory-directed, qualitative study in which researchers used these 15 women as case studies to see whether their experiences followed the patterns of efficacy outlined by Bandura (1993).

The subjects were selected via primary contacts, personal acquaintances and professional networks. They were mostly in their thirties, with three women in their forties, one in her fifties, and two in their late twenties. There was one Japanese-American interviewee, one Latin-American interviewee, and the rest were Caucasian. They were each posed the same nine questions, focusing on efficacy and their careers, all given in the same order for continuity. That said, interviews were open-ended and only semi-structured to encourage a conversational atmosphere. They were also conducted at the participant's place of work so as to engender comfort and a "focus on career-related beliefs" (Pajares & Zeldin, 2000, p. 225). Subjects' interviews were recorded and transcripts were sent to allow them to clarify or expound on previous comments. Additionally, academic colleagues of Pajares and Zeldin, from a variety of disciplines, were solicited to comment on the organization of the study and the resulting data so as to "ensure that alternative theoretical explanations were not ignored," as the objective of the

study organization was to “maximize the likelihood that subsequent investigators following [their] procedures in similar domains would obtain similar data and arrive at similar conclusions” (Pajares & Zeldin, 2000, p. 226).

These interviews focused on several themes which seem to support Bandura’s (1993) beliefs about efficacy development. Women were strongly influenced by vicarious experiences and verbal persuasions (p. 227); strong family support and modeling (p. 227, 229); were exposed to a variety of math-career options (p. 228); had strong mentors in the form of early education teachers, college instructors, and bosses (p. 231, 233); and group membership (p. 233) (Pajares & Zeldin, 2000). Additionally, “Self-efficacy building on relational experiences resulted in a pattern of resiliency to perceived obstacles as women continued along their academic and career paths” (Pajares & Zeldin, 2000, p. 233). This community was attributed with helping women to develop strong self-efficacy at the same time that they were building mastery experiences and competencies.

While this study was incredibly transparent as to the potential effect of researcher bias and the reasoning behind the methodologies of the study, the logic and analysis of subject selection seemed suspect. Because the fifteen women interviewed were sought through professional and personal connections rather than a more random selection, the results are more likely to be indicative of a specific subset of a community and not transferable to other groups. That said, the researchers were very specific in the limitations of their work and were quite transparent as to what their study meant and what it failed to do. Regardless of the issues with sample selection, common themes in

responses pointed to the importance of authentic caring communities, be they familial or peer-related, in the development of higher math-related efficacy beliefs.

Because all teachers were first students, it is necessary to address the fact that there is evidence of a gender difference in self-cognitions with regard to math. The majority of individuals entering the teaching profession with intent to teach at the Elementary level are women and these studies complexify gender differences in math self-cognition and its impact on math performance and future math efficacy. The following section will address the impact of teacher efficacy beliefs on the efficacy and achievement of their students.

## Relationship Between Student and Teacher Self-Efficacy

As stated by Hoy and Spero (2005), "In the past two decades, researchers have found links between student achievement and three kinds of efficacy – the self-efficacy of students, the sense of efficacy of teachers, and the collective efficacy of schools" (p. 344). This section examines studies which show the impact of both teacher personal and collective efficacy on student achievement, self-reported feelings about mathematics, and math efficacy.

Eccles, Feldbaufer, and Midgley (1989) examined the relationship between students' belief in mathematics and their teachers' sense of efficacy during the transition from elementary to junior high school. Their hypothesis was that: (1) teachers with higher efficacy will have students with more positive beliefs about mathematics than will students who have teachers with lower efficacy; (2) changes in student math beliefs over the course of the year are related to their teacher's beliefs (Eccles, et al., 1989, p. 247). Researchers performed a longitudinal study of 1329 students in 95 pre-transition school

classrooms (grade-6 students), and 46 post-transition classrooms (grade-7). It was a quasi-experimental design, a large sample with small-scale effects of 12 school districts of middle-income students within a 50-mile radius of Detroit, Michigan (Eccles, et al., 1989, p. 248). Of the students, 52% were female and 96% were white (Eccles, et al., 1989, p. 249). No demographic data was reported with regard to the teachers involved in this study, however, teachers were given five-item factor analysis, inspired by RAND research, to quantify their personal and general teaching efficacy ($\alpha = .65$). The questionnaire focused on "beliefs, including teachers' trust and respect for students, beliefs about the need to control and discipline students, feelings of personal teaching efficacy, and views of ability as a modifiable intellectual skill or as a stable trait" (Eccles, et al., 1989, p. 249). Questionnaires were also given to students in the fall and spring of each grade year ($\alpha = .72$-$.78$) to measure "expectancies for success in math, perceptions of their performance in math, and perceptions of the difficulty of math" (Eccles, et al., 1989, p. 249).

The results of this study showed strong relationships between teacher and student beliefs, such that "In the spring of both years, students who had teachers with a more positive sense of teaching efficacy believed that they were performing better in math and expected to do better in the future than did students whose teachers had less positive efficacy beliefs" (Eccles, et al., 1989, p. 251). Additionally, results suggested that the beliefs of students with lower-efficacy teachers became more negative over the two years, whereas "the beliefs of students who had high-efficacy teachers became more positive or showed less negative change from the beginning to end of the school years" (Eccles, et al., 1989, p. 254). That said, researchers were cautious to point to causal

relationships and emphasize that while the sample was large, the magnitude of effect was small. The data was critiqued through mean and standard deviation analysis, and the average quantified levels of efficacy were graphed to show trends, however there were no correlative tests done between the variables. Additional mathematical testing of the data (as with correlation assessment of variables) would have been helpful in determining the statistical significance of the small-scale changes found in this study.

This study was very transparent to its goals and the changes it would have made in future research. They would "measure teacher efficacy beliefs in both the fall and spring in order to see if changes in teacher efficacy beliefs are related to characteristics of the students they teach" (Eccles, et al., 1989, p. 256). Additionally, they stated that because elementary school teachers teach more than one subject (math), their sense of personal efficacy in the classroom is based on more than their beliefs in their ability to teach math and would be difficult to separate. This is assumed to be different from the efficacy of junior high school teachers involved in this study as they only taught mathematics.

This study is significant in that it showed a relationship between a math teacher's efficacy and students' beliefs about mathematics. As stated by the researchers, "changes in students' perceptions could reflect not only the effect of their teachers' efficacy beliefs, but also their teachers' skills in helping them learn the subject matter" (Eccles, et al., 1989, p. 255). The results were inconclusive in defining clear efficacy relationships, however other studies researched indicate that teachers with higher personal efficacy are also more likely to use multiple methods of instruction to better help students with mathematics mastery (Hoy, et al., 1998). It seems logical to make the assumption, based

on this research, that teacher beliefs in their ability to teach math will impact students' beliefs that they can learn.

Midgley, Feldlaufer and Eccles (1989) conducted a study on the transition from middle school to high school and how student/teacher relationships and attitudes toward mathematics changed during this time. They sampled 12 school districts in middle-income communities in southeast Michigan as part of another project and analyzed data in a different context for this study. 1,301 students in 171 math classrooms participated in the study. Questionnaires were distributed to students in the fall and again in the spring of 1984-1985. They were designed to measure students' perceptions of the intrinsic value of math and were scored via a 7-point Likert scale ($\alpha = .76$). The student/teacher relationship was also measured in an assessment of student perception of classroom environment, focusing on teacher caring, friendliness, and fairness ($\alpha = .73$); assessed with a 4-point Likert scale. Student achievement in mathematics was assessed by a state-mandated standardized test (Michigan Educational Assessment Program), allowing researchers to assess the bottom 25% of test-takers, designated the low-achievers and assumed to be most affected by relationships with teachers (Midgley, et al., 1989, p. 983-984).

As anticipated, multivariate analysis of variance suggested that changes in students' values of mathematics were related to differences in perceived teacher support during the transition, students whose teachers were perceived to be high in support showed little change in their perceptions of the value of math, and students whose teachers were perceived to be low in support displayed a decline in the value with which they placed on mathematics (Midgley, et al., 1989, p. 984). While averages changes were

on the small scale of results, the change in perceived teacher support and year changes in both intrinsic value of math and the perceived usefulness of math were highly statistically significant in this study (Intrinsic, $F(3,1300) = 21.80$, $p < 0.0001$; Useful/Importance, $F(3,1300) = 16.41$, $p < 0.0001$) (p. 984). These results indicated that while timing may be important in the transition to junior high, "more attention needs to be paid to the nature of the junior high school classroom environment" (Midgley, et al., 1989, p. 988). If one of the primary determinants of classroom environment is teacher efficacy, it stands to reason that teacher's efficacy beliefs will indirectly affect the student transitions. While this study was a reinterpretation of the data from a larger-scale study, it shows implications of teacher beliefs and student achievement as moderated through the student/teacher relationship.

Newstead (1998) conducted a study on the impact of a specific alternative curriculum on student math anxiety, hypothesizing that "pupils who have been exposed to an alternative teaching approach will have lower average mathematics anxiety total scores than pupils who have been exposed to a more traditional teaching approach" (Newstead, 1998, p. 56). The importance of this study is the idea of teacher-student efficacy transmission which Newstead introduced as a contributor to the success of the program as she interpreted in the research data. While this qualitative study "aims to take account of evidence, albeit mainly anecdotal, that such alternative approaches to teaching mathematics have positive affective consequences and may thus help to reduce anxiety" (Newstead, 1998, p. 56), it has the potential to emphasize a consequence of efficacy as defined by Bandura (1993). He wrote that one of the characteristics of efficacious

teachers was comfort with the use of alternative teaching methods and this seems to be supported by the data of this study.

The curriculum introduced was Calculator Aware Number Curriculum (CAN) and focused on the use of calculators in the math classroom in conjunction with an alternative, investigative teaching style, real-life problems, and class discussions of math strategies. Of the six teachers involved in this study, two had received training in CAN curriculum (denoted ex-CAN) and four did not (denoted non-CAN). Two hundred, forty-six students between 9-11 years old were surveyed at the end of their 5-6$^{th}$ grade school year (June and July) in five mixed-sex primary schools in the UK. Because "Age 9 to 11 seems to be a critical stage for the development of attitudes and emotional reactions towards mathematics," Newstead specifically chose this age of students to survey (Newstead, 1998, p. 53). Because it was the end of the school year, it was assumed that teacher and student behaviors at this time would be relatively stable and indicative of normal yearly behavior. Of the student sample, 48.4% were girls and 51.6% were boys (Newstead, 1998, p. 57).

Students were given a mathematics anxiety questionnaire developed in a previous study by Newstead and included questions on general disliking of mathematics, working with numbers and sums, teacher and classroom-related situation, and the use of math in other everyday activities (such as telling time and shopping activities). The validity of this measurement was well supported through interviews in previous studies and had relatively strong internal consistency ($\alpha$ = .82-.87). No further information was given about the specific answer possibilities of the questionnaire or how results were quantified for analysis.

Teaching approaches were also surveyed and based on ex-CAN versus non-CAN status, were characterized as either “alternative” (ex-CAN) *or* “traditional” (non-CAN); the alternative definition was stated above. “Traditional” teaching focused on teacher demonstration, individual practice, pencil-and-paper computation, and word problems. The teacher questionnaire used to additionally assess classroom organization and teacher beliefs was based on teachers’ perceptions of the role and function of the teacher, the nature and process of learning, and classroom management philosophies. Observations were also made to clarify and confirm self-reported practices as “self-reported classroom organization and beliefs as the only source of data on teaching approach is questionable” (Newstead, 1998, p. 58-59). Each class was observed for at least one math lesson and focused on teacher practices. It should be noted that two additional teachers were supposed to be included in this study in the “alternative” classification, however their observation results were markedly different from their self-reported organizational beliefs and CAN training (Newstead, 1998, p. 60-61).

Based on interpretation of student questionnaires, in which student responses were given numerical values from 1-3 based on 1 = least anxious, 3 = most anxious, scores were analyzed and it was found that students who were exposed to more alternative methods of teaching generally had lower average mathematics anxiety than pupils who had experienced more traditional methods of instruction. Students from the group whose teachers had been trained in CAN teaching procedures reported lower levels of anxiety, such that 48.3% declared that they were not anxious about either the social or mathematical aspects of their class; students whose teachers had not been trained in CAN reported only 33.0% who were non-anxious about either the social or mathematical

aspects of their class (Newstead, 1998, p. 65). It should be noted that these students were not tested for mathematical competence, so their anxiety beliefs could not be grounded or compared to their quantified achievement. Because this study focused solely on one factor involved in children's math anxiety, that of teaching approach, there were several hidden variables not discussed. Because CAN is a technology-heavy curriculum, further testing should have been conducted which examined the effect of technology (via calculators) on student anxiety as one of these hidden variables.

The idea that the use of non-traditional, collaborative, discussion-based and real-world-focused mathematics curriculum as the potential to improve student self-beliefs is a helpful method to focus on in the plight to increase efficacy beliefs as a precursor to increasing achievement. As stated by Newstead, "The possibility that mathematics anxiety may be perpetuated in the classroom by mathematics anxious teachers is especially interesting in the light of … findings that highly mathematics anxious teachers tend to teach in traditional ways and in the light of this research which has confirmed that such a teaching approach may in turn affect pupils' mathematics anxiety" (Newstead, 1998, p. 69). Eccles, et al. (1989) mentioned the connection between student mathematics anxiety and that of their teachers and Newstead's research, though, flawed, points again to this connection. Eccles,et al. focused on efficacy beliefs, however in mentioning the connection between anxiety and teaching efficacy beliefs, they helped to make Newstead's results potentially significant in this additional arena.

Allinder (1995) studied the relationship between teacher efficacy and student achievement with regard to the use of a type of formative assessment, Curriculum-Based Measurement (CBM) in math lessons for special education students. Formative

assessment differs from summative evaluation (as with end-of-unit exams and standardized testing) in that "emphasis is on progress, or change over time, rather than performance" (Allinder, 1995, p. 248). Instead of focusing on ability, formative assessment is focused on growth in a subject, helping students to build mastery experiences over time. CBM is a variation of formative evaluation which Allinder states has been tested on reliability, validity, and sensitivity to student progress. That said, not all teachers implement CBM in the same manner and quality of implementation was a primary variable examined in this study. "It is possible that overall quality of formative evaluation implementation may be affected by teachers' degrees of personal and/or teaching efficacy, given that high-efficacy teachers are more likely to implement a greater number of components of new educational practices" (Allinder, 1995, p. 249). In this study, Allinder sought to examine if teachers with higher personal and teaching efficacy implemented CBM with better quality than teachers with lower levels of personal and teaching efficacy. Additionally, she wanted to see if there was more evidence of student academic growth effected by teachers with higher levels of both types of efficacy versus the student growth demonstrated by teachers with lower levels of both types of efficacy.

Participants in the study were 19 special education teachers from a large Midwestern school district who had not previously used CBM instructional techniques. They had an average of 10.95 years of teaching experience (SD = 8.82 years) and 9.73 years experience teaching special education (SD = 7.50 years) (Allinder, 1995, p. 249). No mention was made as to how these teachers were selected for participation, whether it was a random sampling or self-selection. Teachers were trained in CBM procedures

during a 3-hour inservice in the fall and were introduced to formative instructional procedures and taught how to use the CBM software.

Each teacher selected two students with whom to implement CBM who had current Individualized Education Programs (IEPs) for math and were in a grade between grades 3 through 6. Each student had been classified as having a learning disability (60% of the sample), behavior disorder (24%), or mild mental handicap (16%) according to state classification criteria. 75% of students were boys and 45% were nonminority (Allinder, 1995, p. 250). Student achievement was assessed at the beginning of the fall with the Math Computation Test-Revised which features computation problems spanning across first through sixth-grade math and in which students are given 10 minutes to complete as many of the 50 problems as they can. Internal consistency was relatively high ($\alpha = .85$) (Allinder, 1995, p. 251). As the study progressed over four months, students were given daily pen-and-paper tests with the computer monitoring time spent. After a specified amount of time, students entered their scores into the computer, which scored them and gave students their progress though the math curriculum. Student achievement was measured via the slope of student progression through math curriculum, averaged over a seven-day week. If a student had positive slope, it indicated that they were moving through the math curriculum at a rate proportionate to the slope's distance above zero. If a student had a slope value of zero, they had not made any progress through the math curriculum objectives. Students took short biweekly tests on problems which represented the goals individually set for them by teachers and their goals were re-evaluated based on the slope of their progress toward end-of-year goals.

Teacher efficacy was measured by the Teacher Efficacy Scale developed by Gibson and Dembo (1985). It featured 20-items with a Likert-type scale and proved to have reliable internal consistency ($\alpha = .78$ for personal efficacy, $\alpha = .75$ for teaching efficacy, and $\alpha = .79$ combined) (Allinder, 1995, p. 252). The 6 teachers whose personal efficacy score was above the median were considered to have "high efficacy" and the 13 teachers with scores lower than the median were denoted to have "low efficacy." The eight teachers with teaching efficacy scores higher than the median were considered to have "high efficacy" and the 11 teachers with teaching efficacy scores lower than the median were marked as having "low efficacy" (Allinder, 1995, p. 254). Teacher efficacy was assessed at the beginning of the study and CBM implementation was assessed about eight weeks into the study with the Math-Modified Accuracy of Implementation Rating Scale (M-MAIRS) which examined student graphs and judged observations based on instructional procedures and timing. Teachers were evaluated with a 5-point Likert-type scale with $\alpha = .73$ for the process (Allinder, 1995, p. 253). Additionally, teachers were assessed on the number of CBM tests students took, the goals teachers set for students, the number of times instructional changes were made based on student achievement, and the timing of when these changes took place. This all related to student growth with regard to the CBM math curriculum.

