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Engagement with Mathematics Courseware in Traditional and Online Learning Environments: Relationship to Motivation, Achievement, Gender, and Gender Orientation

By

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Doctor of Philosophy

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B.A., College of William and Mary, 1985
M.S., Georgia State University, 1996

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An abstract of a dissertation submitted to the Faculty of the Graduate School of Emory University in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Division of Educational Studies

2004
Abstract

Courseware is instructional software designed to transfer knowledge, skills, or conceptual understanding. The purpose of this study was to examine the relationship between engagement with courseware, academic motivation, and student achievement in two settings: traditional and online college mathematics courses (N=164). Conducted within the framework of social cognitive theory (A. Bandura, 1986), the study addressed three research questions. First, to what degree do course setting, gender, and academic motivation variables predict student engagement with mathematics courseware? Second, to what degree do course setting, gender, academic motivation, and engagement with courseware predict student mathematics achievement? Third, if students’ engagement with mathematics courseware or mathematics achievement differs by gender, is this difference a function of gender orientation beliefs? The first two questions were analyzed using hierarchical multiple regression. Course setting and self-efficacy for self-regulation significantly predicted engagement with courseware. Both mathematics grade self-efficacy and self-efficacy for self-regulation significantly predicted achievement, which was operationalized as a student’s score on a departmental final exam. No significant gender differences were detected in either engagement or achievement; hence the third question was not analyzed. Additional findings revealed that student age also predicted courseware engagement among online students and that the interaction of gender and setting was associated with student retention. In particular, older online students were significantly more likely to engage with the courseware, and female online students were significantly less likely to complete the course than were their female traditional or male online counterparts. Implications for researchers and educators are discussed.
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Emory University  
Division of Educational Studies

2004
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Table 15. Standardized Logistic Regression Coefficients for Variables Affecting Odds of Students’ Decisions to Finish Course ............... 72
Educators at every grade level and across many content areas have shown an interest in using computers to teach students (Christmann, Badgett, & Lucking, 1997a). The interest in computer assisted instruction, or CAI, persists for many reasons. Many instructors believe that the primary benefit of CAI is that each student receives more individualized instruction and feedback than is available through traditional lecture (Kulik & Kulik, 1991). Related to this benefit are perceived benefits of enhanced student learning and improved cost-effectiveness of instruction (Niemiec, Sikorski, & Walberg, 1989).

However, the effectiveness of CAI appears to vary by subject area (Christmann et al., 1997a). Students in some academic subjects, such as science, seem to benefit more from computer-based instruction than do students in other subjects. Although many features of CAI may be universal across subject areas, some features must depend on the subject area in which such instruction is implemented (Dugdale, 1992; Hannum, 1988).

No method of communicating knowledge is independent of the content to be communicated.

In particular, effectiveness of CAI in mathematics has been the focus of much research. Mathematics was among the first academic subjects to foster computer-based activities, and educators have incorporated computers into mathematics curricula more
extensively than into curricula for other subject areas (Howard, Watson, Brinkley, &
Ingels-Young, 1994; Yong, 1989). As CAI has been introduced into the mathematics
classroom, mathematics instruction strategies have evolved from early behaviorist
approaches to more constructivist approaches (Jonassen, 1988). The changes that CAI
has fostered in mathematics education and the ways to increase the benefit of computer-
based mathematics teaching are natural issues for mathematics instructors to address.

The most typical implementation of CAI is the use of courseware— instructional
software designed to transfer knowledge, skills, or conceptual understanding to students
(Jonassen, 1988). Courseware is often divided into three classifications: drill-and-practice
programs, tutorial programs, and simulation programs (McCoy, 1996; Wager & Gagné,
1988). Drill-and-practice programs are designed to build skills or reinforce associations
to which the learner has already been introduced. Tutorial programs relay new content to
the learner; this content may be factual, procedural, or conceptual. Simulation programs
allow the learner to experiment with models of scenarios having different possible
outcomes. The simulation provides feedback by showing consequences of the learner's
selected actions. The simulation environment facilitates trial-and-error and discovery
learning. Simulation environments have also been called microworlds (Edwards, 1995).
Some courseware may combine features from these three categories, thereby blurring the
distinction. For example, tutorial software may contain drill-and-practice components to
reinforce a newly introduced procedure. Similarly, as a mechanism to demonstrate a new
concept, tutorial software may contain an exploration component similar to discovery
environments found in simulation software. Evolving courseware is becoming
increasingly difficult to classify exclusively into one of these three categories (Jonassen, 1988).

Among the most predominant research on CAI are studies examining the overall effectiveness of CAI implementations. Some studies have focused primarily on relative student performance in traditional and CAI settings. Other studies have examined various factors that may be associated with courseware effectiveness. These factors include characteristics of the courseware itself, characteristics of the learning environment in which the courseware is implemented, and characteristics of the learner.

In particular, one learner characteristic that has been the focus of much research in both mathematics education and computer-based instruction is the student’s gender. Researchers have suggested that a student’s gender may mediate not only mathematics achievement (Fan, Chen, & Matsumoto, 1997; Halpern, 1992; Hyde, Fennema, & Lamon, 1990), but also performance in computer-based learning environments (Light, Littleton, Bale, Joiner, & Messer, 2000; Salerno, 1995). Thus, gender is of particular interest when examining student performance with computer-based mathematics instruction.

Clearly, some of the results of computer-based instruction depend on the way in which such instruction is implemented. The variety of implementations is particularly evident at the college level. Some colleges offer online courses, in which students do not meet for traditional instruction. Students in some online mathematics courses have access to mathematics courseware as a learning resource in these online course settings. Likewise, students in a traditional classroom setting may also have the opportunity to use
mathematics courseware to supplement the instructor’s teaching and the textbook assignments. In both cases, the decision as to how much to use the courseware may be left to the student. In these scenarios, the extent to which students choose to use the courseware and the benefit they gain from it may depend in part on whether the setting is a traditional class or an online class (Spence, 2002).

Courseware effectiveness is typically gauged by measuring the achievement of students who have used the courseware (Clariana, 1996; Fraser & Teh, 1994; Khalili & Shashaani, 1994; Leeds, Davidson, & Gold, 1991; Zehavi, 1995). When addressing the potential contribution of courseware to student achievement, one should also consider factors associated with student achievement and investigate how such factors might mediate the effectiveness of the courseware. Because learning is a social cognitive process, one particularly useful theoretical foundation from which to explore these issues is that of Bandura’s (1986, 1997) social cognitive theory.

Theoretical Framework

The central construct in Bandura’s (1986, 1997) social cognitive theory is that of self-efficacy, or “people’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performances” (1986, p. 391). According to Bandura’s theory, people are more likely to perform tasks in which they believe they can succeed; likewise, people are less likely to attempt tasks in which they perceive themselves less competent. Bandura maintained that self-efficacy is the most influential mediator of human functioning.
In particular, self-efficacy beliefs act as filters between a person’s prior achievement or ability and that person’s subsequent behavior (Bandura, 1986). Thus, two persons of the same ability may exhibit different levels of performance because of their differing self-beliefs. Self-efficacy helps to govern how much effort and persistence a person will put forth on a task and how much resilience that person will demonstrate in the face of obstacles. Highly efficacious people are likely to exhibit greater effort and persistence, interpreting their self-beliefs to mean that their sustained effort will result in success. Those with low self-efficacy may give up easily on a task, interpreting their self-beliefs to mean that their sustained effort will be futile.

Self-efficacy beliefs are shaped in a number of ways and these beliefs govern people’s subsequent behavior patterns, which in turn help to further shape their self-beliefs. The sustained effort and persistence put forth by highly efficacious individuals often results in both accomplishment and increased competence, which then further strengthen their self-efficacy beliefs. Likewise, when those with low self-efficacy give up easily, the resulting failure can further erode their self-efficacy beliefs.

According to social cognitive theory, self-efficacy and other constructs associated with self-efficacy are related to academic achievement. These constructs, their relationship to each other, and their association with achievement have received a great deal of attention in current research. The predictions of social-cognitive theory are also applicable in the context of learning environments that incorporate courseware.
Purpose and Rationale

In either the traditional or the online setting, the extent to which the courseware benefits student achievement may depend on the degree to which the student engages with the courseware. Further, researchers have shown that self-efficacy and related motivational constructs are associated with both student engagement and student achievement.

Therefore, the purpose of the present study was threefold. First, I sought to determine the degree to which key motivational constructs and other learner characteristics would predict a student’s level of engagement with mathematics courseware. These motivational constructs included computer self-efficacy, computer playfulness, self-efficacy for self regulation, and achievement goal orientation. Control variables included gender and the course setting chosen by the student. The course setting was either traditional or online. Second, I sought to determine the degree to which a student’s level of engagement with mathematics courseware, combined with the variables used to predict engagement, would predict the student’s mathematics achievement, as measured by a final exam score. A key difference is that instead of computer self-efficacy, mathematics grade self-efficacy was used as a predictor of achievement, because computer self-efficacy corresponds to the outcome of engagement with courseware, whereas mathematics grade self-efficacy corresponds to the outcome of mathematics achievement. Third, if gender differences were evident in student engagement or achievement, I sought to determine if these differences were a function of gender orientation beliefs.
These issues are of concern to both researchers and instructors. Within the framework of Bandura’s (1986, 1997) social cognitive theory, a model with self-efficacy and related motivational constructs as predictors of achievement in computer-based learning environments is warranted. The studies examining factors that affect courseware success have stopped short of addressing the question from the perspective of social cognitive theory. Likewise, the studies examining motivational constructs rooted in social cognitive theory have stopped short of examining these constructs specifically in computer-based learning scenarios. A meeting of the theoretical foundation of social cognitive theory with the line of inquiry into courseware effectiveness is due and may be beneficial to researchers in both fields.

