CHAPTER 2
REVIEW OF THE LITERATURE

Because this study has as its theoretical framework the social cognitive theory of Albert Bandura (1986), a brief overview of the theory will form the first part of this review, followed by a more thorough explanation of the role of self-efficacy. I will then examine literature dealing with efficacy beliefs and academic performance as well as studies investigating the relationship between mathematics self-efficacy and performance. I will continue with a review of literature exploring the relationship of other variables in the study to mathematics performance, to mathematics self-efficacy, and to each other and will conclude with a synthesis of findings as they relate to the major premises of this study.

Overview of Social Cognitive Theory

In 1941, Miller and Dollard proposed a theory of social learning and imitation that rejected behaviorist notions of associationism in favor of drive reduction principles. It was a theory of learning, however, that failed to take into account the creation of novel responses or the processes of delayed and nonreinforced imitations. In 1963, Bandura and Walters wrote Social Learning and Personality Development, broadening the frontiers of social learning theory with the now familiar principles of observational learning and vicarious reinforcement. By the mid-1970s, Bandura was becoming aware that a key element was missing not only from the prevalent learning theories of the day but from his own social learning theory. In 1977, with the publication of "Self-efficacy: Toward a Unifying Theory of Behavioral Change," he was at last able to identify an important piece of that missing element—self-beliefs.

In Social Foundations of Thought and Action: A Social Cognitive Theory, Bandura (1986) wrote that individuals possess beliefs that enable them to exercise a measure of control over their thoughts, feelings, and actions, that "what people think, believe, and feel affects how they behave" (p. 25). These beliefs comprise a self system with symbolizing, forethinking, vicarious, self-regulatory, and self-reflective capabilities, and human behavior is the result of the interplay between this personal system and external sources of influence. In all, Bandura painted a portrait of human behavior and motivation in which the beliefs that people have about themselves are key elements.

Social Cognitive Theory and Self-efficacy

Bandura (1986) argued that self-referent thought mediates between knowledge and action and that the capability to self-reflect is the most distinctively human characteristic, for it permits individuals to evaluate their own experiences and thought processes. Through reflection and self-evaluation, individuals can alter their own thinking and behavior. Knowledge, skill, or prior performance, Bandura claimed, are often poor predictors of subsequent performance, for the beliefs individuals hold about their abilities and about the outcome of their efforts powerfully influence the ways in which they will behave. This view is consistent with that of many researchers who have argued that the potent affective, evaluative, and episodic nature of beliefs makes them a filter through which new phenomena are interpreted and subsequent performance mediated (Abelson, 1979; Calderhead & Robson, 1991; Eraut, 1985; Goodman, 1988; Lewis, 1991; Nespor, 1987; Nisbett & Ross, 1980; Posner, Strike, Hewson, & Gertzog, 1982; Rokeach, 1960, 1968; Schommer, 1990; Underhill, 1988).
Of all self-beliefs, self-efficacy, "people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances" (Bandura, 1986, p. 391), strongly influences the choices people make, the effort they expend, how long they persevere in the face of challenge, and the degree of anxiety or confidence they bring to the task at hand. According to Bandura, how people behave can often be better predicted by their beliefs about their capabilities than by what they are actually capable of accomplishing, although this is not meant to imply that they can accomplish tasks beyond their capabilities simply by believing that they can. Rather, self-efficacy perceptions help determine what individuals do with the knowledge and skills they have. This helps explain why people's behaviors may differ widely even when they have similar knowledge and skills. Competent functioning, however, requires accuracy of perception and harmony between self-efficacy beliefs on the one hand and possessed skills and knowledge on the other.

Self-efficacy beliefs differ from outcome expectations, "judgment[s] of the likely consequence [that] behavior will produce" (Bandura, 1986, p. 391). Outcome expectations are related to efficacy beliefs because these beliefs in part determine the expectations. Individuals who expect success in a particular enterprise anticipate successful outcomes. Students confident in their mathematics skills expect high marks on related exams and expect the quality of their work to reap personal and professional benefits. The opposite is also true of those who lack such confidence. Students who doubt their mathematics ability envision a low grade before they begin a mathematics exam. The expected results of these imagined performances will be differently envisioned: academic success and greater career options for the former, academic failure and curtailed possibilities for the latter.

Bandura (1984, 1986) suggested that because the outcomes people expect are usually the result of the judgments of what they can accomplish, outcome expectations are unlikely to contribute to predictions of behavior. This is not to say that efficacy and outcome judgments are always consistent. A high sense of efficacy may not result in behavior consistent with that belief if an individual also believes that the outcome of engaging in that behavior will have undesired effects. For example, some students may realize that strong mathematics skills are essential for a good GRE score and eligibility for graduate school, and this, in turn, may ensure a prestigious career and affluent lifestyle, but low confidence in mathematics abilities may keep them away from certain courses and they may not even bother to take the GRE or apply to graduate school. Low self-efficacy and positive outcome expectations are similarly possible.

The distinction that Bandura drew between self-efficacy and outcome expectations, as well as the roles he relegated to each, are not without controversy. Kirsch (1985) argued that Bandura used the term outcome expectations in two different ways. A perceived environmental contingency, Kirsch noted, is an outcome expectation beyond the control of the individual. It is an individual's knowledge of "what leads to what" (Bandura, 1978, p. 238), such as knowing that a good score on the GRE results in graduate school admission. These outcome expectations are independent of individuals' self-efficacy beliefs or subsequent behavior. This meaning, Kirsch argued, is at odds with Bandura's (1978) claim that "the outcomes one expects derive largely from judgments as to how well one can execute the requisite behavior" (p. 241), for, in this sense, outcomes are dependent on performance and are basically the consequence of efficacy beliefs and behavior.

Some researchers find the distinction between the two constructs ambiguous and suggest that outcome expectations cannot so easily be extricated from efficacy beliefs (e.g., Eastman & Marzillier, 1984; Kazdin, 1978; Manning & Wright, 1983; Marzillier & Eastman, 1984; Teasdale, 1978). They contend that judgments of capability to perform a specific task are dependent on and inextricably intertwined with perceptions of the outcomes envisioned by actions. Therefore, outcome expectations play a much larger role in judgments of efficacy. To illustrate that Bandura oversimplified the
variables involved in behavior change, Marzillier and Eastman (1984) offered the example of a socially anxious man who is asked to attend a party. To this poor soul, the perceived outcomes are disastrous—people will notice he looks odd and laugh at him, and he will make a fool of himself, be unable to talk to anyone, and drink too much. Marzillier and Eastman argued that these expectations cannot be disassociated from efficacy judgments, that outcomes beliefs are as important in determining whether the man will attend the party as his belief in whether he can cope with the demands of the occasion. In essence, they argue that individuals infer their efficacy beliefs from imagined outcomes.

Bandura (1984) countered that such cart-before-the-horse thinking fails to take into consideration that "one cannot conjure up outcomes without giving thought to what one is doing and how well one is doing it" (p. 232). The man confronted with the decision of whether to attend the party envisions disastrous outcomes precisely because he has little confidence in his capabilities to meet the environmental demands associated with party attendance. Foresightful action requires a causal ordering wherein "human causal thinking places actions before the outcomes that flow from them" (p. 237). It is unlikely, for example, that our partyphobic man, when faced with the decision of whether to attend, envisions the disastrous outcomes and concludes that he is an inefficacious partygoer. More likely, the perceived self-inefficacy creates the envisioned outcomes. It is even possible, Bandura argued, to exclude considerations of outcome from judgments of personal efficacy. For example, students are capable of assessing their mathematics capabilities quite apart from any outcomes they may envision. Eastman and Marzillier (1984) remained "dissatisfied and unconvinced" (p. 257).

Bandura (1984, 1986) maintained that self-efficacy is generally a better predictor of behavior than either outcome expectations, prior performance, or other forms of self-knowledge. These constructs, along with knowledge and skill, act in partnership with self-efficacy, and adequate and satisfactory explanations of behavior cannot be had without considering the role that each may play in human decision-making and functioning. "Expectation alone," wrote Bandura (1977) "will not produce desired performance if the component capabilities are lacking" (p. 194). For example, some students may be highly confident of their mathematical ability, but, if the outcomes they expect are dismal (a poor job market, strong competition for the few jobs available), it is doubtful they will behave in concert with their efficacy beliefs. Conversely, low self-efficacy may be overcome by valued outcomes and potential rewards. If individuals lack necessary skills, no amount of self-efficacy will bring about the desired performance, but increased effort, persistence, and perseverance may lay the foundation for skill improvement and better subsequent performance. Regardless of scenario, self-efficacy will ultimately mediate the effects of its conceptual partners—changes in performance are ultimately affected by changes in self-efficacy.

Few researchers have compared the predictive power of self-efficacy versus that of outcome expectations, but those who have offer contradictory findings. Manning and Wright (1983) found that self-efficacy was a stronger predictor of the perceived need for pain medication during childbirth, whereas Maddux, Norton, and Stoltenberg (1986) reported that outcome expectations were the stronger predictor of behavioral intentions. Bandura (1989, 1991) suggested that such discrepant findings are usually the result of confounding between the constructs and measures. He urged researchers to develop instruments and techniques that clearly differentiate between the constructs and to operationalize and measure them in a manner consistent with their conceptual distinctions.
How Self-beliefs Affect Behavior

Bandura (1986) wrote that self-beliefs affect behavior in three ways. First, they influence *choice of behavior*. People engage in tasks in which they feel competent and confident and avoid those in which they do not. Second, self-beliefs help determine how much effort people will expend on an activity and how long they will persevere—the higher the sense of efficacy, the greater the effort expenditure and persistence. This function of self-beliefs helps create a type of self-fulfilling prophecy, for the perseverance associated with high efficacy is likely to lead to increased performance, which, in turn, raises sense of efficacy, whereas the giving-in associated with low efficacy limits the potential for improving self perceptions (see Bandura & Cervone, 1983, 1986). Self-beliefs also affect behavior by influencing individuals' *thought patterns and emotional reactions*. People with low efficacy, for example, may believe that things are tougher than they really are, a belief that fosters stress and narrow vision of how best to solve a problem and, of importance to this study, a belief that creates anxiety and lowers feelings of self-worth. High efficacy, on the other hand, creates feelings of serenity in approaching difficult tasks, lowers anxiety, and raises self-esteem.

Perceptions of efficacy help determine how individuals think, feel, and behave, and people actively use these beliefs to influence their own behavior. Subsequent results inform and alter their environment and self-beliefs which, in turn, inform and alter their behavior. This is the foundation of Bandura’s (1986) concept of *reciprocal determinism*, the view that behavior, environmental influences, and cognitive and other personal factors (self-beliefs) create interactions that result in a *triadic reciprocity*. Social cognitive theory recognizes humans as producers rather than simply foretellers of behavior. Self-confidence can breed success that breeds more challenging performance; self-doubt may breed hesitancy, defeat, and failure to try.

Bandura (1986) noted that, although the relationship between self-beliefs and behavior is reciprocal, this "coeffect" need not be studied simultaneously. "It is important to understand how certain determinants produce change in the first place, regardless of how the resultant changes, in turn, affect the subsequent operation of the determinants" (p. 28). That is, self-efficacy beliefs and other variables influence choice and performance of a task, and these behaviors may alter self-efficacy percepts and other determinant variables, but the study of influences at any point along the continuum aids in testing and refining theoretical concerns. Bandura noted that the study of initial and reciprocal effects are separable and that exploring each is necessary for a fuller understanding of human functioning. My investigation explored initial effects—the influence of certain variables on performance but not the subsequent effect of performance on these variables. This is a theoretically sound approach with which to explore the mediational role of self-efficacy.

The Relationship Between Self-efficacy and Performance

Human behavior is influenced by many factors. Bandura wrote that self-efficacy beliefs are strong predictors of related performance when they are in harmony with other variables such as knowledge and skills, outcome expectations, the perceived value of outcomes, and other self-beliefs. The mediational role of self-efficacy in human behavior is complex, however, and affected by factors that have direct implications for efficacy and performance assessment. There may be disincentives and performance constraints; that is, even highly efficacious and well-skilled people may choose not to behave in concert with their beliefs and abilities because they simply lack the incentive to do so. Low stakes performance requirements may act as just such a disincentive. If individuals believe that
the task they are asked to perform has little meaning for them, then their reported efficacy judgments may inaccurately predict performance.