Results indicated that there was a strong correlative relationship between teaching efficacy and the ambitiousness with which teachers ascribed year-end goals to their students ($r = .42$, $p < 001$) and for the number of changes that teachers made to the instructional techniques and short-term goals ($r = .24$, $p < .001$) (Allinder, 1995, p. 255). There was an even stronger relationship found between personal teaching efficacy and

the improvement of students in digits ($r = .74$, $p < .05$) and correct problem completion ($r = .75$, $p < .05$) (Allinder, 1995, p. 255). This indicated that for both efficacy measures, personal and teacher efficacy had an impact on high student achievement in the context of this curriculum. Additionally, "Difference between high and low personal efficacy groups were associated with effect magnitudes of .92 for digits, .93 for problems, and .91 for slope" (Allinder, 1995, p. 255). This indicated that Allinder was able to isolate the positive impact of efficacy beliefs on achievement such that students with higher efficacy teachers (in personal and teacher efficacy) better helped their students achieve math goals. Teachers with high efficacy beliefs were more willing to increase goals for their students as students' slopes were higher, thus their goals for students proved more ambitious overall. "This willingness to set and strive for higher goals for their students may be a concrete reflection of a belief in their ability to teach students and a belief that the students whom they teach can benefit from the education offered them" (Allinder, 1995, p. 255).

While the results of this study are quite limited, having examined only two types of efficacy on a small sample group using a specific computerized mode of formative assessment, the implications are significant. Such a strong relationship between students with special needs and the efficacy of their teachers suggests that significant achievement goals and gains might be possible in a classroom where students do not have the same special needs. Students and their teachers could see improvement as it was happening and were thus able to tailor the instruction of the student to their individual needs. Additionally, this research implies that because more efficacious teachers had more positive beliefs in their individual capacity to help students learn, they set higher goals

for achievement. This research seemed to indicate that efficacious teachers, in this formative context, both expressed high expectations and gave the support necessary for students to achieve.

Midgley, Anderman, and Hicks (1995) conducted a study which focused on the difference between school culture in elementary school and that of middle school and the task goals that mediate self-efficacy of both students and teachers. Data was collected (before reform began) as part of a three-year program intended to change instructional focus from performance goals to task goals. The two elementary and two middles schools compared in this study were from a suburban community in which almost 25% of the students in the school district qualified for free or reduced lunches. District-wide, the majority of students were Caucasian, and 17% were African American. There were 50 elementary teachers involve in this study (43 women and 7 men) and 108 middle school teachers (63 women and 45 men) for a total of 158 teachers. Teachers filled out efficacy surveys ($\alpha$ = .62-.92) in the fall and again in the early winter of 1990-1991. The surveys assessed instructional practices, beliefs about the school as being fixed, modifiable, or changing, and teacher goals (task, performance, and student achievement). The students sample was composed of 291 upper elementary-aged students (fourth and fifth grade) and 678 middle school students (sixth and seventh grade) balanced for gender. Students were assessed with the Patterns of Adaptive Learning Survey ($\alpha$ = .55-.71), scored on a 5-point scale and were questioned about perceptions of the school culture, their personal achievement goals, sense of self-efficacy and beliefs about the nature of school ability (Midgley, et al., 1995, p. 94-98).

Researchers used *t* tests to assess the significance between variables and found that middle school teachers perceived "greater schoolwide stress on performance goals than did elementary teachers ($t = -2.44$, $p < .05$), whereas elementary teachers perceived a greater stress on task goals than did middle school teachers ($t = 3.48$, $p < .001$)" (Midgley, et al., 1995, p. 98). Middle school teachers reported stressing performance goals to students more so than did elementary teachers ($t = -2.60$, $p < .01$) and elementary teachers reported stressing task goals more to their students than did middle school teachers ($t = 2.27$, $p < .05$), yet there was no discernable difference in their reporting of performance-focused instructional practices which rewarded students for higher academic achievement (Midgley, et al., 1995, p. 99). As far as efficacy beliefs, teachers at the elementary school reported feeling significantly more efficacious than teachers at the middle school ($t = 3.35$, $p < .001$), while the opposite was true for their students with middle school students reporting higher levels of efficacy than elementary students (Midgley, et al., 1995, p. 100).

While this study showed strong relationships between task versus performance goals and the more significant relationship between high student efficacy and task goals set by teachers, there were some issues which make its generalizability questionable. Because the α-values were so low, low internal consistency with measurement scales question whether this study is representative of solid research. Additionally, the emphasis for teacher efficacy had more to do with teacher intentions than the reality of what they stressed to students in the task versus performance debate. That said, this study shows relationships between student and teacher efficacy levels and the impact of teacher beliefs on student-internalized goals.

In an effort to assess the degree to which collective teacher efficacy shapes the normative environment of a school and its impact on student achievement, Hoy, Hoy, and Goddard (2000) conducted two large-scale studies. The main research questions were as follows: "we postulate two key elements in the development of collective teaching efficacy: analysis of the teaching task and assessment of teaching competence. Further, we postulate that perceptions of group capability to successfully educate students result when teachers consider the level of difficulty of the teaching task (in relation) to their perceptions of group competence" (Hoy, et al., 2000, p. 485). Additionally, researchers predicted that collective teacher efficacy would be a factor in student-level achievement when schools of differing levels of efficacy were compared (Hoy et al., 2000, p. 498). The survey was developed to assess levels of collective efficacy was extensively tested and was found to have strong reliability and reasonable validity in a field test prior to being used in the pilot study.

The pilot study compared the results of 46 teachers, one from each of 46 schools in five states, tested on the psychometric properties of the Collective Teacher Efficacy Scale. "One half of the schools had reputations of relatively high conflict [22 schools] and the other half had relatively low conflict among the faculty [24 schools]. School reputations for conflict were ascertained from educators, administrators, and professors of education familiar with the school" (Hoy, et al., 2000, p. 489). In addition to the collective efficacy items, teachers were also asked to respond to a sense of powerless scale, an individual teacher efficacy scale, and measure of teacher trust in colleagues.

Results from the pilot study indicated that teachers had difficulty separating their perceptions of collective efficacy from their perceptions of the difficulty of the task,

indicating that collective efficacy (like individual efficacy), appears to be context-specific. Conflict was negatively related to collective efficacy, showing that schools with higher collective efficacy generally had less interpersonal conflict (the mean efficacy score for low-conflict schools was significantly higher than the mean efficacy score for high-conflict schools, $t = 5.08$, $p < .001$). Teacher powerlessness was negatively related to collective teacher efficacy ($r = -.51$, $p < .001$), indicating that schools where teachers felt powerless generally had lower levels of collective teacher efficacy. Trust in colleagues was positively related to collective teacher efficacy ($r = .67$, $p < .001$), indicating that schools where teachers had trust in their peers generally had higher levels of collective self-efficacy. Collective efficacy and individual teacher efficacy were positively related ($r = .41$, $p < .001$), indicating that schools were teachers had confidence in building abilities to affect learning generally also had confidence in their own abilities to affect student learning. [All results, (Hoy, et al., 2000, p. 490).]

In the second study conducted and analyzed in this paper, elementary schools within one large urban Midwestern school district were surveyed. Forty-seven schools participated in the study (none were carryovers from the pilot study), for a total of 452 teacher surveys. Student achievement scores on standardized tests and demographic data for all schools were obtained from central administrative offices as well. Teacher efficacy surveys were researcher-administered to faculty groups in the afternoon, during regularly scheduled faculty meetings (Hoy, et al., 2000, p. 491-493). No mention was made as to the time of school year in which the study was conducted. The two surveys administered included a measure of institutional integrity, and the other assessed collective efficacy and other social processes in the school (similar to the individual

efficacy and faculty trust focused on in the previous study). "Distribution occurred so that every other teacher received a collective efficacy survey; teachers sitting next to one another had different surveys" (Hoy, et al., 2000, p. 493).

As predicted, based on the results of the pilot study, "there was a moderate and positive ($r = .54$, $p < .01$) correlation between personal efficacy aggregated at the school level and collective teacher efficacy" (Hoy, et al., p. 494). This reinforced the connection between personal and collective teacher efficacy as found in the pilot study. Additionally, collective teacher efficacy was found to be positively related to student achievement in both mathematics and reading based on data from standardized test scores. "Indeed, the effect of collective teacher efficacy is greater in magnitude than any one of the demographic controls for both achievement variables" (Hoy, et al., p. 500). Specifically, a single unit increase in the level of collective teacher efficacy was found to increase student achievement by more than 40% of a single standard deviation, indicating that "Collective teacher efficacy perceptions are predictive of student achievement" (Hoy, et al., p. 501).

While this study only offers initial support to a connection between collective efficacy and student achievement (it was the only strong instance of a connection between these two variables included in this research), it offered two well-executed and detailed studies which promote strong relationships between efficacy and achievement at the building level. The results of these studies seem reliable because of their breadth and methodical mathematical basis. They reinforce the idea that teachers who believe in a collective ability to educate students are more likely to respond to perceived norms of instruction; and by implication suggest methods in which teacher efficacy can be

improved. As stated at the end of the discussion, "one way for school administrators to improve student achievement is by working to raise the collective efficacy beliefs of their faculties" (Hoy, et al., 2000, p. 502-503)

This section reinforced the notion that there is a connection between personal and collective teacher efficacy in teaching mathematics and the achievement and math-beliefs of their students. Students who had less efficacious teachers tended to have more negative (Allinder, 1995), anxious (Newstead, 1998), and less-efficacious beliefs about their ability in mathematics (Eccles, Feldlaufer, & Midgley, 1989). Students were more successful and positive when their instructors demonstrated more positive self-beliefs with regard to their ability to teach math (Midgley, Feldlaufer, & Eccles, 1989) and a higher degree of collective efficacy school-wide (Hoy, Hoy, & Goddard, 2000). Because these studies focused on the connection between efficacy and student belief and achievement, they reinforce the need to have more efficacious math teachers at both the elementary and middle levels. The following two sections investigate methods and experiences that demonstrably increase the efficacy beliefs of both preservice and inservice math teachers.

## Preservice Teacher Efficacy

The following studies identify typical personal efficacy beliefs of preservice teacher candidates entering both elementary and middle-level mathematics endorsements. This research not only shows the general trends for those entering the profession, but also grounds the need for methods courses to increase efficacy through mastery experiences and a supportive community of learners. Toward the end of the section, research is

focused on studies in which mathematics and teaching efficacy beliefs were increased in preservice teacher candidates.

In a study conducted on 269 students at three Finnish universities, Hannula, Kaasila, Laine, and Pehkonen (2005) quantified the belief profiles (regarding self-perceived talent, difficulty of mathematics, and declared liking of mathematics) of students of elementary education at the beginning of their certification program (p. 89). Researchers wrote that because elementary teachers were the first people to teach mathematics to children, their self-perceived competencies and views of mathematics were profoundly significant. While this study was conducted in Finland and originally written in Finnish (I make the assumption that translation issues exist), it still has relevance to my research because it manages to connect efficacy beliefs to prior mastery experiences (or lack thereof). This is idea supports Bandura's (1993) belief that past experience is a strong indicator of present self-efficacy.

Students were given belief questionnaires ($\alpha$ = .74-.91) and a mathematical skills test to assess achievement as connected to self-belief. Results were separated through cluster analysis into three categories (positive, neutral, and negative), each of which was further divided into two sub-classes. Hannula, et al. quantified questionnaires based on these categories and determined that the students involved in this study could be classified into 21% "Autonomous," 22% "Encouraged" (positive beliefs), 18% "Pushed," 18% "Diligent" (neutral beliefs), 18% "Lazy," and 4% "Hopeless" (negative beliefs) (p. 93-94). While these terms seem to have connotations which deviate from the stated intent of this study (were 18% of the students really "Lazy" about learning mathematics?), they are descriptive in quantifying student views in the context of this

research. Demographic data was also collected to see if there were correlative relationships between certain demographics of student and their quantified mathematical self-beliefs. The main demographics analyzed were gender, the college mathematics course level selected, and the grades students received in high school mathematics (p. 91).

Significant relationships were found between previous grades in math and current beliefs about competency, high school course selection and current mathematical self-confidence, and grade-effects were more pronounced with women than men (Hannula, et al., 2005, p. 93). (Because no p-values were declared, it is difficult to determine exactly how significant results were so I have chosen to omit the correlations and instead rely on researcher-stated results.) The importance of this to my research is to emphasize the idea that past-experiences have significant impact on present self-beliefs about mathematics. I am willing to assume that an individual's grades and high school course selection would have a "significant" affect on their preservice self-efficacy with regard to math, based on the results of this survey.

Gresham (2008) conducted a study of 156 preservice teachers attending a university in the southeastern United States to question the relationship between math anxiety and efficacy and answer the question: "What are elementary pre-service teachers' perceptions toward their mathematical skills and abilities to teach elementary mathematics effectively?" (Gresham, 2008, p. 173). Of the subjects, 148 were female and eight were male, and no effort was made to differentiate results according to gender. All students were working toward K-6 endorsements in elementary education, were taking a math methods course based on NCTM (2000) standards, and participation was

voluntary (it did not affect or at all influence course grades) (Gresham, 2008, p. 173). The math course was "designed to help pre-service teachers develop an understanding of mathematics, mathematics pedagogy, and children's mathematical development; and to cultivate a positive disposition toward teaching mathematics, and lessen pre-service teachers' mathematics anxiety" through an emphasis on making mathematical meaning rather than deriving correct answers (Gresham, 2008, p. 178). The math course seemed to be more the source of a convenience sample than a documented variable in the research as little mention was made about the course's impact on either anxiety *or* efficacy.

Students were given two pen-and-paper assessments during the last week in class to assess anxiety (via the Mathematics Anxiety Rating Scale developed by Richardson and Suinn, 1972) and efficacy (via the Mathematics Teaching Efficacy Beliefs Instrument developed by Enochs, Smith, and Huinker, 2000) (Gresham, 2008, p. 174). Twenty subjects were also given semi-structured oral interviews within one week of the end of the quarter. These students were the 10 who scored the highest and the 10 who scored the lowest on the anxiety scale.

Results indicated in an analysis of the anxiety and efficacy scores that there is a negative relationship between mathematics anxiety and mathematics teacher efficacy among these preservice teachers when the subscales were combined ($r = -.450$, $p < .05$) (Gresham, 2008, p. 176). This finding was confirmed in interviews, as the 10 teachers with more firm beliefs with regard to their abilities to effectively teach mathematics had lower levels of math anxiety. The converse was also true, however, as interviews also showed that "Several of those with high levels of mathematics anxiety expressed some

efficaciousness. However, they continued to doubt their ability to teach effectively due to their mathematics anxiety" (Gresham, 2008, p. 181). Additionally, in the interviews, "all [teacher candidates] expressed a sense of efficaciousness toward using authentic situations that focused on meaningful experiences" (Gresham, 2008, p. 182). These results are interesting in terms of my research because they focus on a population of predominantly woman teachers preparing to enter elementary education and I am a woman working toward an elementary education endorsement. Additionally, this research also implies that if teachers' math anxiety is alleviated, then they might develop better efficacy beliefs.

The only issue which may have skewed these results was that anxiety and efficacy beliefs were measured at the end of a math methods course which was designed to help students become better math teachers (and hopefully make them more confident in their abilities to do so). A comparison of beliefs before the class started as compared to results after the class finished, and again after a year or two of teaching experience would have been helpful. By making this a longitudinal study, it would not only consider the connection between math anxiety and efficacy beliefs, but it would quantify the effect of this methods course and how it helps students to build more meaningful mastery experiences (as was a stated goal of the course). Otherwise, the collection of data at the end of such a course seems to unnecessarily skew data. I am willing to assume that most students will feel more confident at the end of a course designed in part to help their feelings of efficacy than they will as they start to use the taught skills in a real-world context. If the math course is truly effective, will it not prove to have improved efficacy scores a time *after* the course has finished?

Miller and Pajares (1994) examined the role of self efficacy beliefs in determining mathematical problem solving and performance. Their main research goals focused on the interplay between self-efficacy and performance: "Does confidence have more of an impact on performance than math self-concept? Math anxiety, perceived usefulness of mathematics, prior experience, or gender? ... [And] Does self-efficacy mediate gender and prior experience on performance?" (p. 193). They conducted a path analysis of 350 undergraduates at a public university in the United States in conjunction with the university's College of Education. There were 229 women and 121 men in the sample, 137 of whom were education majors (p. 196). While this was a voluntary, self-selecting sample, most instructors did offer college credit. Students were tested on personal feelings about mathematics before being tested on performance during one class period at the beginning of fall classes. Researchers anticipated that their results would support Bandura's assertion that "how people behave can often be better predicted by their beliefs about their capabilities than by what they are actually capable of accomplishing for these beliefs help determine what individuals do with the knowledge and skills they have" (Miller & Pajares, 1994, p. 193). Indeed, results indicated that Bandura was correct in this assertion.

Researchers conducted tests for four different constructs of efficacy beliefs, collected demographic data including information on the highest level of high school mathematics each student achieved, and gave students a math performance exam to assess conceptual understanding and problem solving ability. The test to determine math self-efficacy used a 5-point Likert scale and examined confidence in arithmetic, algebra, and geometry; computation, comprehension, and application; and, real and abstract math

($\alpha = .91$). The test to determine students' perceived usefulness of mathematics was a 20-question instrument asking students to rate how important they perceived math to be in several different domains ($\alpha = .93$). Math anxiety was assessed by the Betz (1978) Mathematics Anxiety Scale and consisted of 10 questions ($\alpha = .86$-$.90$). Math self-concept was assessed through a 180-item survey which asked questions about academic and self-concept items ($\alpha = .74$-$.91$) (Miller & Pajares, 1994, p. 196-197).

Results found that there were stronger relationships between self-efficacy and performance than any other single factor ($r = .70$, $t = 10.87$, $p < .0001$). Efficacy beliefs proved to be more significant than gender ($t = .29$, not significant) or past performance ($t = 2.22$, $p < .05$) (Miller & Pajares, 1994, p. 197-198). That the correlation-value for the relationship between efficacy beliefs and performance was so significant for a sample size of 350 people strongly affirmed the goal of the study, "to discover whether self-efficacy beliefs play the meditational role ascribed to them by Bandura (1986) and social cognitive theory, and whether these beliefs are stronger predictors of performance than are other presumed determinants and common mechanisms" (Miller & Pajares, 1994, p. 200). Because researchers were able to control for so many variables and present data in such a clear way, the results of this study are very reliable. Yet, because this study was self-selecting, there was a large gender imbalance, and college credit was offered (basically a reward for participation), some of the generalizability of these results is called into question. The data were so strong, as mentioned, that in spite of these issues, this study strongly supports the importance of math self-efficacy in influencing performance. This is significant to this research in that it affirms the notion that performance is related to efficacy beliefs. As there were 137 preservice teachers in the

sample, it seems safe to assume based on this research that math-related self-efficacy beliefs will influence their ability to perform math tasks with and for students.