Further, the findings of such a study could inform mathematics instructors about possible factors mediating students’ use of courseware, and the contribution of these factors to student achievement. Such information could ultimately help instructors to adopt more effective strategies in their use of courseware in both traditional and online settings.

Research Questions

I examined factors associated with student engagement with mathematics courseware and student mathematics achievement by addressing the following questions.

1) To what degree do course setting, gender, computer self-efficacy, computer playfulness, self-efficacy for self-regulation, and achievement goal orientation predict student engagement with mathematics courseware?
2) To what degree do course setting, gender, mathematics grade self-efficacy, computer playfulness, self-efficacy for self-regulation, student engagement with mathematics courseware, and achievement goal orientation predict student mathematics achievement?

3) Are gender differences in student engagement with mathematics courseware or student mathematics achievement a function of gender orientation beliefs?

Significance of the Study

No studies to date have examined student performance in computer-based learning environments from the theoretical framework of social cognitive theory. Further, no studies to date have examined the role that computer playfulness might play in a student’s use of courseware or the student’s subsequent achievement. Also, the attention given in this study to gender orientation could shed additional light on the continued question of potential gender differences, both in the content area of mathematics and in the use of computers. Finally, a comparison of factors predicting achievement in online versus traditional settings could be extremely valuable. Not only does the study have the potential to extend the theoretical foundation of motivational constructs in learning, but it also offers potential benefit to instructors of both traditional and online courses about how students might engage with courseware and what factors might play a role in these students’ success.

Delimitations and Limitations

For the purposes of this study, engagement is defined specifically with respect to the courseware, as opposed to general cognitive engagement with the material covered in
the mathematics classes. Further, courseware packages vary in both form and content. It seems plausible that student engagement with courseware could depend partly on the courseware itself. To ensure that all students in this analysis used the same courseware package, participation in the study was limited to students in two remedial mathematics courses using the same courseware package at the same college. Therefore, the study only examined predictors of engagement and achievement among remedial mathematics students in college.

One limitation of this study is that, except for achievement measured by student final exam scores, the data for the study were gathered entirely through student self-report. Students may have found that statements in the survey did not resonate with their own perspectives and unique self-beliefs, or students may have found some survey items difficult to interpret. In addition, self-report data entails the risk that students may not have answered items honestly. I attempted to address this risk by telling participants that their answers would remain completely confidential, and that only aggregate data would be used to report the findings. Nevertheless, the reader should take into consideration the limitations of self-report data when interpreting the results of the study.

The self-report limitation may be compounded in the present study by the fact that all participants were remedial mathematics students. The instrument items required participants to have some degree of quantitative competence: Students were asked to gauge some responses on a numeric scale (e.g., 1 to 6) and to predict their chances of performing at a certain level (e.g., scoring “70 or higher” on an exam). However, it is uncertain whether all participants possessed sufficient quantitative understanding to give
valid or consistent answers to all of these items. To minimize the potential confusion among quantitatively challenged participants, instrument items were presented, where possible, with verbal and visual cues rather than numeric answer scales that participants may have found less intuitive. For instance, when participants were asked to rank their agreement with certain statements, instead of answering with a number from 1 to 6, they were asked to select one of these symbols: F F F T T T. Further, these symbols were shown with verbal translations (e.g., “Definitely False,” “Mostly False,” “A Little Bit False”) on every page on which they were used in the instrument. All answer scales had similar verbal explanations. To further address this issue, I eliminated from the study those participants whose responses on the instrument were clearly quantitatively incoherent (e.g., a participant indicating no confidence that (s)he would pass the class, but high confidence that (s)he would make an A in the class.) Nevertheless, these students’ lack of quantitative proficiency may have added to the limitation associated with participant self-reports.

Another limitation is that online students probably interpreted some survey statements in a much different context than did traditional students. Some survey items made specific reference to the student’s mathematics class, to other students in the class, or to the student’s relationship to the instructor (e.g., “I’d like to show my mathematics teacher that I’m smarter than the other students in my mathematics class.”) Such statements likely held different meaning for online students than for traditional students.

Another potential limitation arose from comparing final course grades assigned by several different instructors. Instructors may have varied considerably in their means of
student assessment. To address this limitation, I obtained each student’s final exam score. The final exam for all students in the study was a departmental exam, graded by a multiple choice key with no partial credit given. All students in all sections of a course, whether traditional or online, took the same final exam. Therefore, the final exam score should have provided a more consistent measure of achievement across students in all classes, both traditional and online. Nevertheless, relying exclusively on final exam scores as indicators of student achievement may present a limitation as well, because a single exam score might not accurately reflect the work performed by a student throughout the semester.
CHAPTER 2
REVIEW OF LITERATURE

I begin this chapter with a brief history and overview of Bandura’s (1986) social cognitive theory as the theoretical foundation for the present study. I then provide a more extensive review of self-efficacy, a primary construct in this theory and a cornerstone of the study. Finally, I review the literature relevant to the other variables in the present study, paying particular attention to the relationship of these variables to each other, to self-efficacy, and to achievement.

Overview of Social Cognitive Theory

Social cognitive theory can be more fully appreciated when it is examined in the historical context of psychological theories. Therefore, I first provide some background of the development of social cognitive theory and then describe the tenets of Bandura’s (1986) social cognitive theory.

Background

Prominent theorists throughout the history of philosophy and psychology have focused in some fashion on the self as a construct in human functioning (Pajares & Schunk, 2002). Among these theorists were William James (1892), Sigmund Freud (1923), Carl Jung (1960), and Erik Erikson (1963). Nevertheless, the behaviorist orientation gained ground as one of the most popular perspectives in psychology during the first half of the twentieth century (Pajares & Schunk). Based on the tenet that
behavior was the only observable and measurable psychological variable, and therefore the only psychological construct worthy of scientific inquiry, behaviorist theories of Ivan Pavlov (1927), Edward Thorndike (1931), John Watson (1925), and B. F. Skinner (1938) attained widespread acceptance in the psychology and educational communities.

However, significant resistance to the behaviorist approach was evident by the 1950’s, first in the humanist movement, characterized by the theories of Abraham Maslow (1954) and Carl Rogers (1961), and later in the “cognitive revolution,” in which psychologists turned their attention to individuals’ internal cognitive processes (Pajares & Schunk, 2002). Yet purely cognitive psychologists derived their models as if from the computer, treating human cognition as the same sort of information processing perhaps found in a machine. The focus on the self, absent in both the behaviorist perspective and in this cognitive revolution, has re-emerged with momentum in recent years and is evident in such theories as those of Albert Bandura (1977b, 1986), one of the most prominent advocates for this renewed focus on the self.

With his own roots in the behaviorist tradition, but dissatisfied with its one-sided and deterministic nature, Bandura first sought to extend learning theory founded in behaviorism by proposing a theory of social learning (Hall & Lindzey, 1978). With his social learning theory, Bandura (1977b) laid the groundwork for his subsequent social cognitive theory. He explained the fundamental tenets of social learning theory:

Social learning theory approaches the explanation of human behavior in terms of a continuous reciprocal interaction between cognitive, behavioral, and environmental determinants. …This conception of human functioning then neither casts people into the role of powerless objects controlled by
environmental forces nor free agents who can become whatever they choose. Both people and their environments are reciprocal determinants of each other (Bandura, 1977b, p. vii).

In the same period, Bandura (1977a) also published work identifying self-efficacy—peoples’ self-perceptions of their capabilities—as a critical element in human behavior. From these principles, Bandura went on to propose a social cognitive theory in 1986, highlighting the important role of self-beliefs in individuals’ behavior and cognition (Pajares & Schunk, 2002).

**Bandura’s Social Cognitive Theory**

Bandura (1986) proposed a social cognitive theory based on a model of triadic *reciprocal* *reciprocality*, echoing and extending the principles of his earlier social learning theory. In this model, an individual’s behavior, cognitive and self-belief factors, and environmental factors all interdependently exert influence on each other. Thus, Bandura asserted that people can and do exercise control over their behavior through this interdependent and reciprocal system, as well as through five specific human capabilities that Bandura identified. These five capabilities are symbolizing, forethought, vicarious learning, self-regulation, and self-reflection.

The ability to symbolize allows people to create meaning from the events they experience. Bandura (1986) maintained that people cognitively represent their environment symbolically, enabling them to interpret past events and predict future ones. Then, people can adapt their behavior to accommodate events they anticipate in the future; individuals’ capacity for forethought facilitates this adaptation. In addition, peoples’ ability to learn vicariously allows them to observe the actions of others and the
consequences of those actions, thus learning some behaviors without experiencing these actions and consequences directly. Further, self-regulation refers to peoples’ ability to control their own behavior by constructing personal standards by which they choose to act. Construction of these standards is achieved not only through individuals’ capacity for symbolizing, forethought, and vicarious learning, but also through the fifth capability that Bandura identified, self-reflection. By reflecting on their own experiences and thoughts, individuals develop an understanding of their environment and a set of beliefs about themselves. These beliefs guide peoples’ subsequent actions and foster individuals’ monitoring and regulating their own behavior.