It is not unusual for individuals to over- or underestimate their abilities and suffer the consequences of such errors of judgment. These consequences of misjudgment play a part in the continual process of efficacy self-appraisals. When consequences are slight or nonexistent, individuals may not feel the need to reappraise their capabilities. In such situations, the relationship between efficacy and performance may be muddled by inaccurate self-perceptions and misjudgment of skills. Students who have abandoned the pursuit of mathematics, for example, are unaffected by subsequent mathematics-related performances, and this results in faulty future self-appraisals. The degree of relationship between efficacy and action is also affected by temporal disparities. Strong efficacy beliefs are generally the product of time and multiple experiences and hence are highly resistant and predictable. Weak efficacy beliefs, however, require constant reappraisal if they are to serve as predictors. In each case, self-efficacy and performance must be assessed in close temporal proximity.

When exploring the relationship between efficacy and performance, one must be careful to measure the beliefs relevant to the performance in question, and vice-versa. Faulty assessment of self-percepts or performance will create ambiguous relationships. It is also important to know the precise nature of the skills required to successfully perform a particular behavior, for misweighting requisite subskills results in discrepancies between efficacy and performance. The problem is worsened when individuals are called on to make efficacy judgments about their own cognitive skills. Similarly, when people are uncertain about the nature of the task, efficacy judgments can be misleading. Tasks perceived as more difficult than they really are result in inaccurate low efficacy readings, whereas those perceived as less difficult may result in overconfidence.

The interplay among these factors, other self-beliefs, knowledge and skill, previous experience, and self-efficacy may create situations in which self-efficacy is clearly not the most important influence on or especially predictive of subsequent behavior (Schunk, 1991). However, Bandura hypothesized that, because self-efficacy mediates the effect of other determinants of behavior, when these determinants are controlled, self-efficacy judgments are better predictors of choice and direction of behavior. It is important that the relationship between self-efficacy and performance be properly assessed, however, and the problems identified by Bandura were carefully considered when designing this investigation.

Sources of Self-efficacy Information

The case for the contextual and mediational role of efficacy in human behavior can also be made by exploring the four sources from which these beliefs are developed. Enactive attainment, the result of purposive performance, is the most influential source. Simply put, individuals gauge the effects of their actions, and their interpretations of these effects alter their efficacy beliefs. Success raises self-efficacy and failure lowers it. But the contextual filter is again at work, for once experience and success have created a strong sense of efficacy, failure is unlikely to affect it. In agreement with Nisbett and Ross's (1980) conception of a perseverence phenomena, Bandura wrote that individuals engage in whatever cognitive tricks are required to maintain certain beliefs. Self-efficacy beliefs also tend to generalize from one experience to another, with the danger that skills from a former experience are not always relevant to a later one.

Bandura's emphasis that enactive attainment is the most influential source of self-efficacy information has important implications for the self-enhancement model of academic achievement (Gorrell, 1990). Proponents of self-concept theory have maintained that, to increase achievement,
educational efforts should focus on raising students' feelings of self-worth. This is usually accomplished through programs that emphasize building self-esteem through verbal persuasion methods (see Marsh & Richards, 1988). Social cognitive theory shifts that emphasis and focuses on a joint effort to raise competence and confidence through successful experience with the performance at hand, through "authentic mastery experiences" (Bandura, 1986, p. 399).

The second source of efficacy information is vicarious experience of the effects produced by the actions of others. This source of information is weaker than enactive attainment, but, when people are uncertain about their own abilities or have limited prior experience, they become more sensitive to it. The effects of modeling are particularly relevant in this context. Bandura (1986) argued that "even the self-assured will raise their perceived self-efficacy if models teach them better ways of doing things" (p. 400). A number of studies by Schunk and his associates have demonstrated that children's self-efficacy and performance can be raised through various modeling techniques (Schunk, 1981, 1983, 1987; Schunk & Gunn, 1985; Schunk & Hanson, 1985; Schunk, Hanson, & Cox, 1987).

Verbal persuasion involves exposure to the verbal judgments of others and is a weak source of efficacy information, but persuaders can play an important part in the development of an individual's self-beliefs. Bandura suggested that the judgments of others are more likely to undermine efficacy beliefs than to enhance or create them. Last, physiological states such as anxiety, stress, arousal, fatigue, and aches and pains also provide information about efficacy beliefs.

The information that individuals use to gauge their sense of efficacy must be processed and interpreted. This cognitive processing of self-efficacy information influences final judgments of efficacy and involves two components. The first is the type of information, of the kinds previously listed, that individuals are likely to consider and use in forming their sense of efficacy. The second concerns the heuristics they use to weigh and blend such information into final judgments. In other words, individuals arrive at a sense of efficacy after interpreting the sources of information available to them—prior experience, other self-beliefs, emotional reactions, knowledge, skills, criterial task. The many possible interpretations make assessing efficacy beliefs and predicting performance an imposing challenge. Also, when forming efficacy judgments, people have to deal not only with different configurations of efficacy-relevant information conveyed by a given modality, but they also have to weigh and integrate efficacy information from these diverse sources. The weights assigned to different types of efficacy information may vary across different domains of activity. (Bandura, 1986, p. 409)

Others have also argued that the influence of beliefs on behavior must be assessed by exploring the centrality of the beliefs in question and their connectedness to other beliefs in an individual's belief system (Kitchener, 1986; Lewis, 1990; Nespor, 198; Nisbett & Ross, 1980; Posner et al., 1982; Rokeach, 1968). Bandura (1986) noted that little research has been done on how people process multidimensional efficacy information, that is, on how they assess the priority of their beliefs and process the connections among them. This study investigated these connections and explored whether self-efficacy beliefs are more central to an individual and mediate the effect of other beliefs and experiences on performance.

The tenets of social cognitive theory have been tested in varied disciplines and settings. Self-efficacy has been the focus of studies on clinical problems such as phobias (Bandura, 1983; Bandura, Adams, & Beyer, 1977), depression (Bloom, Yates, & Brosvic, 1983; Davis & Yates, 1982), social skills (Moe & Zeiss, 1982), and assertiveness (Lee, 1983, 1984; Maddux, Sherer, & Rogers, 1982);
on smoking behavior (DiClemente, 1981; Garcia, Schmitz, & Doerfler, 1990; Maddux & Rogers, 1983); on pain control (Manning & Wright, 1983; Neufeld & Thomas, 1977); on health (Beck & Lund, 1981; O'Leary, 1985); and on athletic performance (Barling & Abel, 1983; Feltz, 1982; Lee, 1982).

Self-efficacy has also been prominent in studies of psychological and educational constructs such as attributions of success and failure (Collins, 1982; Hackett & Campbell, 1987; Relich et al., 1986; Schunk, 1982a, 1989; Schunk & Cox, 1986; Schunk & Gunn, 1986), goal setting (Locke & Latham, 1990; Wood & Bandura, 1989), social comparisons (Bandura & Jourden, 1991), memory (Berry, 1987), problem solving (Larson, Piersel, Imao, & Allen, 1990), career development (Betz, 1978; Betz & Hackett, 1981, 1983; see Lent & Hackett, 1987, for a review), and teaching and teacher education (Ashton & Webb, 1986; Gibson & Dembo, 1984; Woolfolk & Hoy, 1990; Woolfolk, Rosoff, & Hoy, 1990). In general, researchers have established that self-efficacy beliefs and behavior changes and outcomes are highly correlated and that "self-efficacy is an excellent predictor of behavior" (Maddux et al., 1986, p. 783). In spite of the construct's assumed predictive power, however, research on the relationship between self-efficacy and academic performance is, although growing, still limited (Bouffard-Bouchard, 1989).

Self-efficacy and Academic Performance

Bandura (1977, 1982, 1984, 1986, 1991) consistently has argued that the confidence one brings to a specific task mediates the effect of other variables on performance and is a strong predictor of the behavior related to that task. Researchers have generally supported Bandura's claims, although most studies are plagued by assessments of self-efficacy that do not conform to his guidelines regarding specificity of measurement. Faulty assessment is often responsible for ambiguity, confounded relationships, and contradictory findings. In the area of academic achievement, for instance, most researchers agree that efficacy beliefs are related to and predictive of academic performance, both in a global academic sense and in terms of specific subject areas. Felson (1984) studied students' self-appraisals of ability and, although he labeled them as a form of academic self-concept, used path analysis to find that they had a strong direct effect on both effort expenditure and academic performance (GPA). Wood and Locke (1987) examined the relationship between efficacy beliefs and the grades of college students and found that, even when ability was controlled, the direct effect was moderate but significant (.27). They suggested that one reason for such a moderate relationship may have been that efficacy was assessed two months before the outcome measure.

Lent, Brown, and Larkin (1984) found that the efficacy beliefs of students participating in a science and engineering 10-week career planning course were related to their grades and persistence during the following year. Students with higher efficacy received higher grades and persisted longer in related majors. These findings were obtained in spite of self-efficacy being globally assessed by asking the students to indicate whether they could successfully perform the job duties associated with and complete the educational requirements of 15 science and engineering fields. This assessment was then compared with college GPA. In a subsequent study, Lent, Brown, and Larkin (1986) developed a self-efficacy measure to more specifically assess the confidence of 105 undergraduates to successfully perform specific tasks considered critical to academic success in science and engineering courses. Lent et al. (1986) reported that scores on this measure were strongly related to GPA and persistence, and regression analyses revealed that self-efficacy added significant unique variance beyond previous achievement measures (math PSAT score and high school rank). Lent et al. (1986)
underscored, however, the need for "studies demonstrating a causal relationship" (p. 268) between self-efficacy and related academic performance.

Brown, Lent, and Larkin (1989) later studied the relationship between the academic self-efficacy, academic aptitude, and grades of the same undergraduates and found that two measures of self-efficacy were related to academic outcomes (GPA and persistence). One form of efficacy was related to academic achievement regardless of the aptitude involved; another moderated the relationship of aptitude and academic performance. Bores-Rangel, Church, Szendre, and Reeves (1990) studied high school equivalency students and found that academic self-efficacy, although inappropriately defined as confidence to successfully perform 69 occupational activities, was correlated with final GED test scores (.41).

Locke, Frederick, Lee, and Bobko (1984) conducted an experiment in which they asked 209 undergraduates to list different uses for common objects. After a practice trial, they manipulated three conditions: A high strategy group was trained to use three methods to increase responses, a low strategy group was simply told to provide good or high-quality ideas rather than "crazy and far out" (p. 242) uses, and a control group received no training. During seven trials, they recorded the number of uses the students were able to provide. Locke et al. reported that self-efficacy was more strongly correlated with subsequent performance (.61) than was prior ability as measured during the practice session (.47). Using path analyses, they reported that "the most unexpected finding . . . was the very powerful effect of self-efficacy even with ability and past performance controlled" (p. 24). Self-efficacy directly affected task performance (.20) and choice of goal (.44) and mediated the effects of ability, strategy training, the number of strategies used, and a post-training performance (the score after the fourth trial). They concluded that the results provided "very strong support to Bandura's (1982) claim that self-efficacy is a key causal variable in performance and show that its effects on performance are not only direct but indirect as well" (p. 24).

Vollmer (1986a) studied the perceived ability and expectancy beliefs of 267 undergraduates. Perceived ability was defined as confidence to succeed academically; expectancy was defined as the expected grade the students believed they would earn in a psychology course. Both were basically global assessments of self-efficacy. Using path analyses with relationships hypothesized by effort calculation theory, Vollmer found that, with previous grades, amount of time spent preparing for the exam, and perceived ability in the model, expectancy had a direct effect on subsequent course grade (.246). Interestingly, Vollmer did not find support for his hypothesis that expectancy would determine grades through effort expenditure, as those variables were only weakly related. Self-confidence and expectancy were, of course, significantly related. The separation of the efficacy measures, their global assessment, and the different theoretical orientation and subsequent hypothesized causal ordering make additional interpretations difficult.

Some researchers have studied the relationship between self-efficacy/outcome beliefs and specific academic performances. Shell et al. (1989) constructed measures of reading and writing efficacy and outcome expectations and administered them to 153 undergraduates. They reported a significant relationship between self-efficacy and performance but not between outcome expectations and performance. One interesting result is worth noting. Similar to the present study, self-efficacy was the composite score of two subscales, one measuring students' confidence that they could perform specific tasks and another that they possessed specific reading or writing skills. These scales parallel the tasks and problems efficacy scales used in the present study. Writing performance was measured with a 20-minute holistically scored essay and reading performance with a reading comprehension instrument. The criteria for each were similar to the skills on which the skills self-efficacy subscales were based. In both cases, Shell et al. found that the skills subscales had significantly stronger
correlations with performance (.53 reading, .32 writing) than the task subscales (.30 reading, .17 writing).