Bandura (1993) postulated four main sources of efficacy expectation: mastery experiences, emotional state, vicarious experiences, and social persuasion. This portion of the analysis of research about preservice teacher efficacy focuses on the ways in which teacher education programs have the opportunity to impact teachers in a variety of these specified ways. Methods courses as a pre-service teacher and professional development as an inservice teacher give individuals the opportunity to build their skills in teaching mathematics. As stated by Bandura, "Guided mastery serves as the principal vehicle for the cultivation of competencies" (Bandura, 1993, p. 139). The importance of this related to self-efficacy beliefs is that it helps teachers to build mastery experiences and thus build a store of successes to draw from when teaching in the future. Ross and Gray (2006) wrote that the "strongest contributor to high teacher efficacy is mastery experience, i.e., when teachers recognize they have been successful in the past they anticipate they will be capable of handling similar tasks in the future" (Ross & Gray, p. 803). This section focuses on studies which looked to provide preservice teachers with the opportunity for mastery experience.

Philippou and Christou (1998) researched the effects of a math methods course on changing pre-service teacher's attitudes toward mathematics. They were interested in exploring what prospective elementary (primary) educators' beliefs in a University Education program were prior to entering coursework, and whether their beliefs could be altered by the experiences in their preparatory program. The study was conducted in Greece between 1992 and 1995 on a predominantly young and female population of

successful students at the University of Cyprus. The Department of Education in Greece is highly competitive because of the immediate employment of its graduates and college freshmen were generally selected from the top quartile of high school graduates (Philippou & Christou, 1998, p. 195). Additionally, it seemed plausible to the researchers that students would be more interested in studying mathematics because of the history of Greece; math was "mostly developed by their ancestors in their own language, under the conditions of their genesis" (p. 194).

Researchers gave students a pre-test to assess mathematics beliefs with a *Dutton scale*, which asked students to answer whether they agreed or disagreed with eighteen statements such as "I detest mathematics and avoid using it at all times," "I do not think mathematics is fun, but I always want to do well in it," and "I enjoy working and thinking about mathematics problems outside of school" (Philippou & Christou, 1998, p. 197). The pre-test revealed "an alarmingly high proportion of students who brought very negative attitudes to Teacher Education" (p. 196). The majority of students recognized that they needed to study and teach mathematics but that they did not take pleasure in doing so unless they already knew how to do the problems posed to them. Thus, success evoked positive feelings while a lack of confidence was associated with negative attitudes (196). The primary reasons for disliking math "were 'I was afraid of it' (29%), 'because of poor teaching' (27%), and 'lack of teacher enthusiasm' (25%)", (p. 198).

Students were enrolled in two math content classes, one of which also focused on the history of mathematics, and a math methods course; for a total of three courses. "The intervention was of a longer duration than in previous studies, involving exposure to three courses, specially designed to facilitate attitude change" (Philippou & Christou, 1998, p.

194). Additionally, the curriculum was focused on helping students to break away from the idea that mathematical problems have one single solution or avenue by which to find an answer. After finishing the curriculum and completing a post-test to assess for change in attitude, students were also randomly interviewed and asked to "describe their feelings prior and after their attendance of the program" (p. 202) to assess whether the content of program courses may have influenced a change in efficacy beliefs.

Researchers found that completion of the courses brought about significant improvement in students' attitudes about mathematics, "particularly about the satisfaction from and the usefulness of mathematics" (Philippou & Christou, 1998, p. 189). According to Philippou and Christou, " The results of this study seem to provide evidence that (a) prospective teachers bring to Teacher Education misconceptions and negative attitudes toward mathematics, and (b) mathematics preparatory programs provide an opportunity to influence positively" (p. 204). The decrease of those with negative attitudes about mathematics decreased in a statistically significant way ($\chi^2 = 22.5$, $p \leq 0.01$) (p. 200). Based on the results of the pre- and post-course assessments, students' results indicated an improvement of attitudes which "might be due to the exposure of students to the mathematics program" (p. 204). Also interesting to note is that when the results were isolated to examine possible relationships between students' personal characteristics and changes in their attitudes, individual characteristics were found to "not predispose preservice teachers to particular changes in their attitudes toward mathematics" (p. 203); i.e. change was not correlated to gender, socioeconomic status, prior performance, etc. Further studies should investigate the long-term effects of such coursework. Were the results skewed because they were assessed so soon after the

completion of the three courses? What are the efficacy beliefs of these individuals after they enter the teaching profession and practice for a set number of years? Does this series of coursework provide students with lasting confidence?

The importance of this study to this paper has to do with the idea that taking a series of methods courses has the possibility of providing preservice teachers with educative experiences which translate into mastery experiences they can refer back to as inservice teachers. Students took courses dealing with mathematical content, history, and teaching methods with an emphasis on multiple entry points and processes to completing math. These courses were shown to improve their attitudes and efficacy when thinking about math. Because this study was conducted in Greece, assertions about the history of mathematics and its connection to students' national history would be invalid in the United States, however it seems logical that the idea of humanizing the history of math allows for a more personal connection with the discipline, thus making it more accessible and less anxiety-producing for some students. Because this was part of a three year program, it is not likely that all preservice teachers will have similar opportunities to increase their efficacy in this exact way. The results are not readily transferrable to other populations, but provide an interesting note to think of when assessing whether to create the opportunity for development at any level of teacher education.

Nyaumwe and Mtetwa (2006) researched the effectiveness of collaboration between college lecturers and students peers in assessing the instructional practice of student teachers in Zimbabwe through case study. There were two pairs of student teachers (for a total of 22 practicing teachers), one at a state-supported high school, and one at a private school. Both schools were in urban regions. They were visited by a

professor and another preservice teacher from Bindura University's education program, located in Zimbabwe. The researcher pairs observed two lessons in each school, for a total of four lessons. They conducted observation assessments multiple times before the actual data collection so as to "increase the reliability of the assessment process" (Nyaumwe & Mtetwa, 2006, p. 38). The observations were done in conjunction with the student teaching portion of the education program.

The professor-preservice teacher assessments were designed to be formative rather than summative, meaning that student teachers were assessed on personal impression, understanding, and perceptions of constructivist pedagogy. Both assessors sat in on the same lesson, produced individual assessments, and took detailed notes to be used in post-lesson dialogues (which were recorded and transcribed). The researcher additionally interviewed student teachers at the end of the assessment period to determine the professional benefits gained from the observation assessment. Data were analyzed judging the extent to which instruction was "commiserate with constructivist instructional strategies. Similarities and differences between the instructional practice and constructivist perspective were evaluated and recorded on assessment critique forms" (Nyaumwe & Mtetwa, 2006, p. 38). Emphasis was placed on constructivist techniques because "Mathematics curriculum reform in Zimbabwe encourages teachers to adopt constructivist approaches in their teaching because of the potential of these approaches to enable learners to transfer school mathematics to contextualized situations through modeling and problem solving" (Nyaumwe & Mtetwa, 2006, p. 36). Constructivist techniques were believed to be connected to better student learning and thus, they were the primary instructional focus in the education program connected to this study.

Results from the observations found that pair-assessment to assess student teacher's use of constructivist technique is "beneficial to the development of their professional skills" (Nyaumwe & Mtetwa, 2006, p. 40) because the post-observation dialogues helped student teachers to better understand implementation strategies. Professors and preservice peers focused on different aspects of instruction in their assessments, thereby providing complementary views of the student teacher's strengths and areas for improvement. This paper is significant to this paper because it focuses on the peer aspect of preservice teachers' efficacy development. By creating a community of learners in preparation for work in the classroom, this study suggested that teachers will have more confidence in their abilities to help students learn and to understand teaching methods which are believed more likely to support student learning.

This study took place in Zimbabwe, and as such, is limited in its generalizability to the United States educational system. That said, there were ideas in this study which could still be applied to preservice teacher programs in this country. If preservice teachers are encouraged to be more comfortable with assessment by both their instructors and peers, they are more likely to be comfortable with future professional development dialogue which helps them to improve teaching strategies, thus impacting their beliefs that they are able to impact student learning. As stated, "Involvement of peers in assessment has motivational and cognitive merits" (Nyaumwe & Mtetwa, 2006, p. 40), meaning that involving peers in the professor-student dialogue can help to give a more rounded perspective of assessment as demonstrated here. Additionally, the impact of formative assessment in teacher programs (as opposed to summative), open dialogue,

peer relationships, and constructivist teaching strategies seem to promote positive effects in the development of higher teacher efficacy as found in this, and other studies.

Harkness, D'Ambrosio, and Morrone (2007) studied the influence of a math methods course, *Problem Solving*, on preservice elementary teachers. Their research question focused on which "themes emerge from student writing regarding mathematical autobiographies and the influence of a mathematics methods course on student math reflections" (Harkness, et al., 2007, p. 241). Procedures corresponded to a qualitative, grounded theory approach. "Student voices" were used as data and collected via mathematical autobiographies (pre-assessment), written before the methods course began (treatment), and end-of semester reflections in the form of written journals (post-assessment), (Harkness, et al., 2007, p. 241). Responses were coded according to three categories (liked, disliked, or mixed feelings) about students' feelings regarding mathematics. To ensure that responses were typical of previous classes, their responses were compared to writing of students from other semesters, taught by the same instructor (Harkness, et al., 2007, p. 242).

*Problem Solving* was a 6-credit mathematics course which had to be taken prior to admittance to the School of Education at a large urban university in the Midwest. It met three days per week, two hours per day, for fall semester, 2000. Math tasks were designed to be relevant and interconnected, and "Learning or mastery – understanding the "why" of the mathematics and not "performing" mathematics by only memorizing rules, procedures, and algorithms – was the emphasis" (Harkness, et al., 2007, p. 249). According to the researchers, "students struggled to make sense of the mathematics, to value group work as an opportunity to socially construct knowledge, to understand the

role the teacher played in shaping the learning through her enactment of teaching, and to change their self-concept and self-efficacy with mathematics" (Harkness, et al., 2007, p. 251). They worked in groups and worked to create a strong community dynamic while learning about how to best teach mathematics.

Twenty students participated in this study, all but one of them were women, predominantly Caucasian, and were composed of a variety of ages (from young adults first starting their education to older adults returning to college), (Harkness, et al., 2007, p. 240). Autobiography findings stated that approximately one-third of students had positive feelings about math, about one-third had mixed feelings, and about one-third had very negative feelings (Harkness, et al., 2007, p. 242). By the end of the semester, "Fifteen of the 20 students described how *Problem Solving* changed their thinking about mathematics and about learning mathematics; they talked about gaining determination and confidence in their mathematical abilities" (Harkness, et al., 2007, p. 248). Researchers seemed keen to establish that student thinking changed over the course of the semester and that students were much more confident in their mathematical abilities at the end of the course than they were at the beginning. They also acknowledged that journal entries, the bulk of the data generated, may have been skewed because prompts attempted to focus students on "growth," a term which presumably pushed students to more positive realizations at the end of the course; however, they also stated that for the most part, students ignored prompts once they began writing (Harkness, et al., 2007, p. 243).

The importance of this study has to do with the creation of mastery experiences and the community of learners taking this mathematics methods course. Because of the

small scale of the research, the rather sloppy manner in which data collection was carried out, and the fact that all but one student were female, the results are certainly not generalizable to most populations of students. The value in reading, however, has to do with the construction of the course. Students were encouraged to generate specific goals for the course through reflection, and as stated, "Goal theory proponents posit that if teacher practices minimize a focus on ability, students will be active learners who put forth effort and become more cognitively engaged" (Harkness, et al., 2007, p. 237). Throughout their write-up, Harkness, et al., focused on the idea that the value of the course was that it focused on learning rather than achievement, helping to promote positive mastery experiences for students rather than an emphasis on high ability.

Swars (2005) studied efficacy-outliers from a preservice teacher math methods class. As outlined in the paper, "the purpose of the study was to investigate perceptions of effectiveness in teaching mathematics among preservice teachers with differing levels of mathematics teacher efficacy" (Swars, 2005, p. 140). Four students were chosen to interview based on very high (two students) and very low (two students) levels of efficacy as quantified by the Mathematics Teaching Efficacy Beliefs Instrument (MTEBI) which students took as part of a math methods course. The course was conducted at an undisclosed university in the southeastern United States and was connected to the vision of mathematics teaching as outlined by the NCTM (2000); specifically through effective communication, problem-solving, real-world connections, reasoning, and proof. They were instructed in innovative teaching strategies, including the integration of manipulatives, literature, and technology. Preservice teachers modeled group work and had opportunities to teach at least 3 days in local schools as part of a 24-

day observation cycle (Swars, 2005, p. 140-141). The four student participants focused on in this case study were assessed in the researcher's office within a week of the end of the course in 45-minute semi-structured interviews.

There were three main themes to emerge from the interviews which related to the development of students' perceived teaching efficacy. These were past experiences with mathematics, influences up on perceptions of mathematics teaching effectiveness, and mathematics instructional strategies (Swars, 2005, p. 142-143). Likely as a result of the methods course which they had just completed, Swars reported that all four students expressed "the belief that they were confident in their abilities to become effective mathematics teachers," and that their "viewpoints on the importance of "real world" situations in mathematics are consistent with the reform vision of NCTM" (Swars, 2005, p. 143-144). This data seemed to simply reinforce that all four students learned what they were supposed to learn as stated by the goals of the course. The main conclusion which was most relevant to my findings is that the interviews "indicated that mathematics instructional strategies as well as past experiences with mathematics and their influences upon perceptions of teaching effectiveness were associated with mathematics teacher efficacy" (Swars, 2005, 139). Because of the small scale of the study and the fact that results were likely skewed by the interviews being held so soon after the completion of a math methods course designed to help students develop mastery skills which contribute to efficacy, this study provides weak support. There are several other studies in this genre which contribute more reliable findings, however this supports the general trend that methods courses can help preservice teachers to build upon their sense of efficacy.

It should be noted that at the beginning of the paper, Swars stated that students were chosen to interview based on their efficacy scores on the MTEBI. This variable had little to no impact on the findings of perceived confidence as stated in interviews, however it obviously had an impact on students the week before the class finished for the term. A comparison of interviews taken at the beginning of the course (to correspond with a pre-course efficacy measure) and interview conducted after the term's completion (to correspond with a post-course quantitative efficacy measure) would have offered better indication that student beliefs were actually informed by the course.

Basing research on the premise that just because an individual possesses certain skills, it does not mean that they are able to perform them, Huinker and Madison (1997) studied the impact of methods courses on preparing preservice math and science teachers to be efficacious educators. They believed that the "more positive the impact of preservice elementary teachers' efficacy during their teacher preparation program, the ore likely it is that these individuals will engage in effective teaching behaviors in the future" (Huinker & Madison, 1997, p. 109). Their research used both qualitative and quantitative measures to determine whether methods courses consistently influenced personal teaching efficacy beliefs and outcome expectancy beliefs of preservice math and science teachers.

Two cohorts of preservice elementary teachers were used in this study, each enrolled in 3-credit science and mathematics methods courses at an urban university in the United States. No other information was given about the location of the study. The first cohort was enrolled in both courses in fall semester and the second cohort was enrolled in the spring and the same instructors taught both classes each semester. Cohort

One had 32 students, 26 females and six males. Of the students, two were Hispanic, one was African-American, and the rest were Caucasian. In the second cohort, there were 30 students, 24 females and six males. Of these students, three were African-Americans, five were Asians, one was Native American, and the rest were Caucasian. (Huinker & Madison, 1997, p. 110). The cohorts were tested separately because a Mann-Whitney U test was performed which showed significant difference between the two populations (Huinker & Madison, 1997, p. 110-111). The courses were based on collaborative, constructivist philosophy and focused on inquiry-based and student-centered teaching strategies. They promoted positive learning experiences and metacognition in addition to providing fieldwork opportunities to promote authentic experiences for preservice teachers. The science course was supposed to encourage hands-on experiences and the math course presented math as an accessible, sense-making process (Huinker & Madison, 1997, p. 112-113, 122).

Teaching efficacy beliefs were assessed using quantitative measures and a pre-test-post-test one-group research design was used to collect data. The Science Teaching Efficacy Beliefs Instrument was as administered to assess science teaching-efficacy and consisted of 23-items scored with a Likert scale. Personal science teacher efficacy ($\alpha$ = 0.90) and science teaching outcome expectancy ($\alpha$ = 0.76) were the two main types of efficacy measured. Additionally, mathematics teacher efficacy was assessed using the Mathematics Teaching Efficacy Beliefs Instrument, a modified version of the science efficacy instrument also used. A 21-item measure with a Likert-scaled response assessed personal mathematics teaching efficacy ($\alpha$ = 0.88) and mathematics teaching outcome expectancy ($\alpha$ = 0.77). Additionally, interviews were conducted with cohorts to either

confirm results of the pre-and post-test data or to gather more in depth data about students who showed remarkable increases in efficacy. There were 16 subjects interviewed in Cohort 1 and 7 subjects were interviewed in Cohort 2. (Huinker & Madison, 1997, p. 110-111).

Results showed strongly significant increases in efficacy beliefs for both cohorts in personal science teaching efficacy (Cohort 1: $z = -4.13$, $p < .001$, and Cohort 2: $z = -3.67$, $p < .001$), indicating that the methods course had a positive impact on the preservice elementary teachers' beliefs in their ability to effectively teach science to their students (Huinker & Madison, 1997, p. 114). Additionally, results showed significant increases in science outcome expectancy for both cohorts (Cohort 1: $z = -3.64$, $p < 0.001$, and Cohort 2: $z = -1.89$, $p < 0.001$), indicating that teachers increased their belief that effective science instruction would result in science learning (Huinkerr & Madison, 1997, p. 116). The mathematics course also increases in efficacy, for both personal mathematics teaching efficacy (Cohort 1: $z = -4.44$, $p < 0.001$, Cohort 2: $z = -3.85$, $p < 0.001$) and mathematics teaching outcome expectancy (Cohort 1: $z = -3.41$, $p < 0.001$, Cohort 2: $z = -2.74$, $p < 0.001$) (Huinker & Madison, 1997, p. 119-120). This indicated that the mathematics methods course was instrumental in helping students develop stronger beliefs in their ability to teach mathematics and that if they teach mathematics effectively, students with learn from them.