A critical result of self-reflection and source of self-regulation is people’s self-efficacy, or “people’s judgments of their capabilities to organize and execute courses of action required to attain designated types of performances” (Bandura, 1986, p. 391). According to Bandura, self-efficacy is the most influential mediator of human functioning. Thus, self-efficacy is central to Bandura’s social cognitive theory.

Self-Efficacy

Self-efficacy beliefs act as filters between a person’s prior achievement or ability and that person’s subsequent behavior (Bandura, 1986). Thus, two persons of the same ability may exhibit different levels of performance because of their differing self-beliefs. Self-efficacy helps to govern how much effort and persistence a person will put forth on a task and how much resilience that person will demonstrate in the face of obstacles. Highly efficacious people are likely to exhibit greater effort and persistence, interpreting their self-beliefs to mean that their sustained effort will result in success. Those with low
self-efficacy may give up easily on a task, interpreting their self-beliefs to mean that their sustained effort will be futile.

People develop self-efficacy beliefs by interpreting information from four sources: 1) authentic mastery experiences; 2) vicarious experiences; 3) verbal persuasions; and 4) physiological indexes (Bandura, 1997). Of these sources, authentic mastery experiences exert the strongest influence. Mastery experiences are people’s interpretations of their own past performance. Accomplishments can foster a strong sense of efficacy to succeed at similar tasks in the future. Likewise, failure can lower a person’s self-efficacy beliefs.

A second source of self-efficacy beliefs is vicarious experiences that people may have when they observe another person engaged in a task. Through observing another’s success or failure, people may process this information to make judgments about their own abilities, especially if the observed party is perceived as similar to the observer.

Verbal persuasions are a third source of self-efficacy information. Individuals who are verbally encouraged or told that they have the ability to accomplish a task may gain stronger self-efficacy as a result, particularly if they already possess reasonably high self-efficacy. Similarly, verbal discouragement may reduce a person’s self-efficacy, especially if that person has relatively low self-efficacy initially.

Finally, people interpret their own physical and emotional states as sources of self-efficacy information. Feelings of extreme anxiety and signs of tension may be interpreted as signals that an individual is vulnerable or apt to fail, thereby reducing that person’s self-efficacy. However, people’s interpretation of these physiological states is
key to their effect on self-efficacy. For instance, arousal may be interpreted as an energizing factor, fostering higher self-efficacy, or as an incapacitating factor, resulting in lower self-efficacy.

In the field of educational research, self-efficacy has become a prominent construct, particularly in the arena of motivation (Pintrich & Schunk, 1996). In fact, the focus on self-efficacy and other self-beliefs has become so intense that Graham and Weiner (1996) have asserted that the constructs of self and self-belief are on the verge of dominating motivation research. Studies pertaining to self-efficacy and motivation have typically fallen into one of three categories. Some researchers have focused on self-efficacy as a factor in people’s career choices, especially in mathematics and science related fields (e.g., Hackett, 1995; Zeldin & Pajares, 2000). Other researchers have demonstrated that teachers’ self-efficacy beliefs influence not only their own teaching practices, but also the progress of their students (e.g., Tschannen-Moran, Hoy, & Hoy, 1998; Woolfolk, Rosoff, & Hoy, 1990). Finally, researchers have shown associations between students’ self-efficacy, other motivation constructs, and academic achievement (e.g., Pajares, 1997; Pajares & Graham, 1999).

Self-Efficacy and Academic Achievement

Extensive research has established self-efficacy as both a predictor and a mediator of student achievement (Bandura, 1997; Multon, Brown, & Lent, 1991; Pajares, 1997). Self-efficacy mediates between a student’s ability and that student’s academic performance in a cyclic manner (Schunk, 1985). Students with high self-efficacy exert more effort and persistence at academic tasks than do those students with low self-
efficacy. Thus, the more efficacious students achieve greater levels of success, whereas the students lower in self-efficacy experience more failures. These outcomes then foster students’ subsequent self-efficacy beliefs, enhancing successful students’ self-efficacy and diminishing the self-efficacy of students who gave up easily and thereby failed.

In particular, a great deal of academic self-efficacy research has taken place in the content area of mathematics. Findings consistently suggest that mathematics self-efficacy predicts mathematics performance among middle school, high school, and college students (Graham, 2000; Pajares, 1996; Pajares & Graham, 1999; Pajares & Miller, 1994). Research further suggests that mathematics self-efficacy may be as reliable a predictor of mathematics performance as is mental ability (Pajares & Kranzler, 1995).

**Mathematics Grade Self-Efficacy**

Mathematics grade self-efficacy reflects students’ belief in their ability to achieve a certain grade level in a mathematics class. Because self-efficacy is specific to domain and context, the strength of self-efficacy as a predictive variable is linked its use to forecast a specific outcome in a specific setting (Zimmerman, 2000). Thus, a measure of mathematics grade self-efficacy in a particular course would have more predictive value than a general measure of self-efficacy or even a measure of overall mathematics self-efficacy.

**Computer Self-Efficacy**

Distinct from mathematics self-efficacy is computer self-efficacy, which refers to individuals’ beliefs in their ability to use computers. These and similar efficacy beliefs
have been associated with the degree to which individuals are willing to use computers (Hill, Smith, & Mann, 1987; Webster & Martocchio, 1992).

Some findings suggest that computer self-efficacy affects students’ inclination to follow instructions given in computer-based learning environments (Carlson & Grabowski, 1992). However, the effect of computer self-efficacy may vary with the student’s gender. Carlson and Grabowski found that boys high in computer self-efficacy are more likely to follow courseware instructions than are boys low in computer self-efficacy, although girls high in computer self-efficacy are less likely to follow courseware instructions than are girls low in computer self-efficacy. Carlson and Grabowski addressed a limited aspect of the effect of computer self-efficacy on courseware effectiveness. However, other studies examining the relationship between a student’s computer self-efficacy and courseware effectiveness are scarce.

Engagement

According to social cognitive theory, students’ perceptions of their abilities influence the effort they exert on a task, the extent to which they persist in attempting the task, and the resilience they demonstrate when overcoming barriers to their success (Bandura, 1986, 1997; Schunk, 1991; Zimmerman, 2000). The effort and persistence that students demonstrate when undertaking a task are accepted indicators of their level of engagement with the task (Miller, Greene, Montalvo, Ravindran, & Nichols, 1996). Engagement is a frequently used term with multiple shades of meaning in multiple contexts. Nevertheless, two cornerstones of engagement throughout the literature are
effort and persistence (Pajares & Graham, 1999). Researchers distinguish between deep and shallow levels of student engagement (Greene & Miller, 1996).

Researchers have drawn numerous connections between student self-perception of ability and student engagement in tasks, where key components of engagement are the student’s effort and persistence at a learning task (Miller, Behrens, Greene, & Newman, 1993; Schunk, 1991; Zimmerman & Martinez-Pons, 1990). Findings suggest a strong association between students’ self-perceptions of ability and their level of engagement (Ames & Archer, 1988; Greene & Miller, 1996; Meece, Blumenfeld, & Hoyle, 1988; Miller et al., 1993; Miller et al., 1996). Researchers also consider engagement to be a determinant of academic achievement (Miller et al., 1996; Pajares & Graham, 1999; Pintrich & DeGroot, 1990; Schunk, 1984). To date, researchers have not examined students’ levels of engagement with mathematics courseware or the resulting possible association with student achievement in mathematics.

Self-Regulation and Self-Efficacy for Self-Regulated Learning

Related to engagement is the construct of self-regulation, or the monitoring or regulating of one’s thought processes and behavior while attempting a task (Stipek, 1998). Students use self-regulating strategies such as goal setting, self-monitoring, and use of learning strategies to achieve success in academic settings (Pintrich & Schunk, 1996). Some researchers consider self-regulation to be another indicator of engagement (Greene & Miller, 1996).

Findings suggest that self-efficacy beliefs lead to students’ use of self-regulatory processes (Bandura, 1989; Zimmerman, 2000; Zimmerman & Bandura, 1994). In
particular, self-efficacy for self-regulated learning reflects students’ judgments about their ability to use self-regulated learning strategies (Zimmerman, Bandura, & Martinez-Pons, 1992). Research suggests that positive self-efficacy for self-regulation is associated with achievement in mathematics (Pajares, 2001; Pajares & Graham, 1999). Although it seems likely that these constructs might have some association with successful use of courseware, this association has yet to be examined.