Using procedures and instruments similar to those of Shell et al. (1989), Pajares and Johnson (1992) reported that a multiple regression model consisting of writing self-efficacy, writing outcome expectations, writing apprehension, global self-efficacy, and a pre-performance writing measure accounted for 68% of the variance in the writing performance of undergraduates. Although writing self-efficacy and writing apprehension were significantly correlated (.50), apprehension did not account for a significant portion of the variance accounted for in the model. Like Shell et al., they also found that writing skills efficacy was more strongly correlated with performance (.53) than was writing tasks efficacy (.11). Findings from both studies support Bandura's (1986) contention that efficacy must be measured in ways that correspond to the criterial task.

McCarthy, Meier, and Rinderer (1985) defined writing efficacy as students' self evaluation of their own writing skills, constructed an instrument that identified and defined 19 writing "skills," and asked students to indicate whether they could demonstrate the skills (e.g., "Can you write sentences in which the subjects and verbs are in agreement?"). They administered this efficacy instrument, an anxiety measure, a questionnaire to assess locus of control orientation, and a cognitive processing inventory. Writing performance was measured from student essays by four expert raters. Two studies were conducted with the same subjects, and McCarthy et al. found that writing self-evaluations, what Shell et al. (1989) had operationalized as writing skills efficacy, were correlated with writing performance on both studies (.33).

Bouffard-Bouchard (1989) assessed the influence of self-efficacy judgments on the cognitive performance of Canadian college students who were presumed to have the same knowledge and experience of a verbal task. She first induced low and high self-efficacy experimentally by providing negative or positive evaluations to a verbal task performance and thereby created low-efficacy and high-efficacy groups. Students in the positive feedback condition judged they could solve more problems and anticipated greater success than negatively evaluated students. Each group was then asked to complete an experimental task that involved identifying a target word in a sentence in which that word had been replaced by a nonsense word. High-efficacy students used half the number of trial words required by the low-efficacy students to find the correct response, persisted longer, and completed and solved more problems.

Not all researchers have found a significant relationship between efficacy beliefs and academic outcomes. Wilhite (1990) found that college students' self-assessment of memory ability was the strongest predictor of academic achievement (GPA), followed by locus of control. Self-efficacy showed a weak relationship. However, efficacy was measured using Brookover's Self-Concept of Academic Ability Test (Brookover, Erickson, & Joiner, 1967), a global self-concept measure, and the self-assessment of memory ability scale may, in fact, have been an efficacy of memory or cognitive style scale. Neither instrument nor sample items were provided. Smith, Arnkoff, and Wright (1990) used hierarchical multiple regression to test the predictive power of three theoretical models on academic performance. The models were cognitive-attentional, cognitive-skills, and social learning. Smith et al. concluded that, although variables within each model predicted performance to some degree, self-efficacy and outcome beliefs were weak predictors. Self-efficacy, however, was operationalized as study skills or test-taking ability and was measured with items such as "Rate how certain you are that you can study at a time and place where you won't get distracted." This was compared with academic outcomes such as course and exam grades and GPA. When efficacy beliefs do not reflect with specificity the criterial task, they are unlikely to prove predictive.
Some researchers suggest that self-efficacy is related to self-regulated learning variables (Feather, 1988; Fincham & Cain, 1986; Paris & Oka, 1986; Pokay & Blumenfeld; 1990; Schunk, 1985). Findings in this area suggest that students who believe they are capable of performing certain tasks use more cognitive and metacognitive strategies and persist longer than those who do not. For example, Pintrich and De Groot (1990) reported a correlation between global academic self-efficacy and both higher levels of cognitive strategy use (.33) and higher levels of self-regulation through use of metacognitive strategies (.44) in a sample of 173 seventh graders. Test anxiety was significantly correlated with self-efficacy (-.34) but not with the learning variables. In addition, academic self-efficacy was correlated with academic outcomes such as first semester grades (.34), in-class seatwork and homework (.19), exams and quizzes (.24), essays and reports (.25), and second semester grades (.36). A multivariate analysis of variance (MANOVA) revealed that self-efficacy was also significantly predictive of final grades (partial $r = .18$). Students' perceived importance of academic achievement was associated with the outcome variables but was not a significant predictor on the MANOVA. Pintrich and De Groot concluded that self-efficacy played a mediational or "facilitative role" (p. 37) in relation to cognitive engagement, that improving self-efficacy might lead to increased use of cognitive strategies and, thereby, higher performance, and that "students need to have both the 'will' and the 'skill' to be successful in classrooms" (p. 38).

A growing number of findings support Bandura's contention that efficacy beliefs mediate the effect of possessed skills or other self-beliefs on subsequent performance by influencing effort, persistence, and perseverance (see Schunk, 1991). For example, Collins (1982) identified children of low, middle, and high mathematics ability who had, within each ability level, either high or low mathematics self-efficacy. After subsequent instruction, the children were given new problems to solve and an opportunity to rework those they missed. Collins reported that ability was related to performance but that, regardless of ability level, children with high self-efficacy completed more problems correctly and reworked more of the ones they missed. Schunk (1981) used path analysis to show that modeling treatments increased persistence and accuracy on division problems by raising children's self-efficacy, which had a direct effect on skill (.46). He later demonstrated that effort attributional feedback of prior performance (e.g., "You've been working hard") raised the self-efficacy expectations of 40 elementary school children, and this increase was, in part, responsible for increased skill in performance of subtraction problems (Schunk, 1982a). In subsequent experiments, he found that ability feedback (e.g., "You're good at this") had an even stronger effect on self-efficacy and subsequent performance (Schunk, 1983; Schunk & Gunn, 1986). Relich et al. (1986) also used path analysis to show that self-efficacy mediated the role of skill training and attributional feedback and had a direct effect (.40) on the performance of division problems of 84 learned helpless sixth graders. Attribution showed a moderate direct effect on performance and a stronger indirect effect mediated by self-efficacy. Schunk (1991) provided an overview of research on the effect of self-efficacy beliefs on academic motivation, specifically the role played by variables such as perceived control, outcome expectations, perceived value of outcomes, attributions, and self-concept. He concluded that all are a "type of cue" (p. 211) used by individuals to assess their efficacy beliefs.

Multon et al. (1991) found only 68 published and unpublished papers written between 1977 and 1988 on the relationship between self-efficacy and academic performance or persistence. Of these, only 36, encompassing 4,998 subjects (61% elementary school children, 29% college students) assessed academic performance and met their criteria for inclusion in a meta-analytic investigation: containing a measure of self-efficacy and academic performance and providing sufficient information to calculate effect size estimates. They computed that efficacy beliefs were related to performance
(d = .38) and accounted for approximately 14% of the variance in academic performance. However, effect sizes depended on specific characteristics of the studies, such as the time period during which the variables were assessed, students' achievement status, subjects' age, and the type of performance measure used. For example, effects were stronger for high school (d = .41) and college students (d = .35) than for elementary students (d = .21). How the constructs were operationalized also influenced findings. Effects were stronger when performance was assessed with basic skills measures (d = .52) or classroom-based indices such as grades (d = .36) than with standardized achievement tests (d = .13), a finding that supports the context-specific nature of self-efficacy beliefs.

As already noted, Bandura (1986) cautioned that self-efficacy judgments must be specifically rather than globally assessed, must correspond directly to the criterial task, and must be measured as closely as possible in time to that task. Multon et al. (1991) discovered that the strongest effects were obtained by researchers who compared specific efficacy judgments with basic skills measures of performances, developed highly concordant self-efficacy/performance indices, and administered them at the same time. These procedures were followed in the present study. Interestingly, effects are obtained even with more global efficacy measures and standardized achievement tests, a phenomenon that Multon et al. describe as reinforcing "the theoretical and practical value of attending to students' self-efficacy beliefs" (p. 35).

**Self-efficacy and Mathematics Performance**

Confidence in learning mathematics and the perceived usefulness of mathematics, conceptual forerunners to mathematics self-efficacy and outcome expectations, have consistently been found to predict mathematics-related behavior and performance (Hackett, 1985; Reyes, 1984). Usually, however, mathematics confidence has been assessed globally by asking students general questions about their perceived mathematics abilities. These global measures cannot properly be called mathematics self-efficacy, however, as this construct must be assessed in terms specific to the criterial task. It is for this reason that research findings on mathematics confidence obtained prior to Bandura's guidelines for self-efficacy assessment must be carefully interpreted, even though they were important in establishing the first confidence/performance relationships. Correlations in these studies ranged from as low as .20 to as high as .72 (e.g., Aiken, 1970a, 1970b, 1972, 1974; Armstrong, 1980; Crosswhite, 1972; Fennema & Sherman, 1976, 1977, 1978; Hendel, 1980; Sherman, 1980; Sherman & Fennema, 1977; Smead & Chase, 1981).

Mathematics self-efficacy has more recently, and more accurately, been assessed in terms of individuals' judgments of their capabilities to solve specific mathematics problems, perform mathematics-related tasks, and succeed in mathematics-related courses (Betz & Hackett, 1983). The growing career literature (see Lent & Hackett, 1987, for a review) is especially concerned with the latter judgments. There is little research on the relationship between mathematics self-efficacy and mathematics problem-solving, however, and research investigating this relationship in a manner consistent with the tenets of social cognitive theory is almost nonexistent. What few findings have been reported generally support Bandura's contentions and suggest a correspondence.

Dowling (1978) was the first researcher to create a mathematics self-efficacy measure to specifically correspond with a mathematics problem-solving assessment. Drawing from mathematics problems created for the National Longitudinal Study of Mathematical Abilities (NLSMA), she developed an 18-item Mathematics Confidence Scale (MCS) and an alternate-tests performance scale. Dowling administered the instruments to 121 undergraduates and obtained a correlation of .54
between self-efficacy and performance, a significantly higher figure than that reported by most previous researchers assessing global mathematics confidence.

Betz and Hackett (1982, 1983) later created the Mathematics Self-Efficacy Scale (MSES) and the Mathematics Problems Performance Scale (MPPS), instruments similar to those used in the present study. Hackett and Betz (1989) administered them to 262 undergraduates and reported a correlation of .44, not as large as they had hypothesized. However, the MSES included two subscales not used by Dowling (1978). The mathematics tasks scale asked students to rate their confidence to perform specific mathematics-related tasks such as balance a checkbook; the mathematics courses scale asked them to rate their confidence that they could receive a B or better in 16 mathematics-related college courses such as statistics and accounting. Betz and Hackett (1983) created these subscales in the belief that mathematics self-efficacy required "detailed specification of the domain of mathematics-related behavior" (p. 331) and that these domains included the solving of mathematics problems, the mathematics behaviors used in daily life, and, of particular relevance to college students, satisfactory performance in a college course. The researchers defined mathematics self-efficacy as the composite score from the three scales. Correlations between the subscales and performance ranged from .39 to .49, but Hackett and Betz did not report which scores corresponded to which subscales.

It is not surprising that Hackett and Betz (1989) obtained a lower correlation between self-efficacy and performance than had Dowling. Social cognitive theory requires that efficacy assessment specifically correspond to the criterial task. Therefore, it is not especially useful to compare self-efficacy judgments regarding accomplishing mathematics-related tasks or successfully completing mathematics-related courses with a performance measure that requires the solving of mathematics problems. It is for this reason that I hypothesized that the mathematics problems scale would have a significantly stronger relationship with mathematics solving-problem performance than either the mathematics tasks or courses scales.

Hackett and Betz (1989) also reported that most students either overestimated or underestimated their mathematics performance capability. For example, 54% of the men (N = 109) and 44% of the women (N = 153) overestimated their capability, and 16% of the men and 18% of the women underestimated. Only 29% of the men and 39% of the women fell in the congruent category. Hackett and Betz posited that this tendency toward inaccurate judgments, coupled with the moderate correlations between self-efficacy and performance, suggests that correspondence between judgment and performance in mathematics may be more complex and weaker than in other areas of achievement.

In the series of studies noted earlier, Schunk and his associates found that self-efficacy predicted mathematics performance (Bandura & Schunk, 1981; Schunk, 1981, 1982a, 1982b, 1983). Although the focus of these investigations was not the correspondence between mathematics self-efficacy and mathematics performance, Schunk reported that significant correlations were consistently observed. Reviewing the studies, Schunk (1984) noted that "regardless of the treatment condition, children's self-efficacy judgments bore a strong positive relationship to their subsequent demonstrated skills" (p. 54). Norwich (1986) found that mathematics self-efficacy had a significant relationship with both mathematics performance and mathematics self-concept, although a subsequent investigation revealed that this relationship was more complex than he initially thought. In a study previously discussed, Collins (1982) found that, when ability was controlled, children with high self-efficacy outperformed children with low self-efficacy in the completion of novel mathematics problems. The children with high self-efficacy exhibited greater effort and persisted longer in reworking incorrect problems.
Siegel, Galassi, and Ware (1985) contrasted a social learning model and an anxiety/aptitude model to explain mathematics performance. The social learning model included measures of self-efficacy, outcome expectations, and skills (prior mathematics grades); the anxiety/aptitude model included the quantitative score of the Scholastic Aptitude Test (SAT-Q) and a measure of mathematics anxiety. Participating were 143 college students enrolled in an introductory mathematics course. Siegel et al. conducted a priori ordered multiple regression analyses and found that the social learning model accounted for a larger portion of the variance (55%) than the anxiety/aptitude model (16%), although, in the social learning model, prior mathematics grades accounted for the lion's share of variance (49%), with self-efficacy adding a significant but very modest 2%. Siegel et al. suspected that defining skills as prior mathematics grades was inappropriate and may have artificially inflated the variance "owing to the way that the skills variable was measured" (p. 535). A revised social learning model, with the SAT-Q as the skills variable, accounted for 29% of the variance, with self-efficacy being the strongest predictor (13%).