The importance of this study has to do with the specifics of the methods course more than the fact that the course had an impact on teacher efficacy. Because the course had as large an impact as was demonstrated, looking at what was done sheds the most light on what can be done for other preservice teachers to help promote their teaching

efficacy beliefs. In the courses tested, collaboration and meaningful learning experiences were key to helping students to feel a part of a larger community which had a viable impact on their teaching futures. Fieldwork helped preservice teachers to see what good teaching looked like both from the instruction standpoint and from its impact on student learning. They had opportunities to watch professionals model behaviors and philosophies which were concurrently talked about in their methods courses.

This section of research grounded the need for improving preservice teacher's math self-efficacy because of the low efficacy beliefs documented by Hannula, Kaasila, Laine, and Pehkonen (2005); math anxiety by Greshasm (2008); and the role of efficacy in determining math problem-solving competence at the college level by Miller and Pajares (1994). Preservice elementary teacher candidates in particular were shown to possess low levels of mathematics efficacy, especially significant in that they represent students' first exposure to the discipline. Because the previous section focused on the connection between teacher efficacy and student math beliefs and achievement, the need for methods courses to better prepare efficacious teachers was emphasized. The studies conducted by Philippou and Christou (1998); Nyaumwe and Mtetwa (2006); Harkness, D'Ambrosio, and Morrone (2007); and Swars (2005) all contributed provoking looks into the use of methods courses to improve efficacy beliefs in preservice teachers.

## Inservice Teacher Efficacy

This section addresses the efficacy beliefs of inservice mathematics teachers and methods that can be used to increase efficacy. Common to many of the studies detailed in this section is a reference to cycles of efficacy during the first years of teaching and teacher burnout later in teacher careers. Because it is assumed that teacher efficacy is

most easily impacted at the beginning of one's career and beginning efficacy beliefs appear to be resistant to change, it is important to consider the changes which can occur through the early years of education and experience. Additionally, because there appears to be a relationship between efficacy beliefs and burnout, it is important to seek methods to help teachers who have progressed further in their careers to increase their sense of efficacy.

Hoy and Spero (2005) conducted a study designed to track changes in teacher efficacy judgments from the entry of a teacher-education program, through student teaching, and at the end of the first year of teaching post-certification. This study was based on the idea that "Because efficacy beliefs are shaped early, it would be useful to better understand what supports and undermines efficacy in the early years" (Hoy & Spero, 2005, p. 346). This quantitative, longitudinal study mapped the development of efficacy beliefs over time. The main research questions included: "How does sense of efficacy change during student teaching and the first year of teaching for a group of students?" and "What are some possible factors in the first years of teaching that might be related to changes in efficacy?" (Hoy & Spero, 2005, p. 347). Hoy and Spero hypothesized that increases in efficacy would be related to perceptions of task mastery and support. In an effort to confirm results, researchers used Gibson and Dembo's Teacher Efficacy Scale, Bandura's Teacher Efficacy Scale, and a program-specific scale designed to better reflect the specific goals of the education program.

The sample for this study came from the 1997-1998 elementary education Master of Education cohort at a major Midwestern public university and included the entire cohort (53 students). Of these 53 students, 29 also submitted information about their

beliefs at the end of their first year of teaching post-certification. There were 38 females, 15 males; 3 of the females and 2 of the males were African American (no mention is made about the other students' racial backgrounds). The average age of the females was 24.7 years (SD = 5.36) and the average age of the males was 29.9 (SD = 8.85) (Hoy & Spero, 2005, p. 348).

As mentioned above, there were three separate measurement instruments given to students which gave four measures of efficacy. Students also provided personal demographic information and statistics about the schools in which they taught during their first year. The Gibson and Dembo scale consisted of a 10-item questionnaire with four items of personal teaching efficacy, four items of general teaching efficacy, and the original two Rand questions discussed in the history portion of this paper. Each item had a 6-point Likert scale and had relatively strong internal consistency ($\alpha$ = .68-.84) (Hoy & Spero, 2005, p. 348-349). The Bandura Teacher Efficacy scale featured 30 items measured on a 9-point scale and strong internal consistency ($\alpha$ = .92-.95). The program-specific measure listed 32 teaching skills focused on in the program and asked students to rate their perceived competence in these areas on a 6-point scale ($\alpha$ = .70-.97) (Hoy & Spero, 2005, p. 349). Data was collected using these measures during the first quarter of the teacher-preparation program, at the end of the program after student teaching was completed, and at the end of the first year of actual teaching. In addition to these scales, in the final data collection, new teachers were also asked about sources of efficacy and support was quantified on a 9-point scale and factor analysis yielded a single index of support by finding the mean of the five main items (quality of teaching resources, support from colleagues, support from administrators, support from parents of students, support

from the community). Reliability for this scale was also quite strong ($\alpha = .76$) (Hoy & Spero, 2005, p. 350).

For all measurements, "the picture that emerged…is that efficacy, however assessed, rose during teacher preparation and student teaching, but fell with actual experience as a teacher" (Hoy & Spero, 2005, p. 352). All assessments showed significant increases in efficacy from the beginning of the program to the end of student teaching, however the Banduran and Gibson and Dembo scales were significant in showing a *decrease* in efficacy after the first year post-certification. The decreases in efficacy over the first year post-certification were as follows: Banduran Scale, means changed by -.68; General Teaching Efficacy: means changed by -.66 ($p \leq 0.01$); Personal Teaching Efficacy: means changed by -.28 ($p \leq 0.05$) (p. 352). Additionally, one of the most significant factors correlated with feelings of success after the first year of teaching was the socioeconomic status of the school in which teachers worked ($r = -.41$, $p < .05$), such that the lower the SES, the higher the assessment of success). This was counter to other studies (Hoy, et al., p. 1998) which made the claim that teacher efficacy was negatively correlated with low levels of SES.

While this study is certainly small-scale, and confined to the philosophy and support of one teaching program, the results were interesting in the context of cycles of teacher efficacy. Speculation about the reasons *why* teacher efficacy rose after student teaching and then dropped after students finished their first year of teaching elementary education is particularly interesting. As stated, "A challenge for teacher education is to prepare novice teachers to seek and create support for themselves in the early years of teaching" (Hoy & Spero, 2005, p. 353). While in the midst of a teaching program,

students have a support and buffering to help them build their skills and confidence, they need to find ways in which to replace these supports once they enter the teaching profession lest they suffer similar blows to their sense of teaching efficacy.

Another study which focused on beginning teachers' self-efficacy was done by Knobloch and Whittington (2002) in conjunction with an agricultural education program in Ohio. While I am not entering the field of agricultural education, the issues which this study brings up seem to be typical of most research I have read to do with beginning teacher experience. Researchers stated that the three most important facets of teacher efficacy are related to teacher education, mastery teaching experiences, and perceived support from largely mentor-relationships (Knobloch & Whittington, 2002, p. 2). This descriptive-associational study looked to explore the variance in efficacy beliefs after the first 10 weeks of student teaching, and the first through third years of teaching using variables related to perceived levels of support, teacher preparation, and student teaching experience. The objective was to "determine the extent that the variability in teacher efficacy measured at the 10$^{th}$ week of the school year can be explained by variables related to perceived support, perceived teacher preparation quality, and perception of student teaching experience of student teachers and novice teachers in agricultural education in Ohio" (Knobloch & Whittington, 2002, p. 3). Independent variables were identified as whether students utilized a mentor, their perception of principal support, perception of their school's collective efficacy, their perception of the quality of their teacher preparation, and the perceived quality of their student teaching experience.

Subjects were accessed through Ohio State University's agricultural education program and the Ohio State Department of Education. Of the 116 student and inservice

teachers available, 106 teachers (91.4%) responded to the questionnaire sent. There were "24 teacher efficacy items, 7 principal support items, 1 mentor item, 2 teacher preparation items, and 2 student teaching items" on the questionnaire with questions taken from the Ohio State Teacher Efficacy Scale, Organizational Climate Description Questionnaire, with additional questions based on Bandura's theories of self-efficacy. The instrument was pilot-tested on preservice teachers and found to have sufficient internal consistency ($\alpha = .87$) (Knobloch & Whittington, 2002, p. 4).

Of the results, the most significant relationships (with moderate effect sizes) were found between collective efficacy and supportive principal behaviors ($r = .39$, $p < .05$) and between collective efficacy and personal efficacy ($r = .39$, $p < .05$) (Knobloch & Whittington, 2002, p. 5). This data indicated a statistically significant relationship between beginning teacher's interpretation of the collective efficacy of a school and the support they feel that they receive from their principals in addition to the notion that those teacher's efficacy is positively related to the perceived collective efficacy of the schools in which they teach. Additionally, the two independent variables which accounted for the most variance (17%) in teacher efficacy at the tenth week of the school year were the utilization of a mentor and the perception of supportive principal behaviors (Knobloch & Whittington, 2002, p. 5). No other single variable accounted for as much of a difference in levels of efficacy, including perceived preparation from the teacher-education program. Thus, for this study, it was more important for teachers to feel supported collectively in their buildings and by their principals, with the relationship of a mentor, than it was to feel like they had been prepared to teach by their teacher education programs or student teaching experiences.

Because this study was on such a small scale and in a field of education different from the one addressed in this paper, it is difficult to ascribe the significance of collective efficacy and principal support that these researchers seem so eager to do. They additionally only allowed teachers to ascribe their efficacy development to four main themes, a limiting factor which did not comprehensively assess the measure. Also, because data was collected during the tenth week of the school year, there are likely different priorities of teachers at that time than there are later in the school year. That said, their results indicated that "student teachers and novice teachers need to feel that they are part of a team of teachers who are supportive to each other in helping students learn" (Knobloch & Whittington, 2002, p. 6). The idea of supportive and community-based mentorship is one which was mentioned in Hoy and Spero's research as well: "The degree to which the observer identifies with the model moderates the efficacy effect on the observer…The more closely the observer identifies with the model, the stronger will be the impact on efficacy" (Hoy & Spero, 2005, p. 345). While this study did not appear to address the issue of efficacy beliefs as being connected to teaching experience, the reasons *why* teachers seemed to feel more efficacious seemed to both related to early teaching experiences and themes which appear more universal to inservice teachers.

Chester and Beaudin (1996) conducted a study about the efficacy beliefs of newly hired teachers and the idea that efficacy declines over the first year of teaching are not universal experiences. They wanted to examine whether novice teacher self-efficacy varied by teacher characteristics and what school practices did systems contribute to changes in efficacy. One hundred, seventy-three newly-hired teachers were surveyed from Connecticut's nine largest school districts at the beginning of the 1988-1989 school

year, all from districts which researchers believe are characteristic of urban environments throughout the United States. "The districts in this study account for the majority of Connecticut's students of color, with Black and Latino students comprising more than 80% of the largest three districts enrollment" (Chester & Beaudin, 1996, p. 234-235). Teacher demographic variables tested included age, experience (not all new hires in this sample were new to the teaching profession, just new to the district), gender, and race. School variables included reported collaboration with other teachers, the number of times supervisors observed novice teachers (assumed to represent supervisor attention to teacher performance), and the availability of resources and instructional materials (Chester & Beaudin, 1996, p. 240-241). Efficacy beliefs were assessed at the beginning of the school year and again in February to document change in beliefs. Several previously valid measures of efficacy were adapted for this sample and were assigned a 7-point Likert scale for assessment ($\alpha = .75$).

Least squares regression analysis was done to construct a series of models to test via Chi-Squares so as to assess the importance of each variable in accounting for variance between teacher efficacy beliefs at the beginning versus the results of the February testing. Results indicated that teacher age had a more significant effect on change over the course of the induction period than for novices than it did for new hires with previous teaching experience ($p \leq 0.05$, $R^2 = 0.0771$, $df = 143$). Additionally, opportunities for collaboration helped to moderate the affect of age for novice teachers, suggesting that collaboration for novice new hires is a significant factor in supporting higher efficacy beliefs ($p \leq 0.05$, $R^2 = .1529$, $df = 142$). Collaboration was unaffiliated with other school characteristics, suggesting that while age is moderated by opportunities for collaboration,

a collaborative environment was believed to additionally have an independent effect on efficacy beliefs. One finding which was counterintuitive was that an abundance of instructional resources was significantly positively related to experienced new hire efficacy beliefs, but significantly negatively related to novice self-efficacy ($p \leq 0.05$, $R^2 = 0.2215$, $df = 129$). Researchers postulated that this might be because young teachers might be overwhelmed by too many options for instructional tools and become uncertain that they are choosing the right methods to help students learn. (Chester & Beaudin, 1996, p. 243-249).

The importance of this study is that it provides a different viewpoint for the idea that all teachers experience a decrease in efficacy beliefs over the course of their first year of teaching, it effectively complexifies the issue of efficacy cycles in early educational careers. In this study, there additionally were several methods that could be used to increase efficacy based on the relationships found in the data. Younger novice teachers in this study actually significantly increased efficacy in larger schools with more lower-achieving students. It seemed counterintuitive that their efficacy beliefs would be negatively related to an abundance of resources, yet the data supported the idea that collaboration helped teachers function more confidently.

One of the seminal studies to do with self-efficacy beliefs, Bandura and Jourden's (1991) study about the "Self-Regulatory Mechanisms Governing the Impact of Social Comparison on Complex Decision Making" may seem an awkward placement in this category, however, because it focused so heavily on patterns of efficacy with regard to self-comparison to others, it is a good fit for a section to do with the early years of teaching.

The subjects in this study were 40 men and 20 women from a graduate program in Business, ranging from 21 to 40 years of age, with an average age of 31 years. They were randomly assigned, balanced for gender, to four experimental conditions preset by researchers. They were told that the study was part of a program designed to advance managerial decision-making and were given instructions on their role on a computer (to standardize the method of information transfer). Their job was to maximize output of an imaginary production company by managing employee placement through a series of 32 complex decisions. After each trial, subjects received feedback about their own and other simulated performance scores. They did not know that the comparison score was simulated. This led them to believe that they had either similar capabilities to other subjects, superior capabilities, progressive mastery (where they overtook the simulation over time), and progressive decline (where they were overtaken over time) (Bandura & Jourden, 1991, p. 943-945). Subjects rated their perceived self-efficacy as a group comparison on a standard scale, thereby tracking their self-efficacy through the course of the study.

Results showed that "The groups did not differ in their perceived self-efficacy in the initial and middle phases, but by the third phase the decliners expressed a much lower sense of managerial efficacy then did their counterparts in the similar, superior, and progressive mastery conditions (all *ps* < .05)" (Bandura & Jourden, 1991, p. 946). Subjects who believed themselves to have displayed inferior capabilities as compared to others expressed much lower levels of self-efficacy than did those who believed themselves to have either superior or progressive mastery over their peers. In the first phase of the study, prior experience more strongly correlated with performance than did

efficacy beliefs (Prior: r = .53, *ps* < .05; Efficacy: r = .16, *ps* < .05). In the second phase, efficacy beliefs were more strongly correlated with performance than was prior experience (Efficacy: r = .33, *ps* < .05; Prior: r = .30, *ps* < .05) (p. 948). Additionally, the data showed that "with increasing experience, prior performance makes a weaker contribution, and perceived self-efficacy accounts for a larger share of the variance in organizational performance attainments" (Bandura & Jourden, 1991, p. 948).

The implications of this research for beginning teachers involve management of a classroom as opposed to management of a production. If teachers perceive themselves as being as competent instructors as their peers, they will be more likely to develop positive beliefs about their outcome expectancies. Yet, if they see themselves as lacking by comparison, it is possible that this hit to mastery perceptions could cause either burnout or, like in this study, "Perceived self-inefficacy to produce expected organizational outcomes also fosters attributions of blame, recalcitrance, and deficiencies to others" (Bandura & Jourden, 1991, p. 948).

In a longitudinal study designed to investigate the relationship between teacher self-efficacy and teacher burnout, Brouwers and Tomic (2000) examined the impact of emotional exhaustion, depersonalization, and reduced perceptions of personal accomplishment on efficacy. They defined burnout as "a psychological syndrome of emotional exhaustion, depersonalization, and reduced [perceptions of] personal accomplishment…feelings of being emotionally extended and depleted of one's emotional resources" (Brouwers & Tomic, 2000, p. 239). Efficacy beliefs referred to one' perceived ability to accomplish a teaching task and personal accomplishment was the judgment of the consequences of the performance of a task. Additionally, teacher

efficacy was assumed to be connected to cycles of burnout because efficacy development is affected by teacher response to difficult situations and perceptions of external versus internal control. As stated, "The cyclical nature of teacher efficacy implies that lower levels of efficacy lead to lower levels of effort and persistence, which lead to a deterioration in performance, which in turn lead to lower efficacy" (Brouwers & Tomic, 2000, p. 241). As such, mastery experience and psychological states will be affected by burnout which will in turn assumedly impede the experience of positive vicarious experience and verbal persuasion.

Defined by Bouwers and Tomic, burnout is "a crisis in self-efficacy" and "doubts about self-efficacy can in themselves trigger the burnout process" (Brouwers & Tomic, 2000, p. 242). They surveyed a sample of secondary school teachers in the Netherlands twice, with a time lag of five months, to examine the "direction and time frame of the relationships between perceived self-efficacy in classroom management and the three dimensions of teacher burnout" (Brouwers & Tomic, 2000, p. 242). The time lag was arbitrarily assigned and would likely have been better conducted multiple times over the course of a school year as opposed to bookending five months. Researchers sent cooperation requests to the principals of 15 randomly selected schools in the province of Limberg in the Netherlands. Of the 1156 teachers initially surveyed, 558 teachers responded to the first questionnaire (Time 1) and 243 teachers who participated in the first sample also completed the second questionnaire (Time 2) after a period of five months. Time 1 corresponded with October, 1997, and Time 2 was March, 1998. Of the teachers, there were 179 males and 64 females with an average of 21.25 years of teaching experience (SD = 8.92, Range = 1-39 years). The average age was 46.29 years (SD =

8.2, Range = 24-63 years) and researchers found that this sample was characteristic of the larger population of teachers working in secondary schools in this region at that time (Brouwers & Tomic, 2000, p. 243-244).