Computer Playfulness

Related to a learner’s engagement and self-efficacy is a construct called playfulness, which includes a person’s cognitive spontaneity and sense of pleasure in undertaking a task (Barnett, 1990). Applying this construct specifically to computing environments, Martocchio and Webster (1992) defined computer playfulness as a computer user’s propensity to interact with the computer in a spontaneous and creative way. Users exhibiting computer playfulness appear more curious, imaginative, and inventive in their interaction with computers than do non-playful users. Although exceptionally playful computer users may become involved in small details and be perceived as wasting time, the work these users produce on the computer is of higher quality than work produced by less playful users (Starbuck & Webster, 1991). Webster and Martocchio (1992) developed a scale to measure computer playfulness. The scale appears reliable, and longitudinal studies suggest that computer playfulness is a stable trait (Yager, Kappelman, Maples, & Prybutok, 1997). Research also indicates that the measure of computer playfulness is a better predictor of a user’s involvement,
satisfaction, and learning than are measures of computer attitude or computer anxiety (Webster & Martocchio).

Computer playfulness is positively associated with computer self-efficacy (Webster & Martocchio, 1992). There is also evidence to suggest that computer playfulness interacts with student performance in computer training settings to shape computer self-efficacy as a result of training (Potosky, 2002). Researchers further propose that individuals higher in computer playfulness “will be more motivated to engage in microcomputer interactions” (Webster & Martocchio, p. 202, emphasis added). Thus, researchers have suggested associations not only between computer playfulness and computer self-efficacy, but also between playfulness and engagement with computers. Researchers have not yet thoroughly examined the relationship between a student’s computer playfulness and the effectiveness of courseware in fostering student achievement.

Achievement Goal Orientation

Related to these motivational constructs are students’ achievement goal orientations (Pintrich, 2000). Researchers have identified two distinct types of achievement goals: mastery goals and performance goals. Mastery goals are concerned with developing understanding and mastery of a given task, whereas with performance goals, the underlying focus is for the learner to demonstrate competence to others (Ames & Archer, 1988; Dweck, 1986). Researchers have used the terms mastery goals, learning goals, and task goals to describe the orientation of students whose focus is on learning or mastering a task for its own sake. By contrast, the terms performance goals and ego-
involved goals are used to describe students whose focus is on demonstrating performance relative to others (Pintrich, 2000).

Researchers have drawn a further distinction between performance goals into performance-approach and performance-avoid goals (Elliot, 1997; Elliot & Church, 1997; Elliot & Harackiewicz, 1996). A learner with performance-approach goals seeks to demonstrate competence relative to others, whereas a learner with performance-avoid goals seeks to avoid appearing incompetent. Thus, current theory and research support a three-pronged achievement goal model, classifying a learner’s achievement goals as mastery, performance-approach, or performance-avoid goals. Each type of achievement goal appears to affect a student’s behavior (Pintrich & Schunk, 1996), as well as affecting several variables associated with student achievement (Elliot, 1999). In particular, research suggests that a mastery goal orientation enhances student achievement, whereas a performance-avoid orientation inhibits achievement (Pajares, Britner, & Valiante, 2000; Urdan & Maehr, 1995).

Researchers have also explored the association of achievement goals with self-efficacy and other motivation constructs. Findings suggest a positive association between mastery goals and perceived ability (Greene & Miller, 1996). Studies also suggest a positive association between mastery goals and student engagement. (Elliot, McGregor, & Gable, 1999; Meece et al., 1988; Nolen, 1988; Nolen & Haladyna, 1990). Moreover, findings suggest a positive association between mastery goals and self-regulation (Pintrich & Garcia, 1991). The relationship between performance goals and these motivation constructs is less consistent, and the contribution of performance goals to
achievement is the subject of some debate among researchers (Bong, 1996; Elliot & Dweck, 1988; Murphy & Alexander, 2000). In general, however, with respect to several motivation constructs including self-efficacy and engagement, research suggests that beliefs and behaviors linked to achievement are associated more with mastery goals than with performance goals (Ames, 1992; Pintrich & Schunk, 1996). To date, researchers have not explored the association between a student’s achievement goal orientation and the contribution of courseware to that student’s achievement.

Gender

Gender differences have also been explored in relation to self-efficacy, to mathematics, and to performance in computer-based settings. When researchers examine computer-based mathematics learning environments, all three of these issues are significant considerations.

Gender and Mathematics Self-Efficacy

Research suggests that boys and girls differ in their beliefs about their mathematical ability (Lummis & Stevenson, 1990). During elementary grades, boys and girls report equal confidence in their mathematical abilities, but boys begin reporting greater levels of mathematics self-efficacy by the middle school years (Wigfield, Eccles, Maclver, Reuman, & Midgley, 1991). Further, at high school and college levels, male students report greater confidence than do female students in areas of mathematics, science, and technology (Debacker & Nelson, 2000; Lent, Lopez, & Bieschke, 1991; Pajares & Miller, 1994). Some evidence also suggests that girls possess less confidence
in mathematics even before differences emerge in mathematics achievement (Linn & Hyde, 1989).

A number of factors may play a role in self-efficacy gender differences. Some researchers have proposed that boys may be more self-congratulatory, whereas girls may be more modest, resulting in boys and girls giving different responses on self-efficacy instruments (Wigfield, Eccles, & Pintrich, 1996). Researchers have added that self-efficacy ratings may represent more of a performance promise to girls than they do to boys, resulting in boys and girls applying a different “metric” when supplying judgments of their confidence (Pajares, 1997; Pajares & Schunk, 2001). Researchers have also suggested that perceived gender bias in the learning environment accounts for some of female college students’ lower self-efficacy beliefs relative to those of male students (Ancis & Phillips, 1996).

Likewise, researchers propose that differences in boys’ and girls’ mathematics self-beliefs stem from parental attitudes and from cultural and societal expectations (Baker & Jones, 1993). Thus, girls may perceive mathematics as typically a male domain. This conclusion can be viewed in context of the observation that vicarious experiences contribute to self-efficacy beliefs (Bandura, 1997). A girl may interpret her vicarious experience of female role models who are reluctant to participate in mathematics to mean that she, too, will be unsuccessful in mathematics, thus perpetuating the cycle of lower mathematics self-beliefs among females.
Gender and Computer Self-Efficacy

Researchers consistently find that women report lower levels of computer self-efficacy than do men (Jackson, Ervin, Gardner, & Schmitt, 2001; Miller, 1996; Whitley, 1997). Likewise, women are frequently described as less confident and more anxious about using computers than are men (Shashaani, 1997). These gender differences in computer self-efficacy are evident not only among students in the U. S., but also internationally, including among students in Asia and in Eastern and Western Europe (Durndell & Haag, 2002; Durndell, Haag, & Laithwaite, 2000; Makrakis, 1993).

Students’ actual experience with computers may mediate gender differences in self-beliefs about computer ability (Shashaani, 1997; Wilder, Mackie, & Cooper, 1985). The predominance of males in computer-related courses and careers suggests that men are likely to gain more experience with computers than are women (Bunderson & Christensen, 1995; Hoyles, 1988; Temple & Lips, 1989). However, it is unclear whether this experience differential fully explains the gender differences in computer self-efficacy or whether initial computer self-efficacy differences lead men and women to choose different coursework and career paths. Nevertheless, researchers have also found that men use the Internet more frequently and for longer periods of time than do women (Durndell & Haag, 2002; Jackson et al., 2001). This finding again supports the observation that men have greater levels of experience with computers than do women, a pattern likely linked to men’s higher levels of computer self-efficacy.

One interesting phenomenon related to women’s self-beliefs about their computer ability is the “We can but I can’t” paradox, in which females express the belief that as a
group, females are as capable as males in computer ability, but females view themselves *individually* as less capable with computers than are males (Collis, 1985; Makrakis, 1993).

**Gender and Mathematics Achievement**

Questions of gender differences in mathematics achievement have also prompted much research. The goals of this research have been to determine whether gender differences in mathematics exist, to discover the nature of those differences, and to explain the reasons for those differences. Fueling researchers’ interest in the apparent mathematics gender gap is the fact that far fewer females than males enroll in advanced mathematics courses or enter mathematics-related fields (Sadker & Sadker, 1994).

Boys consistently outperform girls on standardized mathematics tests (Halpern, 1992). For three decades, boys have consistently scored on average 40 to 50 points higher on the mathematics section of the Scholastic Aptitude Test (SAT-M) than have girls (National Center for Education Statistics [NCES], 1993). Men have outperformed women on the quantitative section of the Graduate Record Examination (GRE-Q) with mean differences of 80 to 90 points (Educational Testing Service, 1991). These and other similar figures are clear evidence of significant gender differences favoring males on major standardized admissions tests.

Some performance trends in boys' and girls' relative mathematics performance are consistent internationally. Such trends were evident in the Third International Mathematics and Science Study (TIMSS). The TIMSS fourth grade assessment revealed no significant difference between boys' and girls' mathematics performance in most
countries (NCES, 1997). The TIMSS assessment of middle school students revealed few significant differences between boys' and girls' mathematics performance in most countries (NCES, 1996). However, data from approximately 20% of the countries participating in the middle school study revealed small but significant differences in favor of boys (Beaton et al., 1996). The most prominent gender gap evident in the TIMSS data appeared among students in their final year of secondary school. Among these students, boys scored significantly higher than did girls in most countries, including the U.S. (Mullis et al., 1998; NCES, 1998). Similarly, data from the 1991 International Assessment of Educational Progress (IAEP) showed negligible gender differences in 9-year-olds, but among 13-year-olds small but significant differences favored boys (Beller & Gafni, 1996). Data from TIMSS and IAEP suggest that certain gender differences emerge across countries.