Goolsby, Dwinnell, Higsby, and Bretscher (1987) followed the mathematics progress of 118 students denied regular admission to a state university for failing to meet minimum admission standards but enrolled in remedial-type classes in hopes of successful performance and subsequent admission. Goolsby et al. investigated the role of several variables as predictors of the students' performance in their remedial algebra class and reported that a variable combining mathematics confidence and anxiety was a stronger predictor of final course GPA than either prior high school mathematics grades, SAT-Q scores, or other affective measures.

Some researchers have reported a lack of relationship between mathematics self-efficacy and mathematics performance, but these studies often suffer from important conceptual and measurement flaws. Benson (1989) found that the path from what she called mathematics self-efficacy to performance was not significant, whereas that between mathematics self-concept and performance was. However, self-efficacy was assessed with three global items dealing with expected success in the class (e.g., "No matter how hard I study, I will not do well in this class"). Self-concept was assessed with seven items specific to feelings of mathematics self-worth (e.g., "I feel insecure in a math class"). Performance was the mid-term exam grade in a statistics course. Benson concluded that "additional studies need to be conducted to verify the relationship between mathematics self-concept and self-efficacy and to explore why self-efficacy did not influence [performance] nor statistical test anxiety" (p. 259). The answer was self-evident—comparing confidence to succeed in a class with a statistics mid-term grade is not likely to produce the sort of correspondence that social cognitive theory hypothesizes.

Other studies suffer from similar problems. Although Cooper and Robinson (1991) found a low but significant correlation between mathematics self-efficacy and performance (.22), a regression model with mathematics anxiety, the quantitative score on the American College Test (ACT-Q), and prior mathematics experience revealed that self-efficacy did not account for a significant portion of the variance in mathematics performance. Here again, self-efficacy assessment was poor. Cooper and Robinson used scores from the mathematics courses subscale of the MSES and compared them to scores on a performance measure that consisted of solving problems from the Missouri Mathematics Placement Test. One could continue to point out, ad nauseam that, as Bandura (1986) warned, "ill-defined global measures of perceived self-efficacy or defective assessments of performance will yield discordances" (p. 397).

Norwich (1987) reported that when the effects of mathematics self-concept were controlled, self-efficacy made no independent contribution to the prediction of a first assessment of the mathematics performance of 9- and 10-year-olds. Mathematics self-concept contributed the only
variance accounted for in the model (12%). On a second assessment, when students already had some familiarity with the task and had completed one set of mathematics problems, Norwich found that with self-concept and prior performance controlled, self-efficacy made no contribution to prediction in a model that accounted for 37% of the variance. Prior performance was the strongest contributor, and self-concept was also significant. Norwich suggested that to assume that higher self-efficacy leads to greater task initiation and persistence, and therefore attainment, is too simple and concluded that the relationship between the constructs is complex and needs additional study. However, in using hierarchical regression, Norwich entered the variables according to their assumed causal influences from a self-concept perspective, with self-concept entered first, prior performance second, and self-efficacy last. Results may have been entirely different if the order had been entered with causal assumptions hypothesized by social cognitive theory.

There is also evidence to suggest a relationship between mathematics self-efficacy and performance when this variable is operationalized as aptitude (score on a standardized achievement test). Hackett (1985) reported a correlation of .66 between ACT-Q scores and the MSES. Using path analyses, however, she discovered a strong direct effect of aptitude on self-efficacy (.576) but no effect of aptitude on either mathematics anxiety or the outcome measure, mathematics-related choice of major. She concluded that the effect of aptitude on choice and anxiety was mediated by self-efficacy. Cooper and Robinson (1991) reported a weak correlation of .25 between self-efficacy and the ACT-Q, but self-efficacy was assessed only with the courses subscale of the MSES. Using the same instruments, Lent, Lopez, & Bieschke (1991) reported .51. They also used a regression model to predict mathematics course interests and, like Hackett (1985), found that aptitude did not contribute significant incremental variance after controlling for self-efficacy. Recall that Siegel et al. (1985) found that a regression model consisting of social learning variables accounted for a significantly greater portion of the variance in mathematics performance than a model consisting of mathematics anxiety and the SAT-Q (49% to 16%). They added the SAT-Q to the social learning model to better assess the effect of aptitude and discovered that self-efficacy continued to be a stronger predictor. Similarly, Goolsby et al. (1987) reported that an affective variable incorporating a self-efficacy component was a better predictor of mathematics performance than SAT-Q scores.

Hackett and Betz (1989) reported a correlation of .57 between globally assessed mathematics confidence and scores on the ACT-Q, but, after conducting stepwise regression analyses for the prediction of mathematics-related major choices, they found that only self-efficacy was a significant predictor. Neither performance (the MPPS) nor the ACT-Q had predictive value. They concluded that "the cognitive information tapped by the assessment of mathematics self-efficacy should, theoretically, encompass the information an individual has derived from his or her own past performance, making such achievement information as ACT scores redundant if one possesses information about self-efficacy" (p. 270).

Dew, Galassi, and Galassi (1984) and Llabre and Suarez (1985) concurred, adding that aptitude assessments such as the SAT-Q are not pure measures of aptitude and are confounded by attitudinal and mathematics anxiety elements. Thus, the variance accounted for by any aptitude measure could well include self-efficacy and mathematics anxiety components. Llabre and Suarez argued that this confounding is a particularly difficult problem that has plagued both test and mathematics anxiety research. It is for these reasons that such a measure was not incorporated into the path analysis model of the present study.
Mathematics Performance and Other Variables in the Study

The variables most often found to predict mathematics-related behavior include mathematics self-efficacy, the perceived usefulness of mathematics (outcome expectations), mathematics self-concept, mathematics anxiety, gender, and prior mathematics experience (Hackett, 1985; Reyes, 1984). As earlier established, Bandura suggested that differing behaviors are mediated by a common cognitive mechanism—self-efficacy. In the preceding discussion I have attempted to establish that prior research supports the social cognitive view that mathematics self-efficacy is strongly related to mathematics performance. In the present study, prior mathematics experience and gender were hypothesized to influence both self-efficacy and performance, and the following section will establish that research findings support such a connection. In addition, Bandura hypothesized that self-efficacy mediates the effects of self-concept, anxiety and outcome expectations on performance. The following section will illustrate that researchers have generally demonstrated a relationship between the variables noted above and mathematics performance and that those who have investigated the additional influence of self-efficacy concur that these beliefs perform the function Bandura theorized.

Mathematics Outcome Expectations

Recall that Bandura (1986) posited that outcome expectations play an important role in determining choice of behavior, effort, and persistence but that this role is mediated by self-efficacy judgments, for the outcomes that individuals expect are generally a result of the confidence they bring to a task. Bandura added, however, that behavior is best predicted by considering both constructs, for "different patterns of self-efficacy and outcome beliefs are likely to produce different psychological effects" (p. 446). Outcome expectations are an important part of social cognitive theory, but few researchers have compared their effects with those of self-efficacy in studies of academic performance. When they have, they have found that these beliefs are related to performance but are weaker predictors than self-efficacy (e.g., Shell et al., 1989; Siegel et al., 1985).

Just as a form of self-efficacy was initially globally assessed as confidence in mathematics, perceived usefulness of mathematics is the conceptual forerunner to outcome expectations. Noting findings by researchers demonstrating that students' perceived usefulness of mathematics contributed to prediction of mathematics performance and related constructs (e.g., Aiken, 1970a, 1970b, 1972, 1974; Hilton & Berglund, 1974), Fennema and Sherman (1976) incorporated this construct into the Fennema-Sherman Mathematics Attitude Scales. Aiken (1974), for example, had reported that perceived importance of mathematics correlated .27 with the SAT-Q. Subsequent researchers used these and other scales to demonstrate that perceived usefulness was consistently, if moderately, related to mathematics performance (Armstrong, 1980; Armstrong & Price, 1982; Brush, 1980; Fox, Brody, & Tobin, 1980; Pedro, Wolleat, Fennema, & Becker, 1981).

Correlations in these early studies were, as was the case with mathematics confidence, moderate. Fennema and Sherman (1978) reported correlations from .10 to .24 between perceived usefulness and various performance measures, whereas confidence/performance correlations ranged from .21 to .39. Pedro et al. (1981) studied 1205 high school students enrolled in algebra and geometry classes and found that perceived usefulness was related to scores on various timed 30-minutes multiple choice tests of 40 problems. Correlations ranged from .17 to .29. More recent researchers have also found a correspondence between perceived usefulness and mathematics performance. Hackett and Betz (1989) found that perceived usefulness was significantly correlated with the MPPS (.28), a performance measure similar to that used in the present study. Siegel et al.
Note that some anxiety correlations are positive. This is due to the use of anxiety instruments that score higher for low anxiety. Therefore, a positive correlation indicates a correspondence between low anxiety and, for example, high self-efficacy or stronger performance.
Mathematics anxiety is also related to performance when this variable is defined as aptitude (score on a standardized achievement test). For example, Richardson and Suinn (1972) reported that mathematics anxiety was related to the mathematics subscale of the Differential Aptitude Test in two samples of undergraduates. Betz (1978) constructed a Mathematics Anxiety Scale (MAS) from the anxiety subscale of the Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976) to better assess the mathematics anxiety of college students. She then compared mathematics anxiety with the ACT-Q scores of 652 undergraduates and found that correlations ranged from .17 for males to .42 for females. There were also differences between the three groups she investigated—mixed ability, low ability, and high ability. Predictably, low ability students had higher mathematics anxiety than did high ability students. Early researchers reported correlations generally ranging from nonsignificance to -.53 (Hendel, 1980; Plake, Ansorge, Parker, & Lowry, 1982; Plake & Parker, 1982; Plake, Smith, & Damsteegt, 1981; Richardson & Suinn, 1972; Rounds & Hendel, 1980a, 1980b; Sherman & Fennema, 1977; Suinn, Edie, Nicoletti, & Spinelli, 1972).

Slightly higher correlations than those reported by Betz (1978) have more recently been reported when scores on the MAS have been compared to the ACT-Q. Hackett (1985) reported .47, Hackett and Betz (1989) .45, and Cooper and Robinson (1991) .41. Similar correlations are reported when the MARS is used. Plake and Parker (1982) administered the Revised MARS to 170 undergraduates and found a correlation of -.45 with a 48-item achievement measure collected from an item pool associated with the College Mathematics Placement Program of the American College Testing Program. Langenfeld and Pajares (1992) found a correlation of -.54 between the same anxiety measure and the quantitative score on the Graduate Record Exam (GRE-Q) of 98 undergraduates.

Mathematics anxiety loses much of its predictive power when other variables are controlled. For example, Cooper and Robinson (1991) found that mathematics anxiety was correlated with mathematics performance (.47) and, in a model that included self-efficacy, aptitude, and prior experience, accounted for 21% of the variance in performance, second to aptitude (48%). Cooper and Robinson (1989) found that mathematics anxiety was as great a predictor of performance as measures of test and state-trait anxiety combined but a poor predictor when aptitude was controlled. Dew et al. (1984) found that mathematics anxiety did not account for a significant portion of the variance in performance when ability (SAT) was controlled. They suggested that interventions designed to do more than simply reduce anxiety are required if mathematics performance is to be enhanced.

Llabre and Suarez (1985) administered the Revised MARS scale to 184 undergraduates and found that, after controlling for aptitude, mathematics anxiety had little to do with the final grade in an introductory algebra course ($\beta = -.19$ women, -.06 men). They wrote that the small effects indicated that the model had excluded important variables and posited that "other specific attitudes toward mathematics . . . would have yielded stronger effects" (p. 286). This was also suggested by the work of Rounds and Hendel (1980b) and Frary and Ling (1983). Rounds and Hendel (1980b) studied the mathematics anxiety of 350 women enrolled in a mathematics anxiety program and concluded that anxiety added little to the prediction of mathematics grades.