Burnout was measured using the Maslach Burnout Inventory for teachers, translated into Dutch and researcher confirmed for accuracy in the translation. It featured 20-items on three subscales: emotional exhaustion ($\alpha = .87$), depersonalization ($\alpha = .71$), and personal accomplishment ($\alpha = .78$). They were measured by a 7-point Likert scale (Browers & Tomic, 2000, p. 243). Perceived efficacy related to classroom management (chosen because of the assumed emotional contribution to burnout) was assessed with the Self-efficacy scale for Classroom Management and Discipline designed by Emmer and Hickman in 1991. There were 14-items measured with a 6-point Likert scale ($\alpha = .79$) (Browers & Tomic, 2000, p. 243). These tests were performed both at Time 1 and Time 2.

Chi-square testing was done on the results to see if they conformed more to a longitudinal model or a synchronous model, given that all variables were found to be related through statistically significant correlations. In the longitudinal model, self-efficacy beliefs preceded the symptoms of burnout and in the synchronous model, symptoms of burnout were suspected to happen at the same time as lower degrees of efficacy. In simple terms, they were trying to find out if burnout could have been caused by low efficacy beliefs or if burnout happened concurrently with low efficacy. Emotional exhaustion and perceived self-efficacy were found to be synchronous ($\Delta\chi^2_{(1)} = 12.67$, $p < 0.01$ and $\Delta\chi^2_{(1)} = 32.62$, $p < 0.01$), meaning that they appeared to happen at the same time as opposed to one directly influencing the other. The longitudinal model was found to be

most apt for the relationship between efficacy and depersonalization ($\Delta\chi^2_{(2)} = 69.84$, $p < 0.01$ and $\Delta\chi^2_{(2)} = 69.87$, $p < 0.01$), with efficacy influencing depersonalization. The relationship between efficacy and perceived personal accomplishment was found to have a synchronous relationship ($\Delta\chi^2_{(2)} = 166.21$, $p < 0.01$ and $\Delta\chi^2_{(2)} = 177.16$, $p < 0.01$), such that low efficacy and lowered perceptions of personal accomplishment were seen to have occurred concurrently (Browers & Tomic, 2000, p. 247-248).

Thus, these results indicated that emotional exhaustion and personal accomplishment impacted self-efficacy beliefs, while efficacy beliefs impacted depersonalization. This seems logical in connection to mastery experiences in that "The more emotionally exhausted teachers are, the poorer their performances will generally be…[and] perceived self-efficacy in classroom management will likely decrease as a consequence of diminished performances" (Browers & Tomic, 2000, p. 248-249). While this study was conducted on secondary school teachers in the Netherlands, it still has applications to teachers in the United States. Burnout, as a crisis of efficacy, represents one of the worst-case scenarios of teaching, ultimately leading to exit from the field. Understanding that positive longevity in this career will be related to keeping a high sense of teaching efficacy is significant to someone just entering the profession.

Mellony Graven (2004) analyzed a qualitative ethnography which studied ten teachers in South Africa over a two year span and their participation in an in-service education and training project (INSET). Through observations and interviews, the study looked to understand "the role of 'confidence' in mathematics teacher learning and how should it be conceptualized and understood from Wenger's (1998) social practice (as opposed to a psychological) perspective" (Graven, 2004, p. 178). The teachers in the

study were all 7th-9th grade math teachers enrolled in a Program for Leaders in Senior-phase Mathematics Education (PLESME), which worked with "practicing math teachers in so called 'previously disadvantaged areas to support their interpretation, critique, and implementation of current South African mathematics curriculum innovations" (p. 185). Teachers were involved in professional development which was designed to help them make a self-identified transition from "teachers of math" to "math teachers," a small distinction, but one which demonstrated more confidence and efficacy with regard to math teaching. Seeing as how the teachers who entered the program had little mathematical background, their transition from being a *teacher of mathematics* to a *mathematics teacher* was a particularly substantive result (p. 188).

The case studies followed teachers as they participated in PLESME, which included weekly workshops, both individual and group reflection sessions, observation sessions of more experienced professionals *and* participants' peers, written activities, professional fieldtrips, and participation in mathematics conferences (Graven, 2004, p. 186). Teachers independently reported via interviews that these opportunities provided them with the idea that their education was a life-long process and that their "new approach to learning was both a result of confidence and provided teachers with increased confidence. Furthermore, confidence became a resource for further learning" (p. 205). Graven asserted in her analysis of this study that increased efficacy was "both a *product* (resulted from teacher learning) and a *process* (an explanation for teacher learning) of teacher learning. Evidence…illustrates that teachers had indeed become confident in their level of mastery in the practice of being professional mathematics teachers" (p. 205-206). For Graven, confidence related to efficacy beliefs and mastery

experiences that informed the willing participation with which they began to approach their profession.

The move from traditional mathematics teaching to that which is more informed by learner-centered curriculum development and assessment changed the face of math education in South Africa. The transition placed more "pressure on the confidences and competences of the teachers in the study…[as the] new emphasis on mathematical learning as relational, flexible, transferable and integrated into everyday life, increases the mathematical competence demands on teachers" (Graven, 2004, p. 180). The focus of the INSET program was based on the idea that the development of mathematical efficacy "enables and supports mathematical learning necessary for ongoing professional development within mathematics education" (p. 181). This idea is especially pertinent in looking for methods in which teachers can improve their math teaching efficacy. When the demands on teachers change, the opportunity to gain new mastery experiences seems especially important in developing a new sense of efficacy. As Graven wrote, "the success of a teacher's vocation depends on successful learning" (p. 185). "Mastery, in relation to becoming a professional mathematics teacher, involves becoming *confident* in relation to – one's professional knowledge (especially mathematics knowledge for teaching) and experiences, one's participation in professional activities, one's membership in a range of professionally related communities and one's identity as a professional mathematics teacher" (p. 185). This study provided a very interesting look at what it might take for inservice "teachers of math" who are lesson confident in their abilities transition to the efficacious "math teachers."

Middleton (1999) studied how "job-embedded learning" through the use of "Realistic Mathematics Education" curriculum affects the motivation of teachers and students. Based on the case studies of two teachers and their classrooms in a school near Arizona State University (the region or school district is never fully declared), Middleton claimed that sociocultural staff development had a positive effect on the motivation of both teachers and their students (Middlelton, 1999, p. 349). While this study did not once mention the development of teacher self-efficacy, the concept and tenets of efficacy were present throughout the research. According to Bandura, (1993), efficacy has to do with confidence in the ability to impact student learning, is related to lower stress, and the use of less traditional teaching techniques, all of which were present in this study.

The two teachers involved in this study were Mrs. Morris, a grade-7 teacher with "many years" of experience and Miss Burton, a grade-8 teacher with only one previous year of teaching (Middleton, 1999, p. 350-351). The new curriculum introduced was Realistic Mathematics Education (RME), "a sociocultural perspective that has three basic tenets…(a) progressive mathematization, during which mathematical models are developed through the successive positioning of contexts that embody the underlying structure of the concepts…(b)and representational forms are mediated by the teachers, and (c) bridging, through which the transition from informal, everyday thinking to more formal, scientific thinking is facilitated by the introduction of powerful intermediary models" (Middleton, 1999, p. 350). One unit of curriculum was taught in the fall and another in the spring. Teachers were observed two to three times per week during this time. The researcher was a participant who was in constant collaboration with the teachers, sharing field note transcriptions, with cross-checks for accuracy ("theory-guided

bricolage" per Middleton (1999, p. 351)). Teachers were observed one year before and one after the implementation of the RME pilot and were more confident and enthused teachers in the final interviews. According to Middleton, Mrs. Morris stated in an interview: "I've enjoyed teaching a whole lot more. It's a lot of work, but I don't mind putting in the extra time or the effort because the kids, I think, are learning a lot more…I've gotten a lot more confident…Because now I can help the kids to understand what's happening" (Middleton, 1999, p. 356).

Because there are only two subjects in this case study, both women of undisclosed demographics, the results cannot be easily generalized. While Middleton attempted to say that the efforts on student comprehension and teacher confidence can be attributed to the RME program, the effect of having a participant researcher involved in continuous, year-long personal professional development likely had a stronger effect. Middleton referred to the "job-embedded learning" as having an important effect on increased confidence (Middleton, 1999, p. 357), and given the depth of such embedded learning in the methodology outlined, there seems to be far more significance placed on the learning and less on the actual RME curriculum. Middleton mentioned that the collaborative researcher-participant situation resulted in much altering of curriculum text and modification of unit plans (Middleton, 1999, p. 352). Little was said of how much the lessons taught actually resembled the original curriculum units.

The benefit of this study comes in the idea that job-embedded learning can improve teacher self-efficacy which in turn can affect student learning. This approach appears to be beneficial, however impractical (one researcher for two teachers implies financial resources and time not available to the vast majority of school districts). This

article, while a brief report on Middleton's findings, provided support for Graven's research, as outlined above. Both implied that the incorporation of mastery experience and community staff development can have a positive effect on teacher self-efficacy. The RME curriculum is rarely mentioned as opposed to other variables not supposedly examined in this study, such as the presence of a collaborative more capable peer as it relates to the formation of new mastery experiences.

Another theme in inservice teacher development believed to bring about increases in teacher self-efficacy beliefs is that of mentoring programs. Yost (2002) conducted a small-scale study based on interview, observation, and diary data which studied the interplay of experience mentor teachers and their year-one mentees. Before completing her research, Yost believed that participation in a mentoring program would be "valuable not only for the novice but also for the veteran mentor…in that it positively affects teacher efficacy for both" (Yost, 2002, p. 195). The study was conducted in conjunction with a small Midwestern university where both mentors and mentees were enrolled in mentoring classes as part of their graduate programs. There were four mentors, all having between eight and 17 years of teaching experience and who were previously employed as first, third, and fifth-grade teachers. Three of the mentors had two mentees and the final mentor had one, for a total of seven novice teachers. "The mentors were released full time from their teaching duties for the school year, and the new teachers took over the full responsibilities of teaching in the mentor's classrooms" (Yost, 2002, p. 196). Mentors were released from their regular classrooms as part of a district-wide program which allowed them to spend half of their time with mentors and the other half working on projects required by the district. The purpose of the mentor program was to

help socialize new teachers to the school and provide them with support in successfully completing their first year of teaching. Yost interviewed each mentor once with guiding questions and three more times with scripted questions. In addition, she collected journals which were written by mentors throughout the year-long study. Interviews were not conducted with mentees, nor was information collected about their experience in this process.

Though there was no mention of the benefit of this process to the first-year teachers, experienced teachers had a supremely positive experience as reported by Yost. They reportedly became more aware of their teaching and "Looking at classroom learning through the eyes of another often resulted in new realizations about how teacher practice could directly affect learning" (Yost, 2002, p. 196). For teachers who had been in a classroom setting for such a long time, the break in routine was reputed to be a welcome change and one which helped them to visualize themselves in different roles, many of which gave them the district-wide recognition they had lacked when working in a classroom. Successful mentor relationships gave them a new set of mastery experiences, the opportunity to share and validate members of their teaching community, positive vicarious experience while watching the first-year teachers, and were fulfilled by the acknowledgement of being "recognized as a model teacher" (Yost, 2002, p. 197).

While this was a very small write-up of an admittedly small study, there are implications herein for inservice teachers who need to develop more positive teaching efficacy. As stated by Yost: "Because teachers who believe in themselves and their abilities to teach also believe in their students' abilities to learn, such experiences have a significant effect on teacher expectations" (Yost, 2002, p. 197). Bandura's (1993) ideas

that efficacy beliefs are impacted by mastery experiences, vicarious experience, the presence of a supportive community, and verbal support are all represented in the idea of mentor relationships as outlined by Yost. This is certainly a method for more experienced teachers to liven their careers and contribute to the entry-level experience of another professional.

Smylie (1988) performed a path analysis on data to do with the individual change associated with staff development of inservice teachers. His research suggested that individual change, given the professional development opportunities offered to teachers in this study, was a direct function of personal teaching efficacy as opposed to other isolated factors. In researching his study, Smylie found that most staff development was motivated by building maintenance as opposed to the development of individual teachers. Additionally, in the context of schoolwide implementation of new philosophies, the change of individual teachers was far less important than the average gains seen by student achievement testing. Given that the students taking these tests are taught by individual teachers, it seems logical to also look to the impact of reform efforts on teachers as opposed to looking solely for large-scale effects. This study attempted to examine different aspects of the organizational contexts of schools and classrooms in conjunction with teacher psychological states as they related to variation in how teachers internalized the staff development.

The main goals of this research were to find whether "pretraining levels of personal teaching efficacy and certainty of practice, as well as the various dimensions of the interactive contexts of schools, will have direct positive effects on individual change" (Smylie, 1998, p. 11). It was anticipated that the more teaching efficacy demonstrated by

an individual, the more likely they would change practice as a result of staff development. This is somewhat counter-intuitive as mentioned in the introduction to my paper. It has also been assumed that teachers who have higher levels of efficacy would be more likely to hold onto their previous modes of teaching because they perceive them to work, thus teachers with lower teaching efficacy would be more willing to change practice. Smylie addressed this with the idea that the "logic of the positive relationship between efficacy and change implies a congruity between suggested new practice and conditions that teachers believe have led them to be instrumental to their students' learning" (Smylie, 1988, p. 13). Thus, it seems logical to assume that where there is ideological congruity, teachers will be more likely to respond to development opportunities.

The sample was composed of 56 elementary and secondary school teachers, from 13 school districts in a southeastern state, who voluntarily participated in Smylie's Effective Use of Time Staff Development Program (EUOT). The development program consisted of 6-2.5 hour workshops held over the course of an academic semester. The purpose of the program was to help teachers increase the amount of time in which they and their students spent engaged in academic work. Like most development programs, it also focused on classroom management and discipline, lesson development, and the monitoring of student work (Smylie, 1998, p. 13). Teachers were encouraged to be adaptive in the ways that they applied this program to their classrooms; it did not advocate a one-size-fits-all philosophy of education. Teachers were evenly distributed across grade levels, with 32% teaching grades 1-6, 32% teaching grades 7-8, and 35% teaching grades 9-12. The majority of teachers (60%) had between 10 and 20 years of

teaching experience at their grade level and all taught academic subjects (not electives). Additionally, 11% of the subjects were male and 89% were female (Smylie, 1988, p. 13-14).

Data was collected through a series of classroom observations (in the fall, prior to training, and after winter vacation to allow teachers time to adjust to new routines), teacher surveys and interviews, and a classroom information questionnaire (featuring a 5-point Likert-type response with $\alpha = .7124$-$.9243$). The questionnaire focused on the interactive settings of the school, certainty of teaching practice, and personal teaching efficacy. Interviews focused on a recall of the previous 3-days in which teachers were asked how many times they talked to their peers about classroom instruction ($\alpha = .86$). Classroom demographics and size were also collected, as was each class' achievement scores on their last reading standardized test.

Believing that various dimensions of classroom environment and school context could have an impact on how much teachers were impacted by professional development, Smylie took many measurements with which to correlate with demonstrated teacher change. In examining the classroom environmental effect on efficacy, he sampled class size, academic heterogeneity, and the proportion or concentration of low-achieving students. To look to the school environmental effect on efficacy, Smylie sampled principal emphasis on goals and organizational objectives, principal supervision and direction of teacher behavior, the openness with which the school is perceived to accept individual teacher goals, teacher involvement in decision-making, attitudes toward teacher risk-taking, the level of collegiality in the school professional community, and the degree to which the principal is a facilitator of communication (Smylie, 1998, p. 9-10).

The main measure of teacher change was taken from observations, such that the difference between pretraining and posttraining proportions of time teachers spent engaged in interactive instruction was averaged for each individual to quantify results. This was in keeping with the idea that "increasing overall time spent in interactive instruction is central to the goals of the staff development program" (Smylie, 1988, p. 15).

Smylie found through path analysis that all variables with the exception of teacher interactions about instruction were significant to this study. That said, the only variables which showed significant relationships to change in teacher practice were personal teaching efficacy ($r = .3065$, $p < .05$) and high class size ($r = .2575$, $p < .05$) (Smylie, 1988, p. 21). While it was expected that personal teacher efficacy would be related to how much teachers changed instruction as related to the development program, however it was not anticipated that higher class sizes would be positively correlated with change. As stated, "there is nothing about the content or process of the staff development program that would reasonably explain this effect" (Smylie, 1988, p. 20). He speculated that perhaps principals gave more students to teachers perceived to be more competent, but there is not data to either confirm or disprove this hypothesis.

The findings of this study "suggest that in this context of staff development, teachers' perceptions and beliefs about their own practice are the most significant predictors of individual change" (Smylie, 1988, p. 23). While personal teaching efficacy was the variable most strongly correlated with teacher change, it was also interesting to note that teacher certainty of practice was significantly correlated with personal teaching efficacy ($r = .3012$, $p < .01$) and interactions about instruction were significantly

correlated with certainty of practice ($r = .3376$, $p < .01$) (Smylie, 1988, p. 22). This implies that teaching efficacy does not stand alone in determining change from professional development, though this study could not find significant, direct, correlative relationships between these variables and change. Additionally, this study was unlike most other staff development programs in that it "helped teachers adapt new knowledge and skills to their particular classroom settings" (Smylie, 1988, p. 24). Thus, teachers were taught to best serve the needs of their students as opposed to fitting students to an outside, top-down philosophy of education the way many professional development programs operate. Additionally, because this was an outside professional development opportunity, unaffiliated with school administration, teachers were able to change their practice as they saw fit as opposed to receiving pressure from outside sources. Thus, it is questionable as to whether the teachers involved in this study were typical of most teachers in the field because they *chose* to seek out professional development opportunities.

This study was very interesting in looking to the environment in which teachers work as being a significant factor in personal teaching efficacy and by implication, the degree to which teachers will incorporate development into teaching practices. As stated by Smylie, "given the importance of personal teaching efficacy as a predictor of individual change, it seems that efforts to create school and classroom conditions that support and recognize individual practice and accomplishments may increase the influence of school-level factors on individual improvement" (Smylie, 1988, p. 25). Thus the collective atmosphere of a school, often characterized by the collective efficacy of teachers by other studies analyzed for this subsection, is significant in determining

whether development will impact teacher practice and by implication, student achievement.

This section focused on teacher self-efficacy in the transition into education (Hoy & Spero, 2005; Knobloch & Whittington, 2002; and Chester & Beaudin, 1996). These studies all investigated efficacy changes upon entry into the profession and suggested methods for beginning teachers to improve efficacy through mentor programs, the opportunity to generate mastery experiences, and through the establishment of professional communities. Additionally, this subsection critiqued studies for those professionals who have been in education for a substantial time period but who need to continue to develop efficacy beliefs to stave off professional burnout (Brouwers & Tomic, 2000) or to improve performance expectations (Middleton, 1999; Yost, 2002; Smylie, 1988).