As these figures also suggest, gender differences in mathematics appear to increase with age (Hyde, Fennema, & Lamon, 1990). Girls slightly excel over boys in elementary grades, but girls lose the apparent advantage by Grade 6 (Marshall & Smith, 1987). Gender differences favoring boys grow as students advance from Grade 8 to Grade 12 (Fan, Chen, & Matsumoto, 1997). These findings suggest that although girls outperform boys in elementary school, gender differences favoring boys emerge around middle school and increase during high school.

On average, however, boys appear to outperform girls by only a small margin, and this margin has decreased in recent years (Hyde et al., 1990). The magnitude of gender differences found in studies conducted in 1974 and later is less than half the
magnitude of differences observed in studies before 1974 (Friedman, 1989). The small and declining differences favor boys; the gap varies with age of students, selectivity of samples, and cognitive level of the tests (Hyde et al.). These findings suggest that girls are narrowing the gender gap in mathematics.

Gender differences in mathematics performance also appear to vary by content area and cognitive complexity (Willingham & Cole, 1997). Among 13-year-olds in the Second International Mathematics Study (SIMS), girls outperformed boys in arithmetic and algebra, whereas boys outperformed girls in geometry. Girls also outperformed boys on computation, or tasks of lower cognitive complexity, but boys outperformed girls on application, or tasks of higher cognitive complexity (Engelhard, 1990). Likewise, in the TIMSS middle school assessment, small differences favored boys in content areas such as proportionality and geometry but favored girls in algebra (Beaton et al., 1996). The IAEP data revealed that from age 9 to age 13 girls lost the most ground in geometry and data analysis. Algebra was the only content area for which no significant gender differences were apparent among IAEP students at age 13; differences in all other content areas favored boys (Beller & Gafni, 1996). Further, analysis of SAT-M item responses has revealed that among testers of equal overall ability, girls perform better on algebra items, whereas boys perform better on geometry and problem-solving items (Langenfeld, 1997). Research consistently suggests that boys excel over girls in geometry and problems of higher cognitive complexity, and that girls excel in computation and algebra.

Boys also outperform girls on unconventional problems that require mathematical reasoning but that are less likely to mimic problems the student has seen previously
Girls are more likely to attempt to solve problems by applying conventional algorithms that they have learned in mathematics classes. In some cases the conventional approaches require more time than is available (Linn & Hyde, 1989). Boys use insight or intuition in less conventional strategies, such as logical reasoning, shortcuts, or trial and error. By using these strategies more often than do girls, boys achieve greater success (Gallagher & De Lisi, 1994).

Research also suggests that boys have better spatial ability than do girls (Linn & Petersen, 1985). Three categories of spatial ability are spatial perception, mental rotation, and spatial visualization. Spatial perception is the ability to identify an object's orientation while disregarding distracting cues, such as tilted objects. Mental rotation is the *speed* with which participants can accurately imagine rotating a two- or three-dimensional object; speed is critical because given unlimited time, most participants can respond accurately. Spatial visualization is the ability to solve a visually represented complex problem. Boys perform substantially better than do girls in mental rotation and perform slightly better in spatial perception.

Research also suggests that boys and girls differ in the types of mistakes they make on mathematics test items (Marshall & Smith, 1987). Girls are more likely than boys to associate key words or number patterns in word problems with the wrong arithmetic operation. Girls are also more likely to skip a step in a complex procedure. However, boys are more likely to apply erroneous arithmetic rules, such as borrowing or carrying errors. Girls are also more likely than boys to use spatial information incorrectly or to apply irrelevant rules when solving a problem (Marshall, 1983). These differences
seem consistent with findings that girls outperform boys in arithmetic, but boys outperform girls on tasks of higher cognitive complexity.

Gender differences among mathematically gifted students are much greater in magnitude than differences among average achievers (Hyde et al., 1990). Among students in Grade 7 and 8 who participated in the Study of Mathematically Precocious Youth (SMPY) through 1979, boys performed significantly higher than did girls (Benbow & Stanley, 1980). Mean differences in SAT-M scores were as high as 116 points, and boys’ top scores exceeded girls’ top scores by as much as 190 points. However, the largest differences found represented small samples, including a sample with only 12 boys and 10 girls. In the last two years reported, sample sizes were much higher (3000+ total students), and the mean differences and top score differences for these samples were all in the low 30s. Nevertheless, boys outperformed girls in every sample. Benbow and Stanley (1980) suggested that their findings among gifted students could be extended to the general population. This suggestion seems unwarranted; researchers have shown that gender differences in high achieving samples are exaggerated and do not correspond to differences observed in samples drawn from the general population (Fan et al., 1997; Friedman, 1989).

One finding that sheds light on the magnified differences observed among high achieving students is that boys and girls appear to differ in mathematics achievement variability (Feingold, 1992). The standard deviation of men’s scores exceeds that of women’s scores on quantitative sections of several widely used tests: the Differential Aptitude Tests (DAT); the SAT and PSAT; the Wechsler Adult Intelligence Scales
(WAIS and WAIS-R); and the California Achievement Test (CAT). However, variability differences found in the USA may not be present in other countries (Feingold, 1994). Yet greater male variability within the USA is evident across most instruments and has remained consistent over the last three decades (Hedges & Nowell, 1995).

Male variability is an important consideration in mathematics gender differences: Many studies focus on central tendency, but combined mean and variability differences might give researchers a more complete picture (Feingold, 1992). Some researchers believe that the relative number of boys and girls in the extremes of a distribution is a more appropriate indicator of gender differences than relative mean scores (Hedges & Friedman, 1993).

One facet of male variability that few recent researchers appear to have addressed is that males may outnumber females not only in the high end of a distribution but also in the low end (Maccoby & Jacklin, 1974). This pattern is evident in Feingold's data (1992). Males outnumbered females not only in many distributions' right tails but also in left tails for over half the measures Feingold presented (Hedges & Friedman, 1993). Although many studies have explored gender differences exclusively in students of high mathematical ability, few studies appear to focus exclusively on gender differences among low-ability students.

Researchers have explored many possible explanations for the evident differences in boys' and girls' performance in mathematics. The proposed explanations are significant because they bear directly on both validity and precision. When considering validity, researchers question whether differences observed in studies reflect real differences in the
population. When considering precision, researchers want to define accurately those differences that do exist.

One proposed explanation is that males have biologically determined higher mathematical aptitude than do females (Benbow, 1986). In support of this hypothesis, researchers have demonstrated correlations between boys’ high mathematics achievement and other traits such as left-handedness. These correlations have been interpreted as evidence of a biological foundation for male superiority in mathematics, but this logic is questionable (Friedman, 1989). To be more widely accepted, the hypothesis of biologically determined gender differences in mathematical aptitude requires the support of more unequivocal research. It is not clear if such research is possible.

Another explanation that researchers have suggested for evident gender differences in mathematics is gender bias on mathematics tests (Langenfeld, 1997). Under this hypothesis, a test item designed to measure ability "X" may be written so that boys are more likely than girls to determine the correct answer, although no actual difference in ability "X" exists between boys and girls. Potentially in support of this hypothesis, researchers have supplied evidence that standardized test scores do not comparably reflect boys' and girls' mathematics achievement in the classroom (Wainer & Steinberg, 1992). Among men and women receiving the same grade in equivalent first-year college mathematics classes, women had scored on average 36 points lower on the SAT-M. Even when researchers adjusted data for greater homogeneity in classes from which scores were compared (e.g., calculus for engineers was different than calculus for liberal arts students), the mean difference in SAT-M scores was slightly reduced, but not
eliminated (Bridgeman & Lewis, 1996). The finding of disparate SAT-M scores among men and women of comparable classroom achievement focuses attention on how researchers should define mathematics achievement: SAT-M scores alone do not adequately predict college mathematics performance. Yet researchers consistently rely on SAT-M scores alone to claim that men's mathematics achievement is superior to women's.

In further support of the gender bias hypothesis, research has revealed that girls’ performance on mathematics tests depends on the format of the test questions. Togo and Hood (1992) administered two versions of the same test: One version presented quantitative data in tables (tabular format), and the other version presented the same data in graphs (graphics format). Each student in the test group received one of the two test versions. Among students who received the tabular format, no significant gender difference in performance appeared. Among students who received the graphics format, men outperformed women. Women who received the tabular format also performed significantly higher than did women who received the graphics format. However, one could argue that part of successful performance in mathematics is the ability to interpret data presented in graphical format. More generally, one could argue against gender bias on tests like the SAT-M by asserting that the ability to interpret questions presented in a variety of formats is essential to mathematics performance.

Another hypothesis is that girls perform as well as boys relative to the previous exposure they have had to mathematics. When all ability levels are considered collectively, boys and girls who have taken the same mathematics courses show no
differences or very small differences in average mathematics performance (Fennema & Sherman, 1977). However, controlling for differential coursework does not eliminate all gender differences in mathematics (Armstrong, 1981). Controlling for formal mathematics coursework addresses a significant issue but does not address potential differences in boys’ and girls’ nonacademic mathematics-related experiences. Other studies suggest that when girls and boys have equivalent sociocultural experiences, access to education, and career opportunities, girls are more likely to perform at least as well as boys in mathematics, if not better (Baker & Jones, 1993). Boys’ and girls’ different levels of exposure to mathematics-related experiences appear to play a significant role in their relative achievement in mathematics.