Some researchers have failed to find a relationship between mathematics anxiety and mathematics performance, however defined. Dreger and Aiken (1957) reported a nonsignificant correlation of -.25 between number anxiety and the quantitative score on the American Council on Education Psychological Examination. More recently, Llabre and Suarez (1985) reported nonsignificant correlations of -.15 for women and -.04 for men between the Revised MARS and SAT-Q scores. Using path analyses, Meece et al. (1990) found that mathematics anxiety had no significant direct effect on the mathematics grades of 250 adolescents and did not contribute to
prediction of mathematics GPA when the path analysis included measures similar to self-efficacy, self-concept, and outcome expectations. Resnick, Viehe, and Segal (1982) administered the MARS to 1,045 undergraduates and found that most reported low levels of mathematics anxiety. They could find no relationship between anxiety and mathematics performance. They noted, however, that most students in their sample had a strong preparation in mathematics, and that may have influenced results.

In most cases, mathematics anxiety is not a powerful predictor of performance when variables such as prior mathematics experience and mathematics self-efficacy are controlled. Betz (1978) urged researchers to focus on the "genesis" of mathematics anxiety, as intervention measures designed to decrease anxiety may not be sufficient to decrease it. Donady and Tobias (1977) found that, in their mathematics anxiety clinic, they spent much of their time dealing with individuals' feelings and sense of mathematics confidence and that only after dealing with these self-beliefs were they able to affect anxiety. Richardson and Woolfolk (1980) wrote that "undoing mathematics anxiety seems regularly to involve detailed cognitive restructuring of certain faulty beliefs or misconceptions concerning mathematical problem solving" (p. 284). Frary and Ling (1983) suggested that mathematics anxiety may even be the weakest link in the chain of mathematics attitudes that affect mathematics performance.

Mathematics Self-concept

As I noted in the previous chapter, the conceptual difference between self-efficacy and self-concept is not always clear to researchers or in investigations. For example, Reyes (1984) used the terms mathematics confidence and mathematics self-concept synonymously. Felson (1984) referred to academic self-concept as self-perceptions of ability and suggested that one reason why these self-percepts affect performance is because of their effect on students' effort, persistence, anxiety, and attributional beliefs. Other researchers write of self-concept of ability (math or academic) and operationalize it as individuals' ratings of their ability in academic areas, usually in terms of academic comparisons with others (Bachman & O'Malley, 1986; Eccles, Adler, & Meece, 1984; Feather, 1988). Eccles et al. (1984), under the heading of self-concept theories, wrote that self-concept affects "a variety of achievement behaviors including academic performance, task persistence, and task choice; people with positive perceptions of their ability approach achievement tasks with confidence and high expectations for success and, consequently, perform better on these tasks" (p. 27). They even cite Bandura (1977). More recently, Meece et al. (1990) called self-concept of ability and ability expectancies two forms of self-efficacy.

All this is not necessarily due to carelessness on the part of researchers, for, as I have explained, distinguishing between self-efficacy and self-concept is not altogether easy. Self-concept theory has itself a long and distinguished record of imprecision as regards its constructs (Byrne, 1984, 1986; Hummel & Cecil, 1984; Shavelson et al., 1976). Shavelson et al. (1976) broadly described self-concept as "a person's perception of himself" (p. 411), and Shavelson and Bolus (1982) added that it is comprised of collective self-perceptions formed from an individual's experience with the environment, with environmental reinforcements and significant others playing a key role.

Some have argued that self-concept and self-esteem are distinct constructs, with self-concept performing a descriptive function and self-esteem an evaluative one (Beane, Lipka, & St. Bonaventure, 1980; Blyth & Traeger, 1983; Coopersmith & Feldman, 1974). Shavelson et al. (1976) and Shavelson and Bolus (1982), however, concluded that the two are not empirically separable and that self-concept may be thought of as having seven distinct features: It is organized, multifaceted,
hierarchical, stable, developmental, evaluative, and differentiable. This multidimensional nature of self-concept permits an understanding of self-esteem as one of the dimensions of self-concept. For this reason, self-concept and self-esteem are often used interchangeably in self-concept literature and nearly always as regards mathematics.

Shavelson et al. (1976) introduced a hierarchical model that differentiated between general, academic, social, emotional, and physical self-concepts. Academic self-concepts were further differentiated as English, history, science, and mathematics self-concepts. This conceptualization represented an important step in the study of self-concept. The hierarchical nature is now widely accepted and researchers warn that using global indices instead of specific self-appraisals is both inappropriate and of limited value (Byrne, 1984, 1986; Felson, 1984; Fleming & Courtney, 1984; Marsh & Shavelson, 1985; Rosenberg, 1979; Shavelson & Bolus, 1982; Shavelson et al., 1976; Shavelson & Marsh, 1986; West, Fish, & Stevens, 1980). According to this model, subject-specific self-concepts are distinguishable from each other, from more general academic and global self-concepts, and from academic achievement (Marsh, Smith, & Barnes, 1985; Marsh, Smith, Barnes, & Butler, 1983; Shavelson & Bolus, 1982). Further, the relations among self-concept dimensions are themselves hierarchically structured. That is, the relationship between subject-specific self-concepts (e.g., mathematics self-concept) and related performance (e.g., mathematics performance) is stronger than that between academic self-concept and academic performance, which, in turn, is stronger than that between general self-concept and achievement (Marsh 1990c; Marsh, Barnes, Cairns, & Tidman, 1984; Marsh, Byrne, & Shavelson, 1988).

Subsequent to the introduction of the multidimensional and hierarchical model, Marsh and his associates undertook a series of revisions that resulted in what is now called the Marsh/Shavelson Model (Marsh et al., 1988; Marsh & Shavelson, 1985). In this model, academic self-concept is divided into mathematics and verbal self-concepts, which, in turn, individually or jointly influence more specific subareas. For example, physical science is viewed as influenced by mathematics self-concept, foreign languages by verbal self-concept, and geography and biology by both. To test the multidimensionality of this conceptual model, Marsh constructed the Self Description Questionnaires (SDQ) I, II, and III, and he and his associates engaged in a series of studies to validate the instruments and constructs (Marsh, 1986, 1987, 1990c, 1990d, 1992a; Marsh & Hocevar, 1985; Marsh & O'Neill, 1984; Marsh & Shavelson, 1985; Shavelson & Marsh, 1986).

In a meta-analysis of 128 studies through the 1970s, Hansford and Hattie (1982) reported that correlations between self-concept and academic achievement ran the gamut from -.77 to .96, with a moderate but significant mean correlation of .21. Over 90% of the studies reported correlations lower than .40. When academic self-concept was measured, however, correlations averaged .40, a finding subsequently supported by Byrne (1984). More recent correlational findings also attest to the relationship between academic self-concept and achievement (Arap-Maritim, 1983; Chapman, 1988; Cheung, 1986; Colangelo, Kelly, & Schrepfer, 1987; Cooley & Ayres, 1988; Darakjian, Michael, & Knapp-Lee, 1985; Felson, 1984; Kelly & Colangelo, 1984; Leonardson, 1986; Marsh et al., 1988; Maruyama, Rubin, & Kingsbury, 1981; White & Browder, 1987; Wiggins, 1987; Zarb, 1982). The question of causality is thorny, however, and researchers have been unable to agree on whether academic self-concept or academic performance is causally predominant. Some have found self-concept predominant (Marsh, 1990a; Shavelson & Bolus, 1982), others argue for the predominance of academic achievement (Bachman & O'Malley, 1977; Newman, 1984; West et al., 1980), and some could find no consistency or evidence of causal relationship in either direction (Byrne, 1984, 1986; Maruyama et al., 1981; Watkins & Astilla, 1986).
Some self-concept researchers have used cross-lagged correlations to establish causal predominance of one construct over the other. The technique involves measuring self-concept and performance at one time point (T1), then repeating the procedure at a specified later time (T2). The four scores are correlated and cross-correlated. For example, self-concept at T1 is correlated with performance at T1 and with self-concept and performance at T2. If it can be shown that the correlation between T1 performance and T2 self-concept is stronger than that between either T1 self-concept and T1 performance or T2 self-concept and T2 performance, then researchers conclude that the effect of performance is predominant over self-concept. This technique, however, is problematic and highly controversial in studies of this type (Cook & Campbell, 1979; Rogosa, 1980, 1987). Correlations between T1 performance and T2 self-concept of the cross-lag may reflect both a causal effect of performance and the stability of self-concept over the two measurements. Therefore, nothing is clearly established. In fact, this type of analysis not only fails to provide sound information about causality but may actually indicate the causal predominance of one variable over another when just the opposite is true. Properly conceptualized and used, path analyses hold the greatest promise in this regard (Cook & Campbell, 1979; Grusec & Lytton, 1988).

Global indices of self-concept are now seldom used, whereas academic or specific course indices are prominent. One such course index, mathematics self-concept, has been a focus of some study, especially by Marsh and his associates (e.g., Byrne & Shavelson, 1986, 1987; Marsh, 1989, 1990b, 1990c; Marsh et al., 1988; Marsh & O’Neill, 1984; Marsh, Parker, & Barnes, 1985; Marsh, Smith, Barnes, & Butler, 1983; Marsh et al., 1991). Although interpretations are sometimes confounded by imprecise definitions and varying measurement techniques, findings show that mathematics self-concept is significantly related to mathematics performance. Correlations between mathematics self-concept and related achievement indices are also higher than those reported by earlier researchers investigating academic self-concept. Marsh (1990c) reported on a number of studies using the SDQI in which correlations ranged from .17 to .66 with a median of .33. Other studies report considerably higher correlations, generally ranging from .40 to .70, especially when the SDQ instruments are used (Byrne & Shavelson, 1986; Marsh, 1992a; Marsh & O’Neill, 1984; Marsh, Relich, & Smith, 1983; Marsh, Smith, & Barnes, 1985; Marsh, Smith, Barnes, & Butler, 1983; Skaalvik & Rankin, 1990). Typical is a study by Marsh et al. (1988), who reported a correlation of .55 between high school students’ mathematics self-concept (SDQIII) and their subsequent mathematics grades. They conducted a path analysis and reported direct effects of self-concept on GPA (.60 to .66). In addition, boys reported higher mathematics self-concepts than did girls. More recently, Marsh (1992a) reported a correlation of .67 between scores on the SDQII (designed for early adolescents) and the mathematics GPA of 507 students from grades 7-10.

When the SDQ is not the measure of self-concept, findings are sometimes suspect. For example, Marsh (1990b) studied 14,825 high school students from the second follow up of the High School and Beyond study, conducted a path analysis, and reported a direct effect of mathematics self-concept on mathematics performance (.60). However, mathematics self-concept was assessed with four questions that appear to assess mathematics anxiety rather than feelings about abilities and skills (e.g., "I dread mathematics class," "Doing mathematics assignments makes me feel tense," and "Mathematics class does not scare me"). Benson (1989) found that higher mathematics self-concept was associated with higher level of performance (a statistics mid-term exam) in a path analysis ($\beta = .251$). However, self-concept was again measured with three items of dubious validity (e.g., "No matter how hard I study, I will not do well in this class"). Marsh et al. (1991) used path analysis to compare the direct effect of achievement on the mathematics self-concept and mathematics self-efficacy of 410 fifth graders. They reported a stronger direct effect on self-concept (.59) than on self-
efficacy (.43). Such a hypothesized relationship, however, avoids the central question of which self-belief has the strongest effect on achievement.

Two important issues arise from these findings and conclusions. The first is that mathematics self-concept, however defined and measured, is generally acknowledged to be a good predictor of mathematics performance, assessed as either achievement test scores or GPA. The second is that it is difficult to know just where mathematics self-concept ends and other self-beliefs, such as mathematics self-efficacy, begin. Mathematics self-efficacy has often been assessed in global ways reminiscent of self-concept, and mathematics self-concept has often been assessed as little more than global self-efficacy (i.e., in terms of general confidence or ability perceptions). Marsh (1990c) agreed that the two "constructs overlap substantially, and more research incorporating both . . . is needed to clarify their distinctive features. Such an effort will lead to a better understanding of both" (p. 100). This, of course, is one of the purposes of my investigation.