### Impact of Building Principals and School-wide Reform

The previous subsection of this chapter focused on methods to improve individual teaching self-efficacy, and one of the major methods discussed as a way to improve efficacy was through community. It is difficult to separate the needs of an individual teacher from the needs of a school at large and the following studies focused their research more on community development and the leadership needs of efficacious teachers. Beginning with characteristics of positive principal leadership on efficacy, the section will then focus on the impact of school-wide reform on collective efficacy of a teaching community.

Ross and Gray (2006) focused on the issue of principal impact on a school's collective efficacy. While this study expounded on several issues outside of the scope of

this paper, there are several points which can be used to hypothesize methods in which principals can help to increase the collective efficacy of their teaching staff. The main question that this research investigated had to do with the relationships between transformational (versus transactional) principal leadership and the following three dimensions of organizational commitment: "commitment to school mission, commitment to professional community (i.e., to school norms of collegiality, collaboration, and joint work), and commitment to community-school partnerships" (Ross & Gray, 2006, p. 801). The researchers wanted to know if their data showed principals' "indirect influence on achievement by creating the organizational conditions through which teaching and learning occurs" (Ross & Gray, 2006, p. 799). The data sets in this research which focused on the connection between principal leadership and collective school efficacy were of my primary focus in analyzing their findings.

Ross & Gray (2006) "reanalyzed a previously reported database" which consisted of three main forms of information. There were teacher surveys, nationally mandated student assessments, and national census data from 2000 and 2001. In the original data collection, elementary teachers in schools from two Ontario, Canada school districts were invited to participate in a study which took approximately fifteen minutes of their time to complete. Total, between the two districts, 71 schools and a total of 3,042 teachers were involved in this large-scale quantitative assessment. In the smaller district, 71 schools participated. The researchers thought it important to mention that these schools had 2% of their population identified as English as a second language students (researcher wording), that 21% of the grade-3 and grade-6 students had special needs, and that the district had below average achievement scores and family incomes (an indicator of low

socioeconomic status). The second district was larger, with 134 schools, 6% of its students indentified as English as a second language students, and both higher than normal achievement scores and family incomes (an indicator of moderate to high socioeconomic status). The study did not identify the percentage of special needs students in the second school district. (Ross & Gray, 2006, p. 803).

School data was collected which focused on the results of a province-mandated standardized test for grade-3 and grade-6 students. Researchers took notice of the "mean percentage of students in the school who reached the provincial standard in a mandated assessment, administered in May 2001" (Ross & Gray, 2006, p. 805). They also took achievement scores from the prior year, in May 2000, and "averaged across grades and subjects to compile a composite school score" (Ross & Gray, 2006, p. 805). Researchers anticipated confusion with this data decision, stating "Our decision to use residuals rather than separating prior and current achievement may be controversial" (Ross & Gray, 2006, p. 812), however they did not further explain their reasoning for doing so. While researchers might have been attempting to reduce the impact of a potential outlier test year (either higher or lower than "normal" for that school), it seems as if there could be a more reliable way to do so than the method chosen as it reduces the achievement of several potentially diverse groups of students to a single number. .

The socioeconomic data compared in this study came from an analysis of the "mean family income of the enumeration area represented by the postal code of the school (obtained from the 1996 national census)" (Ross & Gray, 2006, p. 805). Again, this measurement was not specifically accounted for in the research other than to say that the postal code of the school was considered a reliable proxy for tracking mean income or

individual postal codes within school boundaries. This generalization will almost certainly skew the results of the socioeconomic testing and further adds to the potential unreliability of the declared results. That said, the focus of this paper is outside the scope of most of the questionable data practice.

In measuring teacher data, the study reviewed responses to a very well-researched and intentionally developed teacher self-response questionnaire, anchored by a 6-point Likert scale with internal validity of $\alpha$=.85-.97 (Ross & Gray, 2006, p. 806). Questions measured: transformational leadership ("perception that their principal leads by developing the capacity of the organization and its members to adapt to the demands of a changing environment" (Ross & Gray, 2006, p. 804)), collective teacher efficacy, teacher commitment to school mission, teacher commitment to the school as a professional community, and teacher commitment to school-community partnerships (Ross & Gray, 2006, p. 804-805).

In analyzing the data, researchers were unable to do hierarchal analysis because survey data were multi-level involving both teacher and school variables while achievement data was only reported at the school level. That said, the highest correlations found were all connected to efficacy beliefs. Results were found which indicated that "principals who adopt transformational leadership styles contributed to higher collective teacher efficacy [.455] and to teachers' commitment to the school mission [.844], to the school as a professional community [.622], and to involving the external community in setting school directions [.436] (Ross & Gray, 2006, p. 808). All correlations were significant, $p<.01$ (2-tailed). The importance to my research is that principals who used a transformational leadership style were shown to have a tangible

affect on teacher efficacy such that "principals who adopt a transformational leadership style are likely to have a positive impact on teacher beliefs about their collective capacity" (Ross and Gray, 2006, p. 811-812).

While this study intended to focus on the impact of principals' leadership style on student achievement, it instead pointed directly to the connection between the collective efficacy of a school and transformational leadership. Principals can influence teacher interpretations of their impact on students because they help to define for teachers what is constituted by "student success." They can model what it means to interact peaceably in a community or with a team of other professionals. Principals have the opportunity to affirm and appropriately motivate teachers in ways that will help to increase rather than quash the collective efficacy of their building. As mentioned previously, empowered teachers are more likely to believe that they are capable of helping students to learn and this is in turn more likely to help students believe that *they* are capable of learning. While this study did not focus on the position of math teachers or specific methods which help to *improve* efficacy, its results suggest specific leadership styles which are more likely to help teachers feel more efficacious (regardless of their primary subject matter).

Researchers Rimm-Kaufman and Sawyer (2004) conducted a three year, quasi-experimental, longitudinal study of six public primary schools in an urban Northeastern school district to research the ways in which implementation of the *Responsive Classroom* (*RC*) approach to school philosophy relates to teachers' beliefs and attitudes about teaching and to what degree it "predicted teachers' self-efficacy beliefs, attitudes toward teaching, disciplinary and teaching priorities, and, in particular, whether positive teacher outcomes were associated with classroom-based and/or schoolwide intervention

efforts" (Rimm-Kaufman & Sawyer, 2004, p. 322). *RC* focuses on activity-based, collaborative learning and a "proactive approach to discipline that helps children acquire self-control and take responsibility for their actions" (Rimm-Kaufman & Sawyer, 2004, p. 325). Implementation of the study began in fall of 2001 and compared three schools in their first year of *RC* implementation. Three other schools within the district were chosen for comparison. For reference, the district consisted of 54% ethnic minority students and 35% of the student body qualified for free or reduced-price lunch (Rimm-Kaurman & Sawyer, 2004, p. 325).

Implementation of the *RC* program involved extensive training for schools. Consulting teachers were trained through a multi-year process and led weeklong training sessions followed by network meetings and twice-yearly coaching sessions to implement new sets of practices. They were then involved in observation sessions with post-observation debriefing and reflection. Consulting teachers met with principals three times a year to check in and re-evaluate current practices. Principals were asked to retool staff meetings, create focus committees, and instigate community-building efforts (Rimm-Kaufman & Sawyer, 2004, p. 328). *Responsive Classroom* is intended as a building-wide overhaul of philosophy and classroom management. As stated, the *RC* approach "emphasizes teacher empathy and the provision of structure with the goal of helping students develop self-control" (Rimm-Kaufman & Sawyer, 2004, p. 328).

One year after implementation at the three focus schools, researchers sent out five questionnaires to all 69 teachers. They were Q-sort exercises to assess teacher demographic characteristics and self-reported adherence to *RC* tenets. School resources were also questioned, as was teacher self efficacy (focusing on disciplinary efficacy,

instructional efficacy, efficacy to create a positive school environment, and efficacy to influence decision making), attitude toward teaching as a career, and additional data about teaching practice priorities. The questions had excellent internal validity, with α-coefficients between .65 and .79 with internal reliability of .91. All teachers received a $75 stipend for their participation (Rimm-Kaufman & Sawyer, 2004, p. 326).

In analyzing the data from the first year of implementation, findings showed that teachers who reported using more *RC* practices also generally reported higher self-efficacy beliefs. The most significant results are as follows: "teachers who reported using more *RC* practices reported greater disciplinary self-efficacy (effect size $r = .66$) and greater efficacy to create a positive school climate (effect size $r = .53$) and to influence decision making (effect size $r = .37$). There was an insignificant connection between instructional self-efficacy and implementation of the approach, with $r = .24$. All correlations were significant at $p < .01$. (Rimm-Kaufman & Sawyer, 2004, p. 330-331). The importance of these results lies in the fact that this was the first year of a typically 3-5 year process of schoolwide reform and even at the beginning, teachers who reported using the new practices perceived themselves as more efficacious teachers, especially with regard to organization and social interaction.

There were some complications with this research that make it difficult to fully accept some of the statements claimed in this study. The direction of the findings remain unclear with regard to instructional efficacy and the use of *RC* practices, raising the question as to how this approach actually differs from others which emphasize such classroom management and communication techniques. According to this research, the *RC* approach is effective in bettering a school culture, but is it really effective in helping

to build all aspects inservice teacher's efficacy? Rimm-Kaufman and Sawyer (2004) claimed that *Responsive Classroom* is potentially "useful for understanding the complicated issue of teacher retention in the teachers who are statistically most likely to leave the teaching profession" (p. 336), yet it was unclear as to how this specific approach is so directly connected to teacher retention or commitment. The results were significant in showing a connection to social and community efficacy and though they appear statistically sound, this was one of the only studies critiqued which promoted a commercially available development program. The language used in the study seemed to go overboard in promoting the benefits of the program as opposed to the specific types of teacher support focused on in other studies. That said, professional development opportunities which focus on empathy and active learning, as demonstrated in Rimm-Kaufman and Sawyer's (2004) data, are methods which can be used to increase teacher efficacy.

Lee, Dedrick, and Smith (1991) investigated the effect of school social organization on teacher efficacy in a study comparing organizational structures of public and private-Catholic high schools in Michigan. Their research sought to analyze the importance of intrinsic sources of classroom performance on teacher efficacy as seen through a lens of school structural features. Data was collected in 1984 as part of another study and analyzed for publication in 1991. The public school sample was composed of 7,467 teachers in 307 schools (for an average of 24 teachers per school) and the Catholic school sample was composed of 1,021 teachers in 47 schools (for an average of 22 teachers per school) (Lee, et al., 1991, p. 194-195). The school structural features investigated were: "teachers' control over classroom practices, perceived sense of

community, students' disorderly behavior, the degree to which principals are considered leaders, the staff's influence in making important school decisions, the encouragement of innovation, administrators' responsiveness to the staff, time spent in collaborative activities, and knowledge of other courses in teachers' departments" (Lee, et al., 1991, p. 195).

These features were compared to levels of teacher efficacy through hierarchical linear modeling. Results indicated that while teachers in the Catholic high schools had higher average teacher efficacy scores, the relationship between efficacy and teacher perceptions of control was essentially equivalent to that of public schools (Public School: mean efficacy = -0.020; Catholic School: mean efficacy = 0.295; Control/Efficacy slope = .0303 and is not significantly different) (p. 198-200) . Additionally, there were positive relationships for both schools between teacher efficacy and both high-(average)socioeconomic status and large school size (SES: $r = 0.0432$, $p \leq 0.01$; Size: $r = 0.0425$, $p \leq 0.01$) (p. 201). In general, the strongest results of the linear modeling indicated that social organization of the school had a larger impact on teacher efficacy (Community: $r = 0.0930$, $p \leq 0.001$) than did academic organization (Control: $r = 0.0813$, NS) for both private-Catholic and public schools (Lee, et al., 1991, p. 199-203).

Perhaps the most important part of this paper had to do with the idea that the social organization of a school, namely the collective context of supportive relationships, had more to do with teacher efficacy beliefs than did the academic, instructional supports. Teachers needed to feel as if they had control over their classrooms, but also needed to feel supported in a larger context. This brings up the idea of collective efficacy in that, "when teachers pursue common, clear purposes and feel shared commitment to an

achievable enterprise, greater efficacy follows" (Rosenholtz, 1989, p. 432). It speaks to the idea that teachers are not automatons, but human beings who need community and a social environment in which to function.

The work of Strahan (2003) also focused on the result of school-wide reform efforts to create collaborative agendas for reform. In a three-year case study of three elementary schools in North Carolina, schools showed increased achievement scores (based on two state-wide major end-of-grade exams administered in the spring) of low-income and minority students from less than 50% proficiency to more than 75% in each school between 1997 and 2002 (Strahan, 2003, p. 127). Researchers constructed case studies to explore the professional culture of these schools, analyzing 79 open-ended staff interviews conducted by one researcher and at least one doctoral student between 1999 and 2002 (Strahan, 2003, p. 131). Researchers focused on questions about professional learning communities and how they "nurtured instructional improvement and continuous school renewal" (Strahan, 2003, p. 131). The general focus of the study was on staff interpretations of the collaborative approach adopted in different ways by each of the three schools; however questions posed were different for each of the three years.

The schools involved in this study were Archer Elementary, Hunter Elementary, and North Elementary. All schools taught students in the kindergarten to the fifth grade. Archer was in Guilford County, North Carolina, and had more than 600 students, 68% of whom qualified for free or reduced price lunch, 70% were ethnic minorities, and 20% were English language learners. At Hunter, also in Guildford County, there were 410 students, 85% qualified for free or reduced lunch, 91% were ethnic minorities, and 20% were English language learners. At North Elementary, in Person County, North Carolina,

there were more than 400 students, 70% qualified for free or reduced lunch, 70% were ethnic minorities, and no data was provided as to the percentage of students who were English language learners.

The first year of interviews, participants reported "(*a*) concentrating instruction on student performance, (*b*) creating inviting school climates, and (*c*) guiding reform through energetic leadership" (Strahan, 2003, p. 130). During the second year, interviews focused more on four guiding questions to do with definitions of success and how it was promoted in classrooms and colleague collaboration. Teachers and administrators reported "defining success comprehensively, building classroom learning communities, designing lessons that engage students in active learning, assessing students' progress in learning strategies and concepts, initiating site-based staff development, developing a shared stance toward learning, and forming partnerships to sustain growth" (Strahan, 2003, p. 131). The third year, interviews focused on the themes brought up in the previous two years and further elaborated on noticeable trends.

Though each school interpreted and carried out "community-building" in different ways, there were themes which were found in interviews throughout the three schools over the course of the study. "At all three schools, teachers and administrators reported that they coordinated efforts to improve achievement" (Strahan, 2003, p. 141). I am choosing to focus this report on the results which are most connected to the improvement of teacher efficacy as articulated by teachers and administrators. At Archer, there was better teacher understanding of expectations, a more socially supportive environment, and collaborative planning sessions which led to improved teacher sharing and more consistent assessment practices. As stated by their principal, "Teachers would ask, 'How

can you expect us to do better?' Now they believe that they can do it. We've seen that if we give them our best, we can do it the right way. Now they believe it's possible" (Strahan, 2003, p. 134). At Hunter, teachers focused on differentiated and integrated instruction as the cornerstone of reform, however there were many staff-related changes as well. Teachers again experienced more clearly stated goals and collaboration with other teachers and school staff, emphasizing "a sense of professional togetherness" (Strahan, 2003, p. 138). As stated in one interview, "working together to accomplish these goals was a source of energy and renewal" (Stahan, 2003, p. 138). Finally, at North, teachers also noted that they were working together more, sharing resources and research monthly, and meeting for collaborative planning sessions weekly. "Like their counterparts at Archer and Hunter, participants at North Elementary drew energy from their colleagues to meet these challenges. They emphasized the collaborative nature of their relationships with each other" (Strahan, 2003, p. 141).

All three schools focused on making the school culture a more positive and collaborative environment, such that "the school provides more social support for learning; school culture grows more collaborative; and teachers develop stronger collective efficacy" (Strahan, 2003, p. 130). All schools had virtually continuous dialogue and noted that their peers provided them with a renewed sense of purpose through this interaction. While the purpose of reform was to improve achievement scores (which it did drastically in each of the schools), schoolwide efforts contributed to the creation of collaborative professional communities which in turn helped to increase the collective efficacy of teachers.

There are several places interview excerpts where interviewees talked about the effects of increased personal and collective efficacy without mentioning the word "efficacy." Because this study did not look specifically at "efficacy" and watch for such themes, it is possible that the results the schools produced in community reform did not have as much to do with "efficacy" as could be ascribed to them. That said, Strahan (2003) did state that efficacy improved as a result of reform. The importance of this study lies in the fact that for each of the schools, community-building reform resulted in renewed purpose and increased levels of collective efficacy. Reform similar to that described by each school *could* help to increase teacher efficacy levels.

Ross, McKeiver, and Hogaboam-Gray (1997) studied fluctuations of teacher efficacy of four "exemplary" grade-9 mathematics teachers during the first year of a district-wide destreaming reform in Ontario, Canada. They wanted to explore the impact of destreaming on teacher efficacy and see whether efficacy decreased, if it returned by the end of the school year, and what methods made it come back. Destreaming is the process of removing students from homogenous ability groupings and was imposed in the 1993-1994 school year without teacher consent as a response to district-wide studies that showed that minority groups were overrepresented in the lower of the three math tracks (Ross, et al., 1997, p. 285). It was reported that teachers felt forced into this process and resented such a fundamental redefinition of their work because it forced them to create new curriculums which would be appropriate for all ability levels as opposed to homogenous groups.