Some researchers have proposed that the observed gender differences in spatial abilities account for many or all of the gender differences in mathematics achievement (Fennema & Sherman, 1977). There is a moderate but consistent association between girls’ mental rotation ability and general mathematics aptitude (Casey, Nutall, Pezaris, & Benbow, 1995). Further, when girls practice spatial visualization exercises, their performance increases both in spatial visualization and in mathematics (Ferrini-Mundy, 1987).

However, the role that spatial ability plays in problem solving differs between boys and girls and between students of high and low spatial ability (Fennema & Tartre, 1985). Among students with low spatial visualization ability, girls appear to have more trouble solving mathematics problems than do boys. Yet in general, students of different skill levels in spatial visualization do not differ in their ability to solve a problem
correctly. Students of low spatial ability often successfully apply other problem solving strategies such as verbalizing details of a problem. Spatial ability also does not account for differences in boys’ and girls’ proportional reasoning (Linn & Pulos, 1983). These findings suggest that researchers do not fully understand the connection between spatial ability and mathematics achievement.

Researchers have also proposed that boys outperform girls on standardized tests because boys recall mathematics-related facts faster than do girls (Royer, Tronsky, Chan, Jackson, & Marchant, 1999). However, the mathematics-fact retrieval hypothesis falls short of explaining boys’ superior spatial ability, which involves visualization and mental manipulation rather than recall of facts. Nevertheless, evidence suggests that boys recall mathematics facts more quickly than do girls. This difference could contribute to boys outperforming girls, particularly on standardized tests, which are subject to a time limit.

Although researchers do not agree on the reasons underlying gender differences in mathematics, some findings are well established. Girls outperform boys slightly in elementary school, but in middle and high school years, boys catch up with and surpass girls in mathematics achievement. In high school and beyond, boys consistently outperform girls on standardized tests such as the SAT-M, but relative to their SAT-M scores, girls outperform boys in college mathematics classes. Boys and girls differ in mathematics achievement variability, and boys significantly outnumber girls among the highest achieving students in gifted groups. Girls outperform boys in algebra and computation, but boys outperform girls in geometry, problem solving, and tasks of higher cognitive complexity. Boys also outperform girls on tasks of spatial ability, particularly
mental rotation. Differences are small among average performers and have declined in recent years.

Proposed explanations for gender differences in mathematics include biological differences, gender bias on tests, differential coursework, and environmental factors that influence students’ attitudes about mathematics. Proposed mechanisms to account for gender differences in mathematics include spatial ability and mathematics-fact retrieval speed. Although many researchers seem to believe that some of these explanations are mutually exclusive, it is possible that each hypothesis plays a role in explaining the complex relationship between gender and mathematics achievement.

**Gender and Computer-Based Learning**

Researchers have also focused on gender as a possible mediating factor in computer-based learning environments. Evidence suggests that when computer-based arithmetic practice is compared to pencil-and-paper practice, boys achieve greater gains from the computer-based practice than do girls (Salerno, 1995). Boys also outperform girls in computer-based problem-solving environments (Light, Littleton, Bale, Joiner, & Messer, 2000). These findings indicate that boys may experience more benefit than do girls in many computer-based learning environments.

Numerous studies have suggested that most software is biased in favor of males (Cooper, Hall, & Huff, 1990; Turkle & Papert, 1990). In particular, findings indicate that educational software employs competition, violence, and substantially fewer female characters than male characters (Biraimah, 1993). In mathematics courseware, levels of violence and competition appear to increase with the target grade level of the software,
and the representation of female characters decreases (Chappell, 1996). Studies also suggest that girls respond with greater interest and more positive attitudes to software that is intentionally designed to be gender-neutral than to male-biased software (Johnson & Swoope, 1987). The prevalent literature on gender bias in courseware appears to focus on student attitudes and student anxiety rather than on student performance in computer-based environments.

As they become aware of gender-related software issues, researchers are examining the impact of various software environments on both male and female students. The presence of others in a computer-based learning environment affects men and women differently (Robinson-Staveley & Cooper, 1990). Among students of low prior computer experience, men perform better and with less anxiety in the presence of another person than they do when working alone, whereas women perform less well and experience greater anxiety in the presence of another than when working alone. Among students of high prior computer experience, student performance and anxiety appear to be unaffected by gender or by the presence of others.

When students work with courseware in groups, the gender composition of the group affects boys’ and girls’ attitudes and interaction with the software differently (Cooper & Stone, 1996). Specifically, when girls work with software in all-female groups, they are less reserved and more inclined to explore than are girls working in mixed-gender groups. Girls working with software in mixed-gender groups defer to their peers more often than do boys in the same setting. Further, girls in all-female groups report their own experience and knowledge of computers more highly than do girls
working in mixed-gender groups. Conversely, boys in mixed-gender groups report their own experience and knowledge of computers more highly in mixed-gender groups than they do in all-male groups.

The gender of peers present in a computer-based learning environment also appears to affect student learning even when no interaction takes place. When girls work independently alongside boys in a computer-based problem-solving environment, their performance is substantially lower than that of girls working alongside other girls in the same environment. However, boys working alongside girls in this environment significantly outperform boys working alongside other boys (Light et al., 2000).

The presence of a simulated human face on the computer screen also affects boys and girls differently, and the effect varies with students’ levels of anxiety (Cooper & Stone, 1996). When a computer-generated image of a human face is present during a computer-based lesson, female students with low anxiety appear to outperform female students with high anxiety. However, with the same simulated human face present, male students with high anxiety appear to outperform male students with low anxiety. This result seems related to the finding that boys with less computer experience work better in the presence of others whereas girls with less experience work better alone (Robinson-Staveley & Cooper, 1990). The students’ lack of computer experience may be associated with their levels of anxiety.

Gender may also interact with other learner traits to govern the effectiveness of various computer-based environments. Gender and ability interact to mediate the effect of learner control: Courseware that allows more learner control appears to foster greater
achievement only among low ability boys and high ability girls (Goforth, 1994). Interactions between gender and many other learner characteristics remain to be examined.

Gender Orientation

Gender orientation refers to a person’s beliefs about gender and identification with gender roles that define the behavior of members of a given gender (Burke, 1996; Bussey & Bandura, 1999). During development, children adopt beliefs that help define their gender orientation; these beliefs may include that boys are competitive and adept in mathematics or technology, and that girls are collaborative, relational, and adept at writing and communication. Many researchers suggest that apparent gender differences in some psychological and behavioral processes may in fact reflect differences in gender orientation rather than actual gender differences (Harter, Whitesell, & Kastelic, 1998; Pajares & Valiante, 2001).

This notion is supported by findings that suggest men and women differ more in their stereotypic gender beliefs about computer use than in their actual use of computers: Boys and men accept more readily the stereotype of computers as a male domain than do girls and women (Whitley, 1997). The association between gender orientation and effectiveness of mathematics courseware has not been addressed.

Course Setting

Researchers consistently report that courseware in conjunction with traditional instruction yields higher student achievement than does courseware alone (Christmann & Badgett, 1999; Christmann, Badgett, & Lucking, 1997b; Clariana, 1996; Khalili &
Although these findings hold across many types of courseware, teachers’ explicit instruction and mediation may be particularly beneficial in microworld environments (Howard et al., 1994).

Edwards (1991) offers a possible explanation for the success of this combination. In her study of geometry instruction with microworld courseware, the learning environment combined microworld courseware with traditional instruction to guide the students’ discovery of patterns. Traditional instruction and worksheets were designed to give structure and direction to the students’ discovery process, especially in guiding students to make generalizations about the patterns they observed. Edwards’ findings suggest that additional worksheets enhanced courseware effectiveness. However, it is not clear whether the same effect could be achieved if a computer-based equivalent to those worksheets were integrated into the courseware. One cannot discern from the findings whether it was the content or the form of the additional worksheets that served to enhance the students’ learning.

Other findings suggest that student performance varies depending on how human instruction is combined with courseware. Zehavi (1995) compared three learning environments that each combined two computer-based tutorials with one class discussion guided by an instructor. The discussion took place before both tutorials in one environment, between the two tutorials in another environment, and after both tutorials in a third environment. The group having discussion between the tutorials demonstrated the highest level of achievement on a subsequent test, whereas the group having discussion before both tutorials performed least well. A possible interpretation of these results is that
the discussion was less relevant to students until they had experienced a tutorial for themselves. Then, once a tutorial provided a meaningful context, the discussion gave direction and structure to the second tutorial, as did the traditional instruction in Edwards’ (1991) study.

The use of courseware with or without traditional instruction could be a key issue in those learning environments that offer both online and traditional course formats, because online settings typically entail use of courseware without traditional instruction, whereas traditional settings in which courseware is used combine the courseware with traditional instruction.

Further, students’ choice of a traditional or an online setting may also be associated with their motivational attitudes or beliefs. In particular, higher mathematics self-efficacy, computer self-efficacy, or self-efficacy for self-regulated learning may lead a student to select an online course setting for mathematics, whereas students lower in their self-perceptions of these abilities may prefer a traditional setting (Spence, 2002).
CHAPTER 3
METHODOLOGY

Participants and Setting

I conducted the present study with students enrolled in several sections of remedial mathematics courses at a state-supported two-year college in the Southeast, during fall term 2003. The student body at this school is ethnically and culturally diverse, and students encompass a broad range of ages, making this setting well suited for an inclusive study across many cultures and adult age groups.