What matters, of course, is not how researchers define self-concept, but how they operationalize it through the instrumentation they use. Some researchers write of self-concept as so multifaceted that it becomes nothing less than a sort of super self-construct encompassing other self-beliefs such as self-efficacy, attributions, and even mathematics anxiety. As such, self-concept, regardless of arguments from self-concept theorists, is precisely what Bandura (1986) said it was--"a composite view of oneself that is formed through direct experience and evaluations adopted from significant others" (p. 409). Even at a level of specificity (e.g., mathematics self-concept), it is a global, comparative assessment that has "difficulty explaining how the same self-concept can give rise to diverse types of behavior" (p. 410). Consider for a moment some questions from the SDQIII. "I am quite good at mathematics" is little more than a global self-efficacy item; "At school, my friends all come to me for help in mathematics" defines self through social comparison and evaluations of others; "Mathematics makes me feel inadequate" has elements of anxiety and perceptions of self-worth. All are global assessments that ask the question, "How do I feel about myself as a math student?" Self-efficacy asks, "Can I do this specific math problem or task?" Some researchers have argued that when a multidimensional and hierarchical model of self-concept that measures content specific levels (e.g., mathematics self-concept) is used, such as in the SDQ scales, Bandura's criticism is less relevant (Marsh, 1990c; Marsh et al., 1991; Norwich, 1987). Bandura's criticism is not only relevant but well-founded.

One of the features of the present study that makes it especially useful rests on the fact that both self-concept and self-efficacy theorists claim it is their construct that mediates the effects of prior experience, knowledge, skills, and other self-beliefs on subsequent performance. That construct is also said to be the stronger predictor of performance when other variables are controlled. This is either a very important or rather foolish question, seeking, as it does, the supremacy of one self-belief over another. The question asks whether how individuals feel about themselves as mathematics students is more predictive of specific mathematics performance than whether they believe they can do the problems required to assess just what sort of students they are. Bandura (1986) suggested that living in the world is largely a matter of performing tasks, largely a matter of doing. As such, perceptions of capability are more central and crucial to this endeavor than feelings of self-worth. Indeed, these perceptions and subsequent performances create those very feelings.

Gender

Literature on the relationship between gender and mathematics performance is abundant in psychology and education. Early findings generally showed that children did not differ in their
mathematics performance during elementary school but that differences began to appear in middle school and increased with time and schooling (Betz, 1978; Fennema & Sherman, 1976, 1977, 1978, Fox, 1977; Goldman & Hewitt, 1976; Sherman & Fennema, 1977; Tobias & Weissbrod, 1980). For example, Hilton and Berglünd (1974) found no sex differences as late as grade 5, but noted that differences began at grade 7 and grew throughout high school. Boys had successively higher mean scores at subsequent grades. Also, women take significantly fewer mathematics courses in both high school and college, and far fewer women elect to major in mathematics (Benson, 1989; Betz & Hackett 1983; Hackett, 1985).

Although early findings consistently showed that boys outperformed girls in most areas of mathematics (see Maccoby & Jacklin, 1974), national attention was not focused on the issue until findings were substantiated by Benbow and Stanley (1980, 1982, 1983) in a series of studies in which boys outperformed girls on standardized tests of mathematics ability. The media attention these findings received encouraged the view that men were superior in this area (see Jacklin, 1989). Benbow and Stanley hypothesized biological causes although they provided no evidence to support that claim. Subsequently, Eccles and her associates conducted a series of studies that showed that differences in performance were directly attributable to factors such as mathematics anxiety, gender-stereotyped parental beliefs, and students’ perceived value of mathematics, a construct similar to outcome expectations (see Eccles, Adler, & Kaczala, 1982; Eccles et al., 1984; Eccles & Jacobs, 1986; Eccles, Kaczala, & Meece, 1982).

Gender differences in mathematics, as in all academic pursuits, have diminished during the last few decades, with the single exception being higher-order mathematics performance. Only at the highest levels of mathematics achievement do men continue to outperform women (Feingold, 1988). Data from the National Assessment of Educational Progress (NAEP), Differential Aptitude Test (DAT) national norming groups, and Preliminary Scholastic Aptitude Test-Mathematics (PSAT-M) show declines over the last two decades in gender differences in quantitative tasks (Feingold, 1988). The largest differences arise on tests of complex applications given to adolescents. Before 1974, studies generally revealed ds of -.40 to -.50, whereas more recent national studies uniformly reveal effects of -.15 (Linn & Hyde, 1988). In general, average quantitative gender differences have declined to essentially zero (Cooper & Robinson, 1989; Hyde, 1988).

Hanna, Kündiger, and Larouche (1990) analyzed data from the Second International Mathematics Study (SIMS) for students in the last grade of secondary school. Data from 15 countries included mathematics achievement for seven mathematics areas and various contextual variables. In the United States, there were no significant gender differences for sets, algebra, number systems, and geometry, but boys obtained higher scores than did girls in finite mathematics, analysis, and probability. Using the same data, Ethington (1989) discovered no gender differences in the mathematical performance of eighth grade students from the United States and eight other countries. Hanna et al. (1990), however, reported significant differences in performance in several countries. Hart (1990) and Ethington (1989) suggested that this supports the notion that gender differences in mathematics achievement stem from sociocultural rather than biological factors and urged researchers to expand the collection of data about sociocultural factors such as student confidence in mathematics (self-efficacy) and student perceptions of the usefulness of mathematics (outcome expectations). Meyer and Fennema (1986) suggested that affective factors may play a more important role in explaining differences in achievement patterns of female than of male students. Hart (1990) added that gender analyses for students at other age levels would be helpful.

Even early researchers had reached these conclusions. Fennema and Sherman (1977) found that when mathematics background was controlled, differences in performance by sex could be
discovered in only two of four high schools studied. When affective variables from their attitude scales, especially confidence in learning mathematics, were included, those differences disappeared as well. This led the authors to conclude that sociocultural factors were the source of sex differences in mathematics, as mathematics confidence was higher in boys. They found this again in 1978 using a middle school sample. Subsequent researchers have reported that when differences in mathematics preparation and mathematics confidence are controlled, fewer gender differences on mathematics achievement are found (Fennema, 1980; Lapan, Boggs, & Morrill, 1989; Pedro et al., 1981). However, differences in self-efficacy cannot be solely explained in terms of prior high school mathematics experiences or prior performance (Betz & Hackett, 1983; Hackett, 1985; Lapan et al., 1989). According to Bandura (1986), gender differences are strongly related to individuals' self-beliefs. As with the other variables under investigation, social cognitive theory hypothesizes that self-efficacy percepts mediate the effect of gender and prior experience on mathematics performance. It is these conclusions and recommendations that prompted the inclusion of gender in the present investigation.

Prior Mathematics Experience

According to social cognitive theory, self-efficacy beliefs are created in a number of ways. One of the most important is prior performance, what Bandura called enactive attainment. Individuals' self-efficacy beliefs are formed as they attempt and complete tasks. Successful experiences generally foster positive percepts; failure experiences create negative ones. However, Bandura (1986) argued that people are more influenced by how they interpret their successes and failures than by their attainments per se. For this reason, self-efficacy beliefs usually predict future behavior better than does past performance. Indeed, prior experience affects subsequent behavior largely through its effect on self-efficacy beliefs, and these beliefs can affect behavior "independent of past behavior or arousal" (p. 424). For example, researchers have demonstrated that successful performances do not always enhance efficacy perceptions. This depends on how the performance is cognitively appraised and interpreted (Bandura, 1986; Eccles, 1983; Meece, Eccles Parsons, Kaczala, Goff, & Futterman, 1982; Schunk, 1984). Once again, it is the mediational nature of self-efficacy that determines the predictive power of prior experiences, and it is this mediational function that can make self-efficacy a stronger predictor of subsequent performance than is prior performance.

Few studies on mathematics performance have included mathematics background (Hackett, 1985), but some early studies that did so reported a strong relationship between the two constructs (Ernest, 1976; Green, 1974). The function of prior background has important implications especially in the area of gender differences in mathematics. Fennema (1980) found that, when mathematics background was controlled, few gender-related mathematics achievement differences were found (also see Fox, 1977). More recently, what few studies include prior performance report moderate to strong relationships. Betz and Hackett (1983) found a strong relationship between years of high school mathematics and scores on the ACT-Q but did not report the correlation. Hackett (1985) reported a correlation of .46 between years of high school mathematics and scores on the ACT-Q. Cooper and Robinson (1991) reported correlations of .37 between years of high school mathematics and scores on the Missouri Mathematics Placement Test and .28 on the ACT-Q for 290 undergraduates. In a regression model with the ACT-Q, mathematics anxiety, and self-efficacy, high school mathematics experience accounted for a moderately significant 12% of the variance in performance. Langenfeld and Pajares (1992) reported a similar correspondence between the number of self-reported mathematics college credits and GRE-Q scores (.27).
Support for Bandura’s contention that self-efficacy beliefs are stronger predictors of subsequent performance comes from two studies that explored the role of these variables from an expectancy-value theoretical orientation using path analyses. The studies will be more fully explained later in the chapter, but at this point it is instructive to focus on findings related to prior performance. Pokay and Blumenfeld (1990) found that algebra grades from the previous year had only indirect effects on the performance of high school students through their mathematics expectancy (a form of self-efficacy). Meece et al. (1990) found that expectancy had a stronger direct effect on Year 2 grades than did Year 1 grades and suggested that expectancies mediate the link between prior and subsequent mathematics performance. The direct and indirect effects of prior experience on self-efficacy and performance were one of the important questions of the present investigation.

Self-efficacy and Other Variables in the Study

In addition to establishing a correspondence between the variables in this study and mathematics performance, some researchers have investigated the relationships between the independent measures and self-efficacy. If, as Bandura (1986) hypothesized, self-efficacy mediates the effects of these variables on performance, then the interplay between self-efficacy and the independent measures must be one in which the mediational role is supported or suspected by prior research, even when this research comes from differing theoretical perspectives. In this section, I review studies that have explored these connections.

Mathematics Outcome Expectations

As might be expected, students’ perceived usefulness of mathematics is related to the confidence they express in their ability, with reported correlations ranging from .28 to .60. For example, Hackett and Betz (1989) compared MSES scores to the perceived usefulness of mathematics subscale of the Fennema-Sherman Mathematics Attitudes Scales and reported a correlation of .47 (.31 for the tasks subscale, .52 for courses, and .41 for problems). Lent et al. (1991) constructed a measure of mathematics courses outcome expectations and found that it was significantly correlated with self-efficacy (.48) and contributed significant additional variance beyond self-efficacy and prior skills in a multiple regression model predicting mathematics-related occupations. They suggested that outcome expectations offer nonredundant information that helps explain and clarify self-efficacy.

Using instruments similar to those in the present study, Langenfeld and Pajares (1992) reported a moderate correspondence between mathematics outcome expectations and the mathematics courses efficacy scale of the MSES (.19) but a nonsignificant correspondence between these expectations and either the mathematics tasks, mathematics problems, or total mathematics self-efficacy scales. However, a large part of their sample consisted of preservice elementary teachers, a group identified as having higher anxiety and greater mathematics avoidance than do other undergraduates (Kelly & Tomhave, 1985), and this may well have influenced the students’ perceived value of mathematics.

Mathematics Anxiety

Social cognitive theory contends that self-efficacy beliefs influence choice of behavior, effort expenditure and persistence, and emotional reactions such as anxiety. Bandura (1986) wrote that
anxiety is "mediated by the perceived predictability and controllability of potentially aversive events" (p. 320). It is only when individuals cannot predict or exercise control over events that they have reason to fear them. To a great extent, anxiety is determined by the confidence individuals bring to a specific task. Thus, efficacy beliefs serve as a "mediating mechanism" (p. 442) by predicting "how well people cope with threats and how much fear arousal they experience" (p. 321). For these reasons, Bandura (1989) argued that "efficacy operates as a cognitive mediator of anxiety" (p. 1177).

Bandura and his associates conducted a number of experiments on phobics to demonstrate that, as self-efficacy increased, their fear arousal declined (Bandura, 1983; Bandura et al., 1977; Bandura, Reese, & Adams, 1982). In each experiment, phobic patients raised or lowered their anxiety and stress reactions as a result of self-efficacy interventions. Bandura (1986) contended that the relationship between efficacy beliefs and anxiety is interactive but asymmetric, for "people are much more apt to act on their self-percepts of efficacy inferred from many sources of information rather than rely primarily on visceral cues" (p. 444). He added that self-efficacy will retain its predictiveness of performance even when the effects of anxiety are controlled, whereas the effect of anxiety should dissipate when self-efficacy percepts are controlled. For these reasons, social cognitive theory posits that self-efficacy beliefs will predict academic outcomes to a greater degree than will feelings of anxiety. Anxiety will predict these outcomes only through the mediational role of self-efficacy.

Bandura's (1977) claim that efficacy beliefs mediate the effect of anxiety on performance was questioned by a number of critics who argued that anxiety is the cause of both self-efficacy and performance (e.g., Borkovek, 1978; Eysenck, 1978; Wolpe, 1978). Eysenck (1978), for example, considered self-efficacy a byproduct of anxiety, noting that, when anxiety is extinguished, avoidance behavior is eliminated. Bandura (1978) acknowledged that reducing anxiety may indeed improve performance, but that it does so primarily by raising efficacy expectations. Researchers have subsequently supported Bandura's contention (see Bandura, 1989; Bandura et al., 1982; Hackett & Betz, 1989; Lee, 1984).