Data was collected in the form of teacher interviews and observations during the 1993-1994 school year. Researchers conducted five interviews, spread through the

course of the first year to assess efficacy cycles within that time. " Tracking teachers' expectations more frequently made visible the decline and rebound of TE and emphasized the interplay of curricular, organizational, and personal factors that contributed to its resurgence" (Ross et al., 1997, p. 294). The first interview focused on teacher feelings about destreaming, efficacy beliefs, and their expectations of the tone of the school year. The second interview asked teachers to identify their definition of destreaming, the problems they saw, and strategies they were developing to cope with these issues. The third focused on collaborative processes, the fourth about the evaluative methods they were using for student assessment, the relationship with principals, and personal goals they had for their classrooms. The final interview had to do with the similarities and differences researchers noticed. Interviews were followed by a two-hour focus group where teachers were asked to provide feedback on the case studies and assess researcher notes. Researchers additionally conducted three observations, in October, November, and December of 1993, taking detailed field notes which helped to inform interview topics (Ross, et al., 1997, p. 287).

The case studies showed themes of initial negative feelings toward destreaming and a lowered sense of teaching efficacy because teachers were less certain of the consequences of their instructional actions, thus they suffered from weakened outcome expectancies. They were unable to see student progress at the beginning of the year and thus were unsure as to if it was right. They also were worried about the monumental task or recreating curriculum to adapt content to appropriate ability levels. After teachers began to accumulate personally meaningful and credible evidence of student learning and their effect on these new populations of students, processes unique to each of the four

subjects, researchers started to notice an increase in efficacy beliefs. Additionally, the organizational culture of the schools changed such that teachers were more willing to collaborate and collectively problem solve curriculum issues and instructional methods to better suite their heterogeneous classrooms. These supportive relationships in addition to perceptions of supportive supervisors and principals helped to further increase teacher efficacy beliefs. The final thematic change had to do with personal change in which teachers were able to put away their resentment toward destreaming and instead make productive moves toward teaching their students. They held firmly onto their personal goals for their classrooms and relied on previous experience to help them adjust to the new department organization. They proved to be more flexible than anticipated, stating that their goals and students were more important than holding onto resentments. The teacher with the least amount of classroom experience worked with peers to gain vicarious experiences which helped her to develop better strategies to cope with her new classes (Ross, et al., 1997, p. 288-290).

One issue with the construct of the study was that the four teachers chosen were selected based on their reputations for being strong educators. Because they were strong, it was assumed that their efficacy would increase as they adjusted to destreaming, however it would be interesting to note how teachers with lower degrees of efficacy would react to similar conditions. Were results indicative of all teachers or just teachers with strong beliefs in their personal effectiveness?

This study was fascinating for the cycle of efficacy it showed over the 1993-1994 school year. While it was an extraordinarily small-scale study, with only four subjects, because of the longitudinal nature of the case studies, it showed efficacy change over

time and demonstrated that efficacy beliefs are not static once formed early in teachers careers. Despite the fact that teachers' efficacy beliefs were never quantified, this study provided some solid and seemingly reliable suggestions for schools looking to increase teacher efficacy. Ross et al. focused on building a school climate for organization, increasing teacher input in decision-making, and be responsive to teacher concerns (Ross, et al., 1997, p. 293). These are all suggestions which have potentially large impacts on teacher efficacy and which are interesting in the context of this study.

The research in this subsection all focused on larger-school issues and their connection to the efficacy of teachers. Efficacy was correlated with professional community and of principal use of transformational leadership (Ross & Gray, 2006). Other studies focused on the connections between teacher efficacy and social and community efficacy (Rimm-Kaufman & Sawyer, 2004; Strahan, 2003; Lee, Dedrick, & Smith, 1991; Ross, McKeiver, & Hogaboam-Gray, 1997). The main themes focused on improving efficacy through community support and professional collaboration.

## Summary

Because all teachers were first students, it was necessary to address the fact that there is evidence of a gender difference in self-cognitions with regard to math. The majority of individuals entering the teaching profession with intent to teach at the elementary level are women and the studies featured in the first subsection of this chapter served to complexify gender differences in math self-cognition and its impact on math performance and future math efficacy. The following section addressed the impact of teacher efficacy beliefs on the efficacy and achievement of their students and reinforced the notion that there is a connection between personal and collective teacher efficacy in

teaching mathematics and the achievement and math-beliefs of their students. Because these studies focused on the connection between efficacy and student belief and achievement, they reinforced the need to have more efficacious math teachers at both the elementary and middle levels.

The next two subsections investigated methods and experiences that demonstrably increased the efficacy beliefs of both preservice and inservice math teachers. Preservice elementary teacher candidates in particular were shown to possess low levels of mathematics efficacy, especially significant in that they represent students' first exposure to the discipline. Because the previous section focused on the connection between teacher efficacy and student math beliefs and achievement, the need for methods courses to better prepare efficacious teachers was emphasized. This subsection was followed by a set of studies which investigated efficacy changes upon entry into the teaching profession and suggested methods for beginning teachers to improve efficacy through mentor programs, the opportunity to generate mastery experiences, and through the establishment of professional communities. Additionally, this subsection critiqued studies for those professionals who have been in education for a substantial time period but who need to continue to develop efficacy beliefs to stave off professional burnout or to improve performance expectations.

Chapter Three finished with a subsection focused on larger-school issues and school-wide reform's connection to the efficacy of teachers. Efficacy was connected with professional community and principal use of transformational leadership while other studies focused on the connections between teacher efficacy and social and community

efficacy. The main themes from this final subsection focused on improving efficacy through community support and professional collaboration.

# CHAPTER FOUR: CONCLUSION

## Introduction

Chapter One outlined the motivating questions for research to be investigated in Chapter Three. Because efficacy is believed to be connected to outcome expectancy and the amount of effort an individual exerts in the face of difficulty, math teachers who demonstrate higher levels of teaching efficacy are desired to maximize potential student learning and positive academic efficacy development. Chapter Two outlined the historical basis for the "Math Wars," beginning with Dewey and Thorndike. The mechanized education and international educational competition pervasive post-Sputnik were discussed in relation to the development of Social Learning Theories, the debate of computation versus mathematical thinking, issues of detracking, and ability theories. Chapter Three the documented relationship between teacher efficacy and student achievement, the pervasive gender issue with math self-efficacy found as early as elementary school, methods which have shown positive increases in both the preservice and inservice teaching populations, and leadership styles paired with school-wide reform that increase the collective efficacy of a professional educational community. Chapter Four addresses major findings in each of the studies, their applicability to use in the classroom, and suggestions for further research.

## Summary of Findings

### Math Self Efficacy and Gender

Seegers and Boekaerts (1996) studied the difference between eighth grade children's self-referenced cognitions about mathematics tasks and their achievement on math problems. They found that girls scored significantly lower on their self-referenced ability in solving math problems, indicating lower levels of self-efficacy with regard to

mathematics then reported by boys of the same age. These lower levels of math efficacy were found to be the most significant factors in determining why boys scored higher, on average, than the girls sampled in this study. Shifting focus from children to adults, Pajares and Zeldin (2000) interviewed women in mathematics-heavy careers to study how these women developed the efficacy necessary for them to believe themselves capable of careers in the more male-dominant workplace. These women commonly claimed that strong mentors and a community of other like-minded individuals significantly contributed to their beliefs that they would be able to succeed in more mathematics, such that "Self-efficacy building on relational experiences resulted in a pattern of resiliency to perceived obstacles as women continued along their academic and career paths" (Pajares & Zeldin, 2000, p. 233). The findings from this gender-related cognition established that there was a difference in self-cognition between girls and boys and that influential teacher and more and more capable peers can prepare girls to be more successful in a future with math. The results from Seegers and Boekaerts (1996) seemed stronger in that they were more reliable and more likely to be repeatable. The study structure of Pajares & Zeldin's (2000) ethnography was too specific to the experiences of the subjects interviewed to be reliably replicated.

## Relationship Between Student and Teacher Efficacy

Eccles, Feldlaufer, and Midgley (1989) examined the effect of teacher efficacy on students' math self-beliefs in the transition from elementary to middle school in a large-scale longitudinal study. Results were more significant for teachers who had lower efficacy such that students with teachers who had lower self-reported math-efficacy beliefs reported much lower rates of math efficacy in their transition to middle school and

students who had taken classes with teachers reporting higher math-efficacy beliefs had much less negative change. These were strong findings for the students from lower reporting teachers, however, despite the large-scale design of the study, the results were small enough to call into question some of the significance of the results. Additionally, because the sample was predominantly Caucasian, the transferability to other more diverse populations is called into question.

Midgley, Feldlaufer and Eccles (1989) focused on the relationships between students and their math teachers in middle school, such that relationships perceived to be more positive or supportive were observed to promote more positive math feelings on the part of the students. Teacher efficacy, as one of the primary determinants of classroom environment, was seen to indirectly affect student transitions from elementary to middle school. While this study was a reinterpretation of data used in the previous study, Eccles, Fleldlaufer, and Midgely (1989), it showed implications of teacher beliefs and student achievement as moderated through the student/teacher relationships, further emphasizing the impact of teacher attitudes on those of their students.

Newstead (1998) studied the implementation of Calculator Aware Number Curriculum (CAN), focused on the use of calculators in the math classroom in conjunction with an alternative, investigative teaching style, real-life problems, and class discussions of math strategies. The focus of the study was to chart the correlation between this curriculum and lowered levels of student math anxiety, additionally hypothesizing that teachers who successfully implemented the new curriculum would also show higher levels of teaching efficacy. Because this study focused solely on one factor involved in children's math anxiety, that of teaching approach, there were several

hidden variables not discussed. Because CAN is a technology-heavy curriculum, further testing should have been conducted which examined the effect of technology (via calculators) on student anxiety as one of these hidden variables. Despite these issues, students were demonstrably more comfortable in a math classroom where teachers demonstrated more confidence with curriculum and relevant materials than in the classrooms where teachers had received less training.

Allinder (1995) studied the relationship between teacher efficacy and student achievement with regard to the use of a type of formative assessment, Curriculum-Based Measurement (CBM) in math lessons for special education students. Teacher efficacy levels were measured with the Teacher Efficacy Scale developed by Gibson and Dembo (1985). Results indicated that Allinder was able to isolate the positive impact of efficacy beliefs on achievement such that students with higher efficacy teachers (in personal and teacher efficacy) better helped their students achieve math goals. Teachers with high efficacy beliefs were more willing to increase goals for their students as students' slopes were higher, thus their goals for students proved more ambitious overall. This connected to student achievement in that teachers with higher efficacy were also more willing to work with struggling special education students to help them achieve their goals and attempted a variety of less traditional teaching methods to do so. This research seemed to indicate that efficacious teachers, in this formative context, both expressed high expectations and gave the support necessary for students to achieve.

Midgley, Anderman, and Hicks (1995) focused on the difference between school culture in elementary school and that of middle school and the task goals that mediate self-efficacy of both students and teachers. Data was collected before, during, and after,

a three-year program intended to change instructional focus from performance goals to task goals. Because the α-values were so low, low internal consistency with measurement scales question whether this study is representative of solid research. Additionally, the emphasis for teacher efficacy had more to do with teacher intentions than the reality of what they stressed to students in the task versus performance debate. That said, this study shows relationships between student and teacher efficacy levels and the impact of teacher beliefs on student-internalized goals.

Hoy, Hoy, and Goddard (2000) created new scales to assess the degree to which collective teacher efficacy shaped the normative environment of schools and its impact on student achievement. They conducted an initial study to develop their scale and test its reliability before conducting a pilot study. Results from the pilot study indicated that teachers had difficulty separating their perceptions of collective efficacy from their perceptions of the difficulty of the task, indicating that collective efficacy (like individual efficacy), appears to be context-specific. This was connected to student achievement in that a single unit increase in the level of collective teacher efficacy was found to increase student achievement by more than 40% of a single standard deviation, indicating that "Collective teacher efficacy perceptions are predictive of student achievement" (Hoy, et al., p. 501). The results analysis offered two well-executed and detailed studies which promote strong relationships between efficacy and achievement at the building level and seem reliable because of their breadth and methodical mathematical basis.

## Preservice Teacher Efficacy

Hannula, Kaasila, Laine, and Pehkonen (2005) conducted a survey of preservice teachers at three Finnish universities to quantify the belief profiles (regarding self-

perceived talent, difficulty of mathematics, and declared liking of mathematics) of students of elementary education at the beginning of their certification program. They focused their research on Bandura's (1993) assertion that past experience is a strong indicator of present self-efficacy. Results were separated through cluster analysis into three categories (positive, neutral, and negative), each of which was further divided into two sub-classes. The main demographics analyzed against these sub-classes were gender, the college mathematics course level selected, and the grades students received in high school mathematics (p. 91). Significant relationships were found between previous grades in math and current beliefs about competency, high school course selection and current mathematical self-confidence, and grade-effects were more pronounced with women than men (Hannula, et al., 2005, p. 93). This further supports the assertion (Pajares & Zeldin, 2000) there are gender differences in self-efficacy beliefs with regard to mathematics, for both children and adults who intend to teach children.

While the Greshasm (2008) study focused the majority of its research on math anxiety rather than efficacy, the efficacy implications found within were impressive. If there is a tangible relationship between teachers' attitudes towards mathematics and their self-perceived effectiveness in teaching math, then it is all the more important to help teachers improve these attitudes. Part of the connection in improving attitudes, as discussed in this study, comes from making meaningful experiences which will impact efficaciousness. Results indicated in an analysis of the anxiety and efficacy scores that there is a negative relationship between mathematics anxiety and mathematics teacher efficacy among these preservice teachers when the subscales were combined ($r = -.450$, $p < .05$) (Gresham, 2008, p. 176). This research also implies that if a teacher's math

anxiety is alleviated, then they will have the opportunity to develop better personal efficacy beliefs.

Miller and Pajares (1994) examined the role of self efficacy beliefs in determining mathematical problem solving and performance by studying undergraduates at a public university in the United States in conjunction with the university's College of Education. Results supported Bandura's assertion that "how people behave can often be better predicted by their beliefs about their capabilities than by what they are actually capable of accomplishing for these beliefs help determine what individuals do with the knowledge and skills they have" (Miller & Pajares, 1994, p. 193). Because researchers were able to control for so many variables and present data in such a clear way, the results of this study are very reliable. Yet, because this study was self-selecting, there was a large gender imbalance, and college credit was offered (basically a reward for participation), some of the generalizability of these results is called into question; in spite of these issues, this study strongly supports the importance of math self-efficacy in influencing performance.

Philippou and Christou (1998) researched the effects of a math methods course on changing pre-service teacher's attitudes toward mathematics to explore what prospective elementary (primary) educators' beliefs in a University Education program were prior to entering coursework, and whether their beliefs could be altered by the experiences in their preparatory program in Greece. The pre-test revealed "an alarmingly high proportion of students who brought very negative attitudes to Teacher Education" (p. 196). After finishing the three-course methods progression, students were randomly interviewed to assess whether the content of program courses may have influenced a

change in efficacy beliefs. Based on the results of the pre- and post-course assessments, students' results indicated an improvement of attitudes, assumedly to be as a result of the math methods coursework. The results are not readily transferrable to other populations because the study was situated in Greece with a largely female population, but its positive results through a series of mastery experiences supporting positive efficacy development invite opportunities for further research.

Nyaumwe and Mtetwa (2006) conducted a case study about the effectiveness of collaboration between college lecturers and students peers in assessing the instructional practice of student teachers in Zimbabwe. Professors and preservice peers focused on different aspects of instruction in their assessments, thereby providing complementary views of the student teacher's strengths and areas for improvement. This supports the notion that by creating a community of learners in preparation for work in the classroom, teachers will have more confidence in their abilities to help students learn and to understand teaching methods which are believed more likely to support student learning. The impact of formative assessment in teacher programs (as opposed to summative), open dialogue, peer relationships, and constructivist teaching strategies seem to promote positive effects in the development of higher teacher efficacy as found in this study. Because it was conducted in Zimbabwe, some of the transferability to an American educational system is called into question, but the ideas found herein seem sound when combined with other results from this section.

Harkness, D'Ambrosio, and Morrone (2007) studied the influence of a 6-credit math methods course, *Problem Solving*, on preservice elementary teachers in a qualitative, grounded theory approach. Researchers seemed keen to establish that student

thinking changed over the course of the semester and that students were much more confident in their mathematical abilities at the end of the course than they were at the beginning. They also acknowledged that journal entries, the bulk of the data generated, may have been skewed because prompts attempted to focus students on "growth," a term which presumably pushed students to more positive realizations at the end of the course. Because there was a small sample size of predominantly female, Caucasian subjects, this study is not easily transferable to other populations and its results are not as strong as other larger-scale studies. That said, the value of the course was that it focused on learning rather than achievement, helping to promote positive mastery experiences for students rather than an emphasis on high ability, significant in the development of positive math efficacy beliefs.

Swars (2005) studied efficacy-outliers from a preservice teacher math methods class by interviewing a very small number of subjects at the completion of the course. The three main themes to emerge from these interviews were past experiences with mathematics, influences up on perceptions of mathematics teaching effectiveness, and mathematics instructional strategies (Swars, 2005, p. 142-143). Because of the small scale of the study and the fact that results were likely skewed by the interviews being held so soon after the completion of a math methods course designed to help students develop mastery skills which contribute to efficacy, the results from this study were comparatively weak, though they do support the general trend that methods courses can help preservice teachers to build upon their sense of efficacy.

Huinker and Madison (1997) also studied the impact of methods courses on preparing preservice math and science teachers to be efficacious educators. Teaching

efficacy beliefs were assessed using quantitative measures and a pre-test-post-test one-group research design was used to collect data. Additionally, interviews were conducted with cohorts to either confirm results of the pre-and post-test data or to gather more in depth data about students who showed remarkable increases in efficacy. Results showed that collaboration and meaningful learning experiences were key to helping students to feel a part of a larger community which had a viable impact on their teaching futures. Fieldwork helped and opportunities to watch professionals model behaviors and philosophies additionally beneficial.

## Inservice Teacher Efficacy

Hoy and Spero (2005) tracked changes in teacher efficacy judgments from the entry of a teacher-education program, through student teaching, and at the end of the first year of teaching post-certification in a quantitative, longitudinal study. Researchers used Gibson and Dembo's Teacher Efficacy Scale, Bandura's Teacher Efficacy Scale, and a program-specific scale designed to better reflect the specific goals of the education program. All assessments showed significant increases in efficacy from the beginning of the program to the end of student teaching, however the Banduran and Gibson and Dembo scales were significant in showing a *decrease* in efficacy after the first year post-certification. While this study is certainly small-scale, and confined to the philosophy and support of one teaching program, the results were interesting in the context of cycles of teacher efficacy at the beginning of an individual's career.