Several students who were initially eligible either did not answer all items in the first survey or dropped the class before the final survey was administered. These participants were removed from the sample. Of the remaining 182 participants, 18 did not attend the final exam, and therefore received a zero on the exam and an F in the course. These students were also removed from the sample. Therefore, the final set of participants in the study consisted of 164 students in Beginning and Intermediate Algebra classes described below. Of these students, 88 were in traditional sections and 76 were in the online setting. 127 participants were women and 37 were men. By self-report, 90 participants were Black, 46 were White, 7 were Asian, 6 were Hispanic, and 2 were Native American. The remaining 13 participants identified themselves as “Other.”
Classes

The classes for the study were 16 sections of Beginning Algebra or Intermediate Algebra. These two courses make up a sequence of remedial mathematics that each student at the college is required to take if a placement test indicates that the student needs further mastery of basic algebraic skills. All classes used the same textbook, *Beginning and Intermediate Algebra* (Lial & Hornsby, 2000) and the same courseware, called MyMathLab, which is designed for use with that textbook. Of the 16 sections from which participants were selected, eight were traditional sections and eight were online sections.

Courseware

The MyMathLab courseware used for all class sections in this study included a multimedia version of the textbook, a video tutor, tutorial exercises, guided solutions, and computer-based quizzes and tests. The video tutor showed an electronic video of a human instructor demonstrating how problems in each section were worked. The tutorial exercises provided practice exercises similar to those in the text; after a student completed each exercise, the tutorial indicated whether the answer was correct or incorrect. If a student was confused on a tutorial exercise, the student could select a guided solution for that exercise, which would break down the problem into intermediate steps and have the student attempt the answer to each of those steps. These features were available to students through a web-based. Access to this interface was included with the purchase of a new text or could be purchased separately for students with a used text. An advantage to this web-based interface was that an instructor could track the student’s
progress and assign quizzes and tests for the student to take for a grade. The web-based interface also allowed an on-line classroom community to be implemented, with features such as class announcements, chat sessions, and e-mail access to the instructor and other students in the class. However, students needed Internet access to use the interface, and the access needed to be relatively high speed (e.g., DSL or network connection) to use the video tutor component effectively.

**Online Sections**

Four sections of each course (Elementary Algebra and Intermediate Algebra) were taught as on-line classes that did not meet for traditional instruction but relied solely on the textbook and courseware for students to learn the material. All eight of these online sections were included in the present study. Students came to campus for orientation, the midterm exam, and the final exam. These occasions were the only time the online students met in a classroom. Throughout the rest of the semester, the students worked independently using an online schedule and assignment list provided by the course instructor.

Students in each on-line section were required to use the web-based interface described above to be in the class. However, their only requirement on the web-based interface was to take assigned quizzes and tests and keep up with class deadlines and issues by reading announcements and e-mail. Although the instructor could track student use of other features, such as tutorial exercises, student use of these features was optional. Online students also had access to the instructor by e-mail, by phone, or by visiting the instructor’s office in person.
Traditional Sections

Several sections of each course were also taught through traditional in-class instruction with courseware used as an optional supplementary learning tool. Eight traditional sections were included in the study. Traditional students had access to the same courseware features as did the online students, although traditional instructors did not give any specific computer-based assignments or post online tests or quizzes for students to take. However, sample tests were available in the courseware for students in addition to the tutorials and other features in the computer-based environment. Students in traditional sections were provided information about the courseware and were encouraged to use it, but traditional students were not required to use the courseware.

Variables and Instruments

The instruments used in the study are shown in Appendix A. Unless otherwise indicated, a 6-point Likert scale was used for each item, where 1 represents “definitely false” and 6 represents “definitely true.”

Course Setting

The course setting variable reflects whether a student was enrolled in a traditional section or an online section of the course. This information was gathered by tracking the section in which each participant was enrolled when the participant took the initial survey. The setting variable was coded as 0 for online and 1 for traditional.

Gender

Students identified themselves as male or female on the initial survey. The self-reported gender item was coded as 0 for male and 1 for female.
Mathematics Grade Self-Efficacy

Mathematics grade self-efficacy reflects students’ confidence in achieving a certain grade level in their mathematics class. Because achievement in the present study was defined as a student’s final exam score, mathematics grade self-efficacy was defined as students’ confidence in their ability to achieve at certain level on their mathematics final exam. A sample item is “How confident are you that you will make a score of 80 or higher on your mathematics final exam?” For such academic self-efficacy scales, reported alpha coefficients have ranged from .86 to .90 (Pajares, Britner, & Valiante, 2000; Pajares & Valiante, in press). An alpha coefficient of .93 was obtained in the present study.

Computer Self-Efficacy

Computer self-efficacy reflects students’ confidence in their ability to use a computer successfully. The 10-item scale is a subscale adapted from the computer self-efficacy (CSE) scale developed and validated by Murphy, Coover, and Owen (1989). A sample item is “I feel confident working on a computer.” Variations of this scale have been used by a number researchers, who obtained alpha coefficients of .90 to .96 (Durndell & Haag, 2002; Torkzadeh & Koufteros, 1994; Torkzadeh, Pflughoeft, & Hall, 1999). The alpha coefficient obtained in the present study was .96.

Self-Efficacy for Self-Regulated Learning

Self-efficacy for self-regulated learning reflects students’ judgments of their ability to use self-regulated learning strategies. The seven-item scale is a subscale adapted from Bandura’s Children’s Multidimensional Self-Efficacy Scales (see
Zimmerman et al., 1992). A sample item is “How well can you motivate yourself to do schoolwork?” Answers on the 6-point Likert scale range from 1 (not well at all) to 6 (very well). A validation study suggests that a single factor underlies all items on the scale (Zimmerman & Martinez-Pons, 1988). Researchers have reported Cronbach’s alpha coefficients ranging from .80 to .87 (Pajares, 1996; Pajares, Miller, & Johnson, 1999; Zimmerman et al., 1992). An alpha coefficient of .86 was obtained in the current study.

Degree of Use

Degree of courseware use reflects how many of the available features of the courseware each student has used. These features include the video tutor, tutorial practice problems, guided solutions, and sample tests. One item for each of these four features ascertains whether or not the student has used that feature. A sample item is “I have used the MyMathLab video tutor.” Responses are either yes or no for each item. Degree of use was tracked to help determine student engagement with courseware: If a response for a given courseware feature is “yes,” the survey then measures the extent of the student’s engagement with that feature (next variable). If the response is “no” then the student’s engagement with that feature is scored as zero.

Engagement with Courseware

Engagement with courseware reflects the degree of effort and persistence students report putting forth when working with those features of the courseware that they do use. For each feature, three items target the student’s effort and persistence in using the feature. Sample items for a specific courseware feature are “When a tutorial practice problem is difficult for me to solve, I put more effort into it;” “I will work as long as
necessary to solve a difficult tutorial practice problem;” and “When I find a tutorial
practice problem difficult, I usually give up it” (reverse scored). These items are adapted
from engagement items used by Pajares and Graham (1999). Possible answers are on a
Likert-type scale from 1 (definitely false) to 6 (definitely true) if the student uses the
indicated feature. Students who indicate they do not use a given courseware feature will
be assigned a score of zero for the engagement items associated with that feature. The
alpha coefficient obtained for the engagement scale in the current study was .95.

Computer Playfulness

Computer playfulness reflects an individual’s cognitive spontaneity and tendency
to interact inventively and imaginatively with computers (Webster & Martocchio, 1992).
The seven-item scale is a subscale of Webster & Martocchio’s initial 22-item Computer
Playfulness Scale (CPS). The scale asks students to indicate their degree of agreement or
disagreement with adjectives indicating how they would describe themselves when
interacting with a computer (sample adjective items are “spontaneous” and “creative”).
The seven items used have been found to represent a reliable, unidimensional scale, with
Cronbach’s alpha coefficient ranging from .86 to .94 (Webster & Martocchio, 1992;
Yager et al., 1997). The same seven item subscale was also used by Potosky (2002). The
alpha coefficient in the present study was .78 for this scale.

Achievement Goal Orientation

A student’s achievement goal orientation is that student’s objective when
performing an academic task (Pintrich & Schunk, 1996). The 16-item scale to be used in
this study was derived from the Patterns of Adaptive Learning Survey (PALS)
(Middleton & Midgely, 1997) and adapted to reflect goals related to academic success. A student may have mastery goals, performance-approach goals, and performance-avoid goals. Mastery goals reflect a student’s desire to learn or master a task (Elliot & Harackiewicz, 1996). The scale includes five mastery goal items (sample item: “I like mathematics assignments I can learn from, even if I make a lot of mistakes”). Performance-approach goals reflect a student’s desire to appear competent. The scale includes five performance-approach items (sample item: “I’d like to show my math instructor that I’m smarter than the other students in my math class”). Performance-avoid goals reflect a student’s desire to avoid appearing incompetent. The scale includes six performance-avoid items (sample item: “One reason I might not participate in math class is to avoid looking stupid”). Alpha coefficients for this scale have ranged from .77 to .89 (Middleton & Midgley, 1997; Pajares et al., 2000; Pajares & Valiante, 2001). In the current study, the alpha coefficients obtained were .80 for the mastery goals scale, .72 for the performance-avoid scale, and .83 for the performance-approach scale.