Fennema and Sherman (1976, 1977, 1978) were among the first to suggest that mathematics anxiety was little more than an individual's lack of confidence to learn mathematics, but their correlational studies added little beyond demonstrating that the two constructs are, as Bandura suggested, highly related. For example, Fennema and Sherman (1976) reported a correlation of .89 between mathematics confidence and mathematics anxiety. Correlational studies have since shown that mathematics anxiety is negatively related to mathematics confidence in the more moderate range of between -.50 and -.60 (Fennema, 1980; Fennema & Sherman, 1977, 1978; Hackett, 1985; Hendel, 1980; Langenfeld & Pajares, 1992; Lapan et al., 1989; Rounds & Hendel, 1980a; Wigfield & Meece, 1988).

Hackett (1985) reported a correlation of .58 between the confidence and anxiety of 117 college undergraduates, a number more in keeping with recent investigations. Wigfield and Meece (1988) found that mathematics anxiety was correlated with four measures of ability perceptions (-.52 to -.60). Hackett and Betz (1989) gave 262 undergraduates the MSES and Betz's (1978) Mathematics Anxiety Scale and reported a correlation of .56 between mathematics self-efficacy and mathematics anxiety (.40 for tasks efficacy, .43 for problems efficacy, .61 for courses efficacy). Lapan et al. (1989) used the same instruments with 148 undergraduates and reported a correlation of .57. Langenfeld and Pajares (1992) reported -.59 using the MSES and the revised MARS with a sample of 145 undergraduates. Cooper and Robinson (1991) studied 290 undergraduates attending a summer orientation session who had selected math-oriented college majors. They administered the Mathematics Courses subscale of the MSES and Betz's (1978) Mathematics Anxiety Scale and reported a correlation of .41 between mathematics course self-efficacy and mathematics anxiety. As
earlier noted, Siegel et al. (1985) reported that mathematics self-efficacy was a stronger predictor of college students' performance on a mathematics exam than was mathematics anxiety.

Hackett (1989) is the only researcher to investigate the direct and indirect effects of mathematics self-efficacy on mathematics anxiety using path analyses with relationships hypothesized from a social cognitive orientation. She reported that self-efficacy had a strong direct effect (.595). Although choice of mathematics related careers, rather than problem-solving performance, was the outcome measure of her study, she found that self-efficacy had a significantly stronger direct effect on that choice (.244) than did anxiety (.168) and an even stronger total effect (.344 efficacy; .168 anxiety). Mathematics self-efficacy was also a stronger predictor of mathematics anxiety than either prior mathematics experience, mathematics achievement test scores, or gender. Until the present study, no researcher had used structural equation modeling to explore the relationship of these variables to mathematics performance.

Mathematics Self-concept

Recall that Bandura (1986) criticized the use of global indices of self-conceptions and was especially critical of the global assessment of self-concept as it has often been measured. Recent conceptualizations of self-concept have involved hierarchical models, such as the Marsh/Shavelson Model, that assess content-specific areas such as mathematics or even particular areas of mathematics. Some researchers have argued that stable academic self-concept judgments with such degrees of specificity should be related to task specific self-efficacy and, specifically, that mathematics self-concept and task specific mathematics self-efficacy should exert a mutual influence on each other (Marsh, 1990c; Norwich, 1986, 1987). They argue that hierarchical self-concepts models can be extended to very specific tasks within an area such as mathematics and should, therefore, be compatible with the task-specific orientation of self-efficacy theory. According to the multidimensional view of self-concept, confidence is one dimension of self-concept and, therefore, self-efficacy is but a component of a multifaceted self-concept. As I explained earlier, however, these arguments are not supported by definitions of self-concept as operationalized by the instruments used by self-concept theorists.

Interestingly, few researchers have investigated the relationship between mathematics self-concept and mathematics self-efficacy, and none has done so from the perspective of social cognitive theory. Marsh (1990c) cites a study by Relich (1983) in which mathematics self-concept, mathematics achievement, performance on a division task, and self-efficacy for the division task were assessed. Relich reported that mathematics achievement correlated equally strongly with mathematics self-efficacy (globally assessed) and mathematics self-concept. Specific performance on the division task, however, was more strongly correlated with specifically assessed self-efficacy than with mathematics self-concept. These results provide support for the task-specific nature of self-efficacy measurement.

Other findings on the relationship between mathematics self-concept and self-efficacy are contradictory. Norwich (1987) found that mathematics self-concept was not related to self-efficacy either when students were familiar or unfamiliar with a performance task. Benson (1989) conducted a path analysis, hypothesized self-concept as causally predominant, and found that mathematics self-concept had a direct effect on self-efficacy (.693). Marsh et al. (1991) compared the mathematics self-concept and self-efficacy of 410 elementary school students and reported correlations as low as .18.

It merits noting that the MSES and SDQ were each developed by researchers from the competing theoretical orientations and are considered the measures of choice with which to assess
mathematics self-efficacy and mathematics self-concept. The present study represents the first effort to compare the effects of these constructs on mathematics problem-solving performance from a social cognitive perspective using these instruments.

**Gender**

The relationship between gender and mathematics self-efficacy has not been explored as thoroughly as that between gender and mathematics performance. And, whereas recent findings suggest that gender differences in mathematics achievement are diminishing, some contemporary researchers have found that differences in confidence are still prevalent (Lapan et al., 1989; Matsui, Matsui, & Ohnishi, 1990). Early studies suggested that boys were more confident in their mathematics skills than were girls. For example, in a study of over 1200 high school students, Fennema and Sherman (1977) reported that boys had more positive attitudes toward mathematics, including greater confidence in their ability to learn mathematics. In a subsequent study of 1320 middle school students, they again found boys more confident. When they compared their middle and high school results, they found that these differences in confidence increased as students progressed from grade 6 to 11. Early studies also showed that, by middle school, boys began to rate mathematics as more useful than did girls (Fennema & Sherman, 1977; Hilton & Berglund, 1974) and that girls' perceptions of usefulness decline throughout high school (Sherman, 1980). More recently, Linn and Hyde (1988) also found gender differences in high school on the perceived usefulness of mathematics.

Boys and girls report equal confidence in their mathematics ability during the elementary years, but, by high school, boys are more confident (Eccles, 1983). Even by middle school, boys rate themselves more efficacious than do girls (Pintrich & De Groot, 1990). National studies consistently report that, among high school students, more boys than girls consider themselves good at mathematics. And, although there has been an overall increase in confidence during high school by both sexes in the last two decades, the "confidence gap" remains large. For example, in 1978, 49% of girls and 59% of boys reported they were good at mathematics. In 1982 it was 53% of girls and 63% of boys. By 1986 it was 55% of girls and 66% of boys. Differences between the sexes were significant for all years. These findings are consistent with those from the United Kingdom, where men consistently expect better grades on university examinations than do women (Erkut, 1983; Vollmer, 1984, 1986a, 1986b).

Results are not always consistent, however. Sherman and Fennema (1977) found no difference in the mathematics confidence of 716 high school boys and girls when achievement level, intent to study mathematics, verbal ability, and spatial visualization were controlled. As would future researchers, they suggested that confidence may be a function of the mathematics opportunities experienced by students, including the schools they attend and the courses they take. The implications are especially important to areas such as career development (Betz & Hackett, 1981).

Most recent researchers have found that male students express higher mathematics confidence than do female students. For example, male college students reported higher mean self-efficacy scores on the MSES and on the confidence scale of the Fennema-Sherman Mathematics Attitudes Scales, leading Betz and Hackett (1983) to conclude that "math-related cognitions are suggested both theoretically and empirically to be important moderators of sex differences in major and career choice behavior" (p. 343). Hackett (1985) also found that mathematics self-efficacy and gender were correlated (.25), with men reporting higher confidence scores. Pokay and Blumenfeld (1990) reported that high school boys had higher geometry expectancies than did girls. Vollmer (1986a) studied 267 undergraduates and found that men reported higher expectancy and perceived ability
beliefs. Both are a type of academic confidence. Lapan et al. (1989) found that male undergraduates reported higher mathematics self-efficacy and lower mathematics anxiety.

Some researchers report a weaker or nonsignificant relationship between mathematics self-efficacy and gender. Lent et al. (1991) reported a small but significant difference. Men were more self-efficacious on the courses scale of the MSES. However, when the researchers regressed self-efficacy on the source variables with gender as the last step, gender no longer entered the equation as a significant predictor. Lent et al. suggested that this may be because men tend to enroll in more mathematics courses prior to college and so have a greater opportunity to develop their mathematics skills and efficacy percepts. Benson (1989) also found that men reported higher mathematics self-efficacy and also suggested it was a function of women having taken fewer mathematics courses. She used path analysis to find that sex had a direct effect on self-efficacy (.15) but not on mathematics self-concept or performance (a statistics mid-term exam). Hackett (1985) found a direct effect of gender on years of high school mathematics (.18) and from this prior experience to self-efficacy (.19) in a path analysis. Some researchers have found no gender differences on mathematics self-efficacy (Cooper & Robinson, 1991; Langenfeld & Pajares, 1992; Lent et al., 1986; Zimmerman & Martinez-Pons, 1990).

Prior Mathematics Experience

Although the link between prior mathematics experience and performance has received extensive study, few researchers have explored the relationship between mathematics self-efficacy and prior experience. As can already be anticipated by the previous discussion on gender, those who have are consistent in finding a relationship. For example, Pedro et al. (1981) and Sherman and Fennema (1977) found that mathematics attitudes were the most important predictors of mathematics achievement only when mathematics preparation was controlled. Hackett (1985) found years of high school mathematics significantly correlated with mathematics self-efficacy (.47), and path analysis indicated that mathematics self-efficacy was influenced by prior mathematics performance (direct .19, indirect .25, total .46). Cooper and Robinson (1991) found a moderate but significant correlation of .20 between mathematics self-efficacy and prior experience, and Langenfeld and Pajares (1992) reported .27 between scores on the MSES and earned mathematics college credits.

As with self-efficacy and performance, when a study fails to find a correspondence between self-efficacy and prior experience, this failure can usually be explained by conceptual or methodological flaws inherent in the study. For example, Benson (1989) used path analysis to find that prior mathematics courses had a direct effect (.472) on mathematics self-concept but not on mathematics self-efficacy. Self-efficacy, however, was measured globally with three items (e.g., "No matter how hard I study, I will not do well in this class"). What Benson actually discovered was that prior mathematics courses were not related to a measure of confidence to succeed in a class rather than to a measure of confidence in mathematics.

Relationship Among Variables in the Study

Some investigators have incorporated several of the variables used in this study, but theoretical, conceptual, definitional, methodological, or design differences make comparisons problematic. The most ambitious was conducted by Meece et al. (1990), who constructed two structural equation models to investigate the relationship among mathematics ability perceptions, performance expectancies, perceived importance, anxiety, and mathematics performance in a two
year longitudinal study of 250 students from grades 7 through 9. This investigation differed from the present study in several important ways. The most critical difference was that their study was "guided by a model of academic choice and achievement based on expectancy-value theories of motivation" (p. 60) earlier put forward by Eccles (1983), and so the hypothesized relationships and causal directions tested reflected that theoretical orientation rather than that of social cognitive theory. Second, mathematics ability perceptions and mathematics performance expectancies, which they wrote about in ways analogous to mathematics self-concept and mathematics self-efficacy, were considered "two types of efficacy beliefs" (p. 62). According to social cognitive theory, they are not. Third, mathematics ability perceptions were broadly and globally assessed with only three items (e.g., "How have you been doing in math this year?"), performance expectancies with two (e.g., "How well do you expect to do in math this year?"), and importance of mathematics, somewhat analogous to outcome expectations, with two (e.g., "Being good at math is important"). In all three cases, the global nature of the questions was such that identification of and distinction among the constructs were clearly blurred.

Model 1 tested the effects of perceived ability, expectancies, and importance on anxiety, and Model 2 tested the effects of those four constructs on performance (GPA). In both cases, perceived ability (presumably mathematics self-concept) was used as an exogenous variable hypothesized to be causally predominant over all others. Perceived expectancies (math self-efficacy?) were hypothesized to have a reciprocal (noncausal) relationship with importance in Model 1 and with importance and anxiety in Model 2. Social cognitive theory hypothesizes that self-efficacy is causally predominant over self-concept, mathematics anxiety, and outcome expectations and that this predominance should form the basis for a structural equation model. To complicate matters, because Meece et al. (1990) conceptualized ability perceptions and performance expectancies as two types of self-efficacy, they used mathematics ability perceptions from Year 1 to predict both anxiety and performance in Year 2 in an effort to avoid potential problems of multicolinearity. Comparing a child's year-old self-concept beliefs to current efficacy beliefs, mathematics anxiety, and performance is methodologically awkward, conceptually problematic, and at odds with social cognitive guidelines that beliefs and performance be assessed within as close a time period as possible.