Knobloch and Whittington (2002) conducted a descriptive-associational study to examine the variance in efficacy beliefs after the first 10 weeks of student teaching, and the first through third years of teaching using variables related to perceived levels of

support, teacher preparation, and student teaching experience. While their study was done in conjunction with an agricultural program, the themes it addressed are in keeping with Bandura's philosophies and much of the other studies from this particular subsection of Chaper Three. This data indicated a statistically significant relationship between beginning teacher's interpretation of the collective efficacy of a school and the support they feel that they receive from their principals in addition to the notion that those teacher's efficacy is positively related to the perceived collective efficacy of the schools in which they teach. Researchers only allowed teachers to ascribe their efficacy development to four main themes, a limiting factor which did not comprehensively assess the measure. Also, because data was collected during the tenth week of the school year, there are likely different priorities of teachers at that time than there are later in the school year.

Chester and Beaudin (1996) examined whether novice teacher self-efficacy varied by teacher characteristics and which school practices systems contributed to changes in teacher efficacy. Results indicated that teacher age had a more significant effect on change over the course of the induction period than for novices than it did for new hires with previous teaching experience, opportunities for collaboration helped to moderate the affect of age for novice teachers, suggesting that collaboration for novice new hires is a significant factor in supporting higher efficacy beliefs, and an abundance of instructional resources was significantly positively related to experienced new hire efficacy beliefs, but significantly negatively related to novice self-efficacy. This study importantly provided a different viewpoint for the idea that all teachers experience a decrease in efficacy beliefs over the course of their first year of teaching, it effectively complexified the issue of

efficacy cycles in early educational careers. Additionally, the sample was taken from an urban region, which according to the majority of literature available is supposed to be correlated with lower levels of teaching efficacy, results which did not appear in this study.

Bandura and Jourden (1991) conducted a study on students from a graduate program in Business which examined the effect of perceived successes within a group. While this study does not have to do with the field of education directly, because it focuses on the perception of other individuals possessing more experience or capability in a specific context, it is well-suited to comparisons within the field of education for teachers who are first entering the profession. In the context of this study, subjects who believed themselves to have displayed inferior capabilities as compared to others expressed much lower levels of self-efficacy than did those who believed themselves to have either superior or progressive mastery over their peers. Additionally, the data showed that as subjects continued with the experiment and were told that others were continuing to contribute at a higher level, the perceived self efficacy of these individuals was the strongest determiner in whether they were discouraged by achievement (as with lower self-efficacy), or challenged to work harder (as with higher self-efficacy). The transfer to teachers comes in that if teachers perceive themselves as being as competent instructors as their peers, they will be more likely to develop positive beliefs about their outcome expectancies. Yet, if they see themselves as lacking by comparison, it is possible that this hit to mastery perceptions could cause either burnout or feelings of resentment toward their peers.

Brouwers and Tomic (2000) conducted a longitudinal study designed to investigate the relationship between teacher self-efficacy and teacher burnout, examining the impact of emotional exhaustion, depersonalization, and reduced perceptions of personal accomplishment on efficacy beliefs. Researchers assumed teacher efficacy to be connected to cycles of burnout because efficacy development is affected by teacher response to difficult situations and perceptions of external versus internal control, with higher levels of burnout exhibited by individuals who believed control to be out of their hands. The strongest results suggested that emotional exhaustion negatively impacted perceived self-efficacy, that perceived self-efficacy impacts (or prevents, as with higher levels of efficacy) depersonalization, and that emotional exhaustion is related to fewer mastery experiences created over a set period of time. Additionally, stronger rates of self-efficacy were related to a higher sense of personal accomplishment.

Mellony Graven (2004) analyzed a qualitative ethnography of teachers in South Africa who participated in an in-service education and training project (INSET). The study looked to understand the role of confidence in a teacher enrichment and inservice methods course. Teachers were involved in professional development which was designed to help them make a self-identified transition from “teachers of math” to “math teachers,” a small distinction, but one which demonstrated more confidence and efficacy with regard to math teaching (p. 188). Despite the fact that this study was conducted in South Africa, it emphasized the fact that when the demands on teachers change, the opportunity to gain new mastery experiences seems especially important in developing a new sense of efficacy. Public education in the United States is always in a state of flux based on the political needs of a time period and this study provided interesting results

based on balancing the needs of teachers with the whole-scale reforms rippling through South Africa.

Middleton (1999) studied how “job-embedded learning” through the use of “Realistic Mathematics Education” curriculum affected the motivation of teachers and students by the case study of two teachers. The researcher claimed that sociocultural staff development had a positive effect on the motivation of both teachers and their students. Because there are only two subjects in this case study, both women of undisclosed demographics, the results cannot be easily generalized. While Middleton (1999) attempted to say that the efforts on student comprehension and teacher confidence can be attributed to the RME program, the effect of having a participant researcher involved in continuous, year-long personal professional development likely had a stronger effect on the variables investigated in this study.

Yost (2002) conducted a small-scale study based on interview, observation, and diary data which studied the interplay of experience mentor teachers and their year-one mentees. Mentors were released from their regular classrooms as part of a district-wide program which allowed them to spend half of their time with mentors and the other half working on projects required by the district. The purpose of the mentor program was to help socialize new teachers to the school and provide them with support in successfully completing their first year of teaching. While this was a very small write-up of an admittedly small study, there were implications for inservice teachers who need to develop more positive teaching efficacy given that the experienced mentors claimed that the break in routine was reputed to be a welcome change and one which helped them to visualize themselves in different roles, many of which gave them the district-wide

recognition they had lacked when working in a classroom. This is certainly a method for more experienced teachers to liven their careers and contribute to the entry-level experience of another professional.

Smylie (1988) performed a path analysis on staff development of inservice teachers, suggesting that individual change as a result of staff development was a direct function of personal teaching efficacy rather than factors. It was anticipated that the more teaching efficacy demonstrated by an individual, the more likely they would change practice as a result of staff development opportunities. The main measure of teacher change was taken from observations, such that the difference between pre-training and post-training proportions of time teachers spent engaged in interactive instruction was averaged for each individual to quantify results. The sample for the study, despite not showing conclusive results for the relationship between efficacy and change after development opportunities, was not representative. All of the teachers included in this study *chose* to seek out professional development opportunities.

## Impact of Building Principals and School-wide Reform

Ross and Gray (2006) studied relationships between transformational (versus transactional) principal leadership and the connection between principal leadership and collective school efficacy. They reanalyzed data from another large scale study looking at the connection between student achievement, socioeconomic status, principal leadership, collective teacher efficacy, teacher commitment to school mission, teacher commitment to the school as a professional community, and teacher commitment to school-community partnerships. While several of the data collection methods were overly reductionist and seem to measure variables not accounted for in the data analysis,

the focus of this paper is outside the scope of most of the questionable data practice. While this study intended to focus on the impact of principals' leadership style on student achievement, it instead pointed directly to the connection between the collective efficacy of a school and transformational leadership. It outlined how principals can influence teacher interpretations of their impact on students because they help to define for teachers what is constituted by "student success." They additionally can model what it means to interact peaceably in a community or with a team of other professionals. By effectively using transformational leadership in the context of the whole school, this study suggested that principals can help to uplift the collective efficacy of a school.

Rimm-Kaufman and Sawyer (2004) conducted a quasi-experimental, longitudinal study to research the ways in which implementation of the *Responsive Classroom* (*RC*) approach to school philosophy related to teachers' beliefs and attitudes about teaching. After completing the multi-year supported training sessions, findings showed that teachers who reported using more *RC* practices also generally reported higher self-efficacy beliefs. The results were significant in showing a connection to social and community efficacy and though they appear statistically sound, this was one of the only studies critiqued which promoted a commercially available development program. That said, professional development opportunities which focus on empathy and active learning, as demonstrated in Rimm-Kaufman and Sawyer's (2004) data, are methods which demonstrate an increase in teacher efficacy at both the personal and community level.

Strahan (2003) focused on the result of school-wide reform efforts to create collaborative agendas for reform, focused on staff interpretations of the collaborative

approach adopted in different ways by each of the three schools studied. Though each school interpreted and carried out "community-building" in different ways, there were common themes found in interviews throughout the three schools over the course of the study. All three schools focused on making the school culture a more positive and collaborative environment; all schools had virtually continuous dialogue and noted that their peers provided them with a renewed sense of purpose through this interaction. Because this study did not look specifically at "efficacy" and watch for such themes, it is possible that the results the schools produced in community reform did not have as much to do with "efficacy" as could be ascribed to them. The importance of this study lies in the fact that for each of the schools, community-building reform resulted in renewed purpose and increased levels of collective efficacy.

Lee, Dedrick, and Smith (1991) studied the effect of school social organization on teacher efficacy, focusing on the differences between selected public and Catholic schools in Michigan. Perhaps the most important part of this paper had to do with the idea that the social organization of a school, namely the collective context of supportive relationships, had more to do with teacher efficacy beliefs than did the academic, instructional supports. Teachers needed to feel as if they had control over their classrooms, but also needed to feel supported in a larger context. Results indicated that the strongest predictor of positive teacher efficacy in either school system was the present of a strong professional community.

Ross, McKeiver, and Hogaboam-Gray (1997) studied fluctuations of teacher efficacy via case study to explore the impact of destreaming on teacher efficacy and see whether efficacy decreased, if it returned by the end of the school year, and what methods

made it come back. Destreaming is the process of removing students from homogenous ability groupings and it was reported that teachers felt forced into this process and resented such a fundamental redefinition of their work because it forced them to create new differentiated curriculums appropriate for all ability levels as opposed to the homogenous groups of the old system. The case studies showed themes of initial negative feelings toward destreaming and a lowered sense of teaching efficacy because teachers were less certain of the consequences of their instructional actions, thus they suffered from weakened outcome expectancies. After teachers began to accumulate personally meaningful and credible evidence of student learning and their effect on these new populations of students, researchers started to notice an increase in efficacy beliefs. Additionally, the organizational culture of the schools changed such that teachers were more willing to collaborate and collectively problem solve curriculum issues and instructional methods to better suite their heterogeneous classrooms. The results of this study were so specific to the schools and individuals interviewed that the results are likely not generalizable. One issue with the construct of the study was that the four teachers chosen were selected based on their reputations for being strong educators and it is questionable that less efficacious teachers would respond to such reform so quickly or positively. Despite this, the fact that this study demonstrated that efficacy beliefs are not static once formed early in teachers careers was highly a highly significant finding.

## Classroom Implications

Elementary education and middle-level math are seminal educational experiences in children's lives because they constitute the beginning of a child's either educative or non-educative academic experiences. As stated, "Elementary school teachers'

competences in and view of mathematics have a profound significance, because they are the first ones to teach mathematics to children" (Hannula, et. al, 2005, 89). Additionally, middle-level mathematics has the biggest impact on what class students begin when they reach high school, often determining the track that students enter, be it college-preparatory or not. As a teacher entering these fields, I find it necessary to seek out ways to ensure that from my first day in the door, I am an effective, supportive, and worthwhile teacher for my students. Understanding that my self-efficacy has an impact on the academic environment I am able to provide for my students will be a huge motivator in making sure that I make deliberate, theory-guided decisions for my students and maintain a sense of excitement and positivity with regard to teaching and subject matter.

The studies outlined in my research have investigated the impact of gender on efficacy, the impact of multiple types of teacher efficacy on student achievement, the impact of development pre-certification and professional development post-certification. I examined the importance of making sure that I maintain a peer community to help provide mentorship and vicarious experiences. I have viewed the effects of social comparison as seen by Bandura and Jourden (1991), in their study on social comparison and its impact on decision making, "Seeing oneself surpassed by others undermined personal efficacy, increased erratic analytic thinking, and progressively impaired performance attainments…By contrast, seeing oneself gain progressive mastery strengthened personal efficacy, fostered efficient thinking , and enhanced performance attainments" (Bandura, 1993, p. 123). By making sure that all individuals (students *and* teachers) have access to opportunities for positive mastery experience which builds on

previous positive experiences, the potential for developing and maintaining strong personal efficacy will increase.

By making sure that I am prepared for possible cycles of self-efficacy, I am confident that I stand a better chance at being less effected by symptoms of burnout because I know going into the profession the precautions to take to prevent this "crisis of self-efficacy." My goal is to use these strategies so that I do not become one of the "Teachers who lack a secure sense of instructional efficacy show weak commitment to teaching and spend less time on academic matters…teachers who distrust their efficacy try to avoid dealing with academic problems and, instead turn their effort inward to relieve their emotional distress. This pattern of withdrawal coping contributes to occupational burnout" (Bandura, 1993, p. 134).

Because "once formed, efficacy beliefs contribute significantly to the level and quality of human functioning" (Bandura, 1993, p. 145), I will take care to make sure that the efficacy I am developing even now, while completing my degree program, is based on solid experiences, valuable relationships, supportive peers, and mentors so that I will have the resiliency to pick myself back up when the days are as difficult as I know they occasionally will be.

## Suggestions for Further Research

In future research, it would be helpful to see more longitudinal studies, carried out over a longer period of time. As with Gresham (2008), several of the studies in Chapter Three were conducted right at the end of methods courses or as subjects were finishing professional development opportunities. Given that individuals are more apt to feel inspired and by implication, more efficacious, at the end of an educational experience,

additional research a period of time after the emotional effects of coursework would be helpful to determine longer-term effects of development. What is actually remembered from the enrichment? What lessons have been learned which help to support higher levels of efficacy in the future? What is the connection to future burnout?

Several studies, as with Hannula, Kaasila, Laine, & Pehkonen (2005), lacked clearly defined terms in assessing efficacy beliefs. By ascribing emotionally charged labels to individuals (as with the dichotomous "Diligent" versus "Lazy" in Hannula, et al, 2005), it becomes clear to both reader and subject that the wording adds an additional set of emotional connotations and thereby variables to poorly defined or incorrectly ascribed terminology. By being clear with wording or using previously established Likert-scale instruments, future researchers would not create such issues. Seegers and Boekaerts (1996) additionally ascribed "intelligence" to certain subjects based on results, and further clarification about what was actually meant by the term would have been helpful given the controversy of incremental theories of intelligence outlined in Chapter Two.

Eccles, Feldbaufer, & Midgley (1989) conducted a study that was typical of many examined in this paper, in which the student and teacher populations of the subjects assessed were predominantly white and of middle-income. In order to better serve the diverse body of students utilizing the public education system in the United States, it seems that research about efficacy beliefs and achievement which features more representative populations would be necessary for results to truly be generalizable. While most studies referred to the notion that students with low socioeconomic status were traditionally assumed to be contributors to lower levels of teacher satisfaction and self-efficacy, the only study that directly addressed this issue was Hoy, Hoy and Goddard

(2000). Their research indicated much higher levels of self-efficacy for teachers who taught in schools that served students with predominantly low socioeconomic status.

Additionally, research conducted within the United States seemed to be centered predominantly in the mid-western region and a diversity of state location would be helpful in assessing the needs and corresponding solutions for teachers and students in a different place in the country. Teachers in rural areas in the South are likely to face different challenges from those who teach in urban New England, however the research critiqued for this review seemed to make the assumption that teachers faced semi-universal challenges and whose self-efficacy could be improved by generally blanket methods. More research that looked into the regional differences on the expectations placed on teachers would be helpful in determining generalizability for methods used to increase efficacy.

Because the studies featured in Chapter Three focused more heavily on the efficacy beliefs of women than of men, further research would be interesting to learn whether there is a gender difference in math efficacy development just as there appears to be a difference in math efficacy beliefs. While searching for studies to compile, there did not appear to be any which focused predominantly on men with regard to math efficacy development. While elementary education is a female-dominant field, the gender balance in middle level mathematics is much different. Research which focused further on gender issues with regard to teacher's math efficacy would be helpful in preparing to meet the needs of all students in a classroom, in addition to the females focused on through the studies featured here.

Several of the studies in Chapter Three incorporated mixed methods, elements of both quantitative and qualitative data taking. Further research which incorporated these methods would be helpful in that the research would be a balance of scientific (or sociological) analysis and human contact. Despite the face that Philippou and Constantinos (1998) interviewed select students who had strikingly different efficacy levels between their pre- and post-assessments, the outliers, it would be interesting to additionally have interviewed more typical subjects. In the interests of transparency, it would be better to also assess subjects with more "normal" impact to seek out any other hidden variables which might have affected the group at large. For instance, students in this study took three methods courses over the course of three years and were only assessed twice for their levels of math self-efficacy. Three years of education is a significant time to wait between assessments and while it would have been better to test subjects (or at least interview them) more regularly. It also seems logical to connect with some of those students showing more typical or average results to rule out the possibility of many other hidden, unknown variables which could have arisen in three years.

Additionally tied to the history of education is the idea that more research needs to be done to positively connect teacher efficacy to student achievement to ground the importance of the issue. If creating globally competitive students is as important as outlined in Chapter Two, it seems that for efficacy development to become a priority, especially with regard to mathematics, more research needs to be conducted to definitively connect achievement to the personal and collective efficacy of teachers and schools.

## Conclusion

In conclusion, Chapter One outlined the motivating questions for the research investigated in Chapter Three. Because efficacy was demonstrated to be connected to outcome expectancy and the amount of effort an individual exerts in the face of difficulty, math teachers who demonstrate higher levels of teaching efficacy are desired to maximize potential student learning and positive academic efficacy development. Chapter Two outlined the historical basis for the "Math Wars," beginning with Dewey and Thorndike. The mechanized education and international educational competition pervasive post-Sputnik were discussed in relation to the development of Social Learning Theories, the debate of computation versus mathematical thinking, issues of detracking, and ability theories. Chapter Three the documented relationship between teacher efficacy and student achievement, the pervasive gender issue with math self-efficacy found as early as elementary school, methods which have shown positive increases in both the preservice and inservice teaching populations, and leadership styles paired with school-wide reform that increase the collective efficacy of a professional educational community. Chapter Four addressed major findings in each of the studies, their applicability to use in the classroom, and suggestions for further research.

Perhaps the biggest ideas to be culled from this research are the notions that professional learning communities, mentor relationships, and the opportunities to create and evaluate mastery experiences in the classroom are the most important methods to sustain high levels of teaching self-efficacy. Authentic, caring relationships with leadership and educational peers were demonstrated to be the best methods to gain

efficacy and stave off emotional and professional burnout through the course of a teaching career.

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