Meece et al. (1990) found that expectancies had stronger direct and indirect effects on anxiety (-.45, -.46) than did importance (-.32, -.27) and that expectancies and importance were correlated (.44). Expectancies also had a stronger direct effect on Year 2 grades (1.13) than did Year 1 grades (.48), and Meece et al. suggested that expectancies mediated the link between prior and subsequent mathematics performance, a curious claim in light of their inability to discover a significant relationship between Year 1 grades and expectancies. Neither perceived ability, importance, anxiety, nor sex had significant effects on Year 2 grades, lending support to social cognitive theory by suggesting that "expectancy and importance ratings are stronger determinants of subsequent performance . . . than is math anxiety" (p. 68) and that, poorly measured though it was, self-efficacy was the strongest predictor of subsequent performance. Meece et al. recommended that researchers develop "models that examine reciprocal relations among mathematics anxiety, efficacy beliefs about mathematics, and mathematics achievement values, and their causal links to academic performance" (p. 69), especially assessing the generality of their findings to other age groups.

Meece et al. (1990) expressed surprise at finding that expectancy (self-efficacy) and perceived importance (a type of outcome expectation) were significantly related in both models, noting that, according to expectancy value theory (Atkinson, 1957), the constructs should have an inverse relationship. According to social cognitive theory, the perceived importance of a task is the result of the outcome expectation an individual has for a particular task and is related to self-efficacy judgments
in much the same way as outcome expectations. For example, a student expects that high scores on the GRE will ensure admission to graduate school. She will value scoring highly to the extent that she values the GRE, which she will value to the extent that she values graduate school admission. Her self-efficacy beliefs about her ability to obtain a successful score on the GRE will correspond as closely to her outcome expectations as they will to the value she gives those expectations. She will, as Bandura (1986) noted, "act in terms of value preferences" (p. 324). Bandura argued that because beliefs in part determine expectations, people generally value those things they feel capable of accomplishing and do not place as much value on those for which they have little confidence to perform. It is not unusual, then, that expectations and perceived importance should be related, though the relationship is often complex. I share the concerns of researchers who find this portion of social cognitive theory problematic. Recall that Langenfeld and Pajares (1992) found no relationship between the mathematics outcome expectations and self-efficacy of 145 undergraduates.

Like Pintrich and De Groot (1990), Pokay and Blumenfeld (1990) were interested in whether the effect of expectancies for success on performance was due to students' use of learning strategies, and they conducted an investigation similar to that of Meece et al. (1990). Pokay and Blumenfeld studied 283 high school students and used path analysis to test the effects of self-concept of ability, expectancies, and subject matter values on the use of learning strategies and, subsequently, the effect of all variables on early and late semester geometry grades. Gender and prior mathematics grades were included as exogenous variables. Like Eccles (1983) and Meece et al. (1990), Pokay and Blumenfeld considered expectancies a form of self-efficacy and assessed them globally with two items. Hypothesized relationships again reflected expectancy-value theory, and so the three motivational variables were hypothesized to affect learning strategies and these, in turn, mathematics performance.

Pokay and Blumenfeld (1990) administered the motivational measures at start of semester, but, because they assumed students would not have developed a geometry self-concept of ability or perception of value before taking geometry, algebra self-concept and perceived value were used at this point. Grades from the previous year's algebra class measured prior performance. Five weeks later, after students had received a grade on their first geometry test and become familiar with geometry, geometry self-concept, value, and early use of learning strategies (metacognitive, general cognitive, geometry specific, and effort management) were assessed. All measures were administered again after a second geometry test, with the single and unexplained exception of geometry expectancies. Zero-order correlations revealed that self-concept, expectancies, and value were significantly correlated with each other at beginning of term and after five weeks (r ranged from .33 to .53). Perceived value correlated with use of all learning strategies at both points in the semester, but self-concept and expectancies correlated only with the strategy of effort management. Geometry self-concept and expectancy correlated strongly with prior algebra grades and both geometry tests, but perceived value of geometry correlated with the first geometry test but not the second.

For the path analyses, the motivation variables were first regressed on prior grades and sex, whereas the strategy variables were regressed on the motivation variables, prior grades, and sex. Two models were constructed. The first reflected start of term beliefs (algebra self-concept and values), algebra grades, and strategies reported after geometry test one. Another model reflected geometry self-concept and values, algebra and first geometry test grades, sex, and strategies reported after the second test. Recall that geometry expectancies (a global self-efficacy measure) was removed from the later model.

The most notable finding from the first model was that only geometry expectancy had a direct effect (.30) on the first performance measure, the early geometry test. Prior algebra grade and gender
had indirect effects on performance through expectancy. Neither self-concept nor perceived value had direct effects on performance. All three motivational variables had direct effects on most of the strategy measures, although self-concept, inexplicably, had negative effects. On the second model, after geometry expectancy had been removed, self-concept of geometry ability (.37), prior geometry grade (.28), and prior algebra grade (.26) had direct effects on the second performance measure, the second geometry exam. Geometry self-concept had no direct effect on strategies, but Pokay and Blumenfeld suggested that, and this is a key point, had expectancies been included in this model, "self-concept might have influenced strategy use through its relation to expectancies" (p. 48). Perceived value had a direct effect on all strategy measures but no direct effect on performance.

Feather (1988) also used an expectancy-value orientation in a path analysis to study the effect of mathematics self-concept, perceived value of mathematics, and gender on the enrollment decisions of 444 university students. Like Meece et al. (1990), Feather defined mathematics self-concept as a reflection of "expectancies of success in mathematics" (p. 381) that "could therefore be classified as self-efficacy expectations" (p. 382) and assessed it with two global items, the first asking students to report their previous mathematics grades (top 10%, well above average, etc.) and the second with the item, "In general, how do you rate your ability to do well at mathematics?" Appreciating the limitations of this assessment, he urged future researchers to use longer self-concept scales with known psychometric properties and specifically recommended the SDQIII. Like Meece et al. (1990), Feather also found that perceived mathematics ability and importance were correlated (.41), though he also did not hypothesize a causal direction. Sex had a low but significant direct effect on importance (-.10) but not on perceived ability. Perceived ability showed a stronger direct effect on choice of majors (.24) than did perceived importance of mathematics (.11). What is noteworthy about these studies is that, although from other theoretical orientations, they all demonstrate the mediational role of self-efficacy, even when globally assessed.

One of the assumptions of structural linear modeling is that variables in the model must be shown to have a relationship with each other. I have explored in the preceding pages the relationships between these variables and either mathematics performance or self-efficacy. Research findings also attest to their correspondence with each other. For example, some researchers have reported a significant relationship between mathematics anxiety and self-concept (Benson, 1989: Benson & Bandalos; Brush 1978; Gourgey, 1984). Brush (1978) was among the first to explore this area when she found that the correlation between MARS scores and reported dislike of mathematics was .39 in a sample of 189 undergraduates. Benson (1989) and Benson and Bandalos (1989) found that mathematics self-concept had a direct effect on statistical test anxiety (-.21 and -.27) in path analysis models. Previous mathematics courses had direct effects on mathematics self-concept (.47 and .36).

Mathematics anxiety has also been compared to prior mathematics experience, and findings generally show that students with weaker mathematics backgrounds experience more mathematics anxiety (Alexander & Cobb, 1987; Betz, 1978; Brush, 1978; Burton & Russell, 1979; Fox, 1977; Langenfeld & Pajares, 1992). In studies of college students, women in general or men with poor mathematics preparation have the highest levels of mathematics anxiety (Betz, 1978; Fox, 1977; Rounds & Hendel, 1980; Tobias, 1978). For example, Betz (1978) reported correlations from -.19 to -.43 between mathematics anxiety and years of high school mathematics. Brush (1978) also reported a significant correlation between mathematics anxiety scores and number of years of high school mathematics (-.44). High anxiety students also less frequently enrolled in calculus. Frary and Ling (1983) found that a factor they identified as mathematics anxiety was correlated with the maximum level of mathematics attained in high school (-.44), with college GPA (-.28), and with grade in college mathematics course currently being taken (-.54). However, the factor also had a factor
loading of .90 with mathematics confidence (.89 with mathematics anxiety), so it is unclear just what they may have been measuring. Hackett (1985) reported a correlation of .33 between mathematics anxiety and years of high school mathematics, and Langenfeld and Pajares (1992) reported .22 between the mathematics anxiety and number of mathematics college credits earned by undergraduates.

High school and college women generally rate themselves as more mathematics anxious than do men (Armstrong, 1980, 1985; Betz, 1978; Betz & Hackett, 1983; Brush, 1985; Dew et al., 1983; Fox, 1977; Fox, Fennema, & Sherman, 1977; Llubre & Suarez, 1985; Meece et al., 1990; Morris et al., 1978; Pintrich & De Groot, 1990; Richardson & Suinn, 1972; Richardson & Woolfolk, 1980; Wigfield & Meece, 1988), but sex typically accounts for only a small proportion of the variance in students' responses on mathematics anxiety measures (Meece et al., 1990). Resnick et al. (1982) administered the MARS to 1,106 undergraduates and found no sex differences. Cooper and Robinson (1989, 1991) also found no differences. Dew, Galassi, and Galassi (1983) suggested that, although gender differences in mathematics anxiety may well exist, they are probably much smaller than has been reported. What may well be at work is a failure to control for other variables. For example, when Brush (1978) controlled for prior mathematics experience (years of high school math), gender differences in mathematics anxiety disappeared.

The relationship between self-concept and gender has also been explored. As is the case with self-efficacy, some researchers report that men have higher mathematics self-concepts than do women (Benson, 1989; Byrne & Shavelson, 1987; Pokay & Blumenfeld, 1990), but Benson (1989) suggests this is a function of women having taken fewer mathematics courses. Others have found no gender differences (Eccles et al., 1984; Feather, 1988).

Summary

Mathematics self-efficacy, the perceived usefulness or importance of mathematics (outcome expectations), mathematics self-concept, mathematics anxiety, gender, and prior mathematics experience are the variables most often found to predict mathematics related behavior. Bandura (1986) suggested that differing performances are mediated by a common cognitive mechanism—self-efficacy. Consequently, it was the premise of this study, guided by the tenets of social cognitive theory, that, as Lent et al. (1991) suggested, self-efficacy beliefs serve as the "cognitive pathway" (p. 424) through which other self-beliefs, knowledge, skills, and prior experience affect human behavior. This literature review demonstrates that considerable research findings lend support to this view and to Bandura's hypothesized role of self-efficacy in human functioning.

The purpose of this study was to investigate whether mathematics problems self-efficacy is a stronger predictor of mathematics problem-solving performance than the variables noted above and whether self-efficacy mediates the effect of these variables on that performance. Specifically, I used path analysis to investigate whether mathematics problems self-efficacy has stronger direct effects on mathematics problem-solving performance than does mathematics self-concept, mathematics anxiety, mathematics outcome expectations, prior mathematics experience, or gender. If this is the case, then mathematics problems self-efficacy can be said to mediate the effects of these variables on mathematics performance. Guided by previous research and based on social cognitive theory as it relates to self-efficacy, a model of the relationships among the variables was hypothesized.

Lapan et al. (1989) noted that several criteria must be met before a variable in a path analysis can be said to play a mediational role. One criterion is that a relationship must exist between the hypothesized mediator and the dependent measure. The preceding literature review illustrated that
prior research findings support the social cognitive view that mathematics self-efficacy is significantly related to mathematics performance. Indeed, although guided by other theoretical orientations, some researchers have used path analyses to demonstrate that constructs similar to self-efficacy perform the function that Bandura hypothesized. Two additional criteria must be met: Significant relationships between the independent variables and both the presumed mediator and dependent variable must exist. In the present study, prior mathematics experience and gender were hypothesized to influence self-efficacy and performance, and self-efficacy, in turn, was hypothesized to influence the effects of self-concept, anxiety, and outcome expectations on performance. Much prior support exists not only for these hypothesized relationships but for the hypothesized role of self-efficacy as a mediator. That is, researchers have generally demonstrated a relationship between the variables noted above and mathematics performance, and those that have investigated the additional influence of self-efficacy concur that these beliefs perform the function Bandura theorized. As such, the literature review satisfied another important criterion for the proper use of structural equation modeling—that the hypothesized model carefully and accurately reflect both existing theory and prior research findings.
REFERENCES