**Gender Orientation**

Gender orientation reflects a person’s stereotypic beliefs about gender. Researchers now agree that gender orientation is not unidimensional with a high masculinity score always coinciding with a low femininity score or vice versa. Rather, masculinity and femininity are viewed as orthogonal variables representing two separate dimensions of an individual’s self-conception. A person may have a high score in both masculinity and femininity dimensions (androgyny), a low score in both dimensions (undifferentiated), or a high score in one dimension and a low score in the other
(Boldizar, 1991; Harter, Waters, & Whitesell, 1997; Spence, 1991). The two 10-item scales (one for masculinity and one for femininity) contain items used by Harter et al. (1997) and by Pajares and Valiante (2001). These items are adapted primarily from the short form of the Children’s Sex Role Inventory (CSRI) (Boldizar, 1991). A sample masculinity item is “I like building and fixing things,” and a sample femininity item is “I am a warm person and express these feelings to those I feel close to.” Researchers have reported a Cronbach’s alpha ranging from .69 to .80 for the masculinity scale and .83 to .88 for the femininity scale (Britner, 2002; Oberman, 2002; Pajares & Valiante, 2001). In the present study, the alpha coefficients obtained were .76 for the masculinity scale and .85 for the femininity scale.

**Mathematics Achievement**

Students’ mathematics achievement was represented by both their final course grade and their score on the departmental final exam. Both of these items were obtained from the course instructor.

**Data Collection**

Participants completed all scales in the instrument during the first six weeks of class, with the exception of the scales measuring mathematics exam self-efficacy and engagement with courseware. The students did not have enough exposure to the courseware early in the semester to report their behavior with the courseware accurately. Participants completed a second survey at or after mid-term, which measured engagement with courseware, and mathematics exam score self-efficacy.
Analysis

For each setting (traditional and online), the mean and standard deviation of every other variable was computed, and correlations between each pair of variables were computed within each setting. The SAS instructions used for these computations in each of the two settings appear below.

<table>
<thead>
<tr>
<th>Instructions</th>
<th>Variable</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>DATA GrpTrad; SET BASIC; IF SETTING = 1; PROC CORR DATA=GrpTrad; VAR AG_M AG_AV AG_P GO_F GO_M MGSEF SE_SR CSE CP ENG EXAM GENDER; RUN;</td>
<td>SETTING</td>
<td>Course setting</td>
</tr>
<tr>
<td></td>
<td>AG_M</td>
<td>Mastery goals</td>
</tr>
<tr>
<td></td>
<td>AG_AV</td>
<td>Performance avoid goals</td>
</tr>
<tr>
<td></td>
<td>AG_P</td>
<td>Performance approach goals</td>
</tr>
<tr>
<td></td>
<td>GO_F</td>
<td>Femininity</td>
</tr>
<tr>
<td></td>
<td>GO_M</td>
<td>Masculinity</td>
</tr>
<tr>
<td></td>
<td>MGSEF</td>
<td>Mathematics grade self-efficacy</td>
</tr>
<tr>
<td></td>
<td>SE_SR</td>
<td>Self-efficacy for self-regulation</td>
</tr>
<tr>
<td></td>
<td>CSE</td>
<td>Computer self-efficacy</td>
</tr>
<tr>
<td></td>
<td>CP</td>
<td>Computer playfulness</td>
</tr>
<tr>
<td></td>
<td>ENG</td>
<td>Engagement</td>
</tr>
<tr>
<td></td>
<td>EXAM</td>
<td>Final exam score</td>
</tr>
<tr>
<td></td>
<td>GENDER</td>
<td>Student gender</td>
</tr>
</tbody>
</table>

After means and correlations were computed in each setting, the mean of each variable was compared between the two settings to determine if the mean was significantly different in one group than in another. The test for statistically significant difference in means between the two groups was conducted using Tukey’s HSD (honestly significant difference) test, $\alpha = .05$. Below are the SAS instructions used to conduct Tukey’s HSD test, using the same variables as shown above.

<table>
<thead>
<tr>
<th>Instructions</th>
<th>Variable</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROC GLM DATA=BASIC; CLASS SETTING; MODEL GO_M GO_F AG_M AG_AV AG_P MGSEF SE_SR CSE CP ENG EXAM GENDER = SETTING; MEANS SETTING / TUKEY;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
To determine the degree to which course setting, gender, computer self-efficacy, computer playfulness, self-efficacy for self-regulation, and achievement goal orientation predicted engagement with courseware, a hierarchical multiple regression analysis was conducted. The first regression model included only course setting, gender, and the interaction between course setting and gender as predictors of engagement. The second model added computer self-efficacy, computer playfulness, and self-efficacy for self-regulation to those variables included in the first step. The third model added mastery goals, performance avoid goals, and performance approach goals to those variables included in the first and second steps. The SAS instructions used to conduct this analysis appear below.

<table>
<thead>
<tr>
<th>Instructions</th>
<th>Variable</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROC REG DATA=BASIC; MODEL ENG = SETTING GENDER IntSG / STB; RUN;</td>
<td>SETTING</td>
<td>Course setting</td>
</tr>
<tr>
<td>PROC REG DATA=BASIC; MODEL ENG = SETTING GENDER CSE CP SE_SR / STB; RUN;</td>
<td>GENDER</td>
<td>Student gender</td>
</tr>
<tr>
<td></td>
<td>IntSG</td>
<td>Setting x gender interaction</td>
</tr>
<tr>
<td></td>
<td>CSE</td>
<td>Computer self-efficacy</td>
</tr>
<tr>
<td></td>
<td>CP</td>
<td>Computer playfulness</td>
</tr>
<tr>
<td></td>
<td>SE_SR</td>
<td>Self-efficacy for self-regulation</td>
</tr>
<tr>
<td>PROC REG DATA=BASIC; MODEL ENG = SETTING GENDER CSE CP SE_SR AG_M AG_AV AG_P / STB; RUN;</td>
<td>AG_M</td>
<td>Mastery goals</td>
</tr>
<tr>
<td></td>
<td>AG_AV</td>
<td>Performance avoid goals</td>
</tr>
<tr>
<td></td>
<td>AG_P</td>
<td>Performance approach goals</td>
</tr>
<tr>
<td></td>
<td>ENG</td>
<td>Engagement</td>
</tr>
</tbody>
</table>

To determine the degree to which course setting, gender, mathematics grade self-efficacy, computer playfulness, self-efficacy for self-regulation, engagement with courseware, and achievement goal orientation predict mathematics achievement, a second hierarchical multiple regression analysis was conducted. The structure of this analysis was similar to that of the first regression analysis used to predict engagement, except that...
mathematics grade self-efficacy replaced computer self-efficacy, and courseware engagement was an additional variable included in the second model of the analysis. Therefore, the first model included course setting, gender, and their interaction; the second model added mathematics grade self-efficacy, computer playfulness, self-efficacy for self-regulation, and engagement; and the third model added mastery goals, performance avoid goals, and performance approach goals. The SAS instructions used to conduct this analysis appear below.

<table>
<thead>
<tr>
<th>Instructions</th>
<th>Variable</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROC REG DATA=BASIC;</td>
<td>SETTING</td>
<td>Course setting</td>
</tr>
<tr>
<td>MODEL EXAM = SETTING GENDER IntSG / STB;</td>
<td>GENDER</td>
<td>Student gender</td>
</tr>
<tr>
<td>RUN;</td>
<td>IntSG</td>
<td>Setting × gender interaction</td>
</tr>
<tr>
<td>PROC REG DATA=BASIC;</td>
<td>MGSEF</td>
<td>Mathematics grade self-efficacy</td>
</tr>
<tr>
<td>MODEL EXAM = SETTING GENDER IntSG MGSEF CP</td>
<td>CP</td>
<td>Computer playfulness</td>
</tr>
<tr>
<td>SE_SR ENG / STB;</td>
<td>SE_SR</td>
<td>Self-efficacy for self-regulation</td>
</tr>
<tr>
<td>RUN;</td>
<td>ENG</td>
<td>Engagement</td>
</tr>
<tr>
<td>PROC REG DATA=BASIC CORR;</td>
<td>AG_M</td>
<td>Mastery goals</td>
</tr>
<tr>
<td>MODEL EXAM = SETTING GENDER IntSG MGSEF CP</td>
<td>AG_AV</td>
<td>Performance avoid goals</td>
</tr>
<tr>
<td>SE_SR ENG AG_M AG_AV AG_P / STB;</td>
<td>AG_P</td>
<td>Performance approach goals</td>
</tr>
<tr>
<td>RUN;</td>
<td>EXAM</td>
<td>Final exam score</td>
</tr>
</tbody>
</table>

Finally, additional hierarchical regression analyses were planned to determine whether gender differences in engagement or in achievement are a function of gender orientation. However, because no significant gender differences were detected in either engagement or achievement, these analyses were not conducted.

Plots of residuals from each regression analysis were examined to ensure that assumptions of normality and homoscedasticity were met. All analyses were conducted using the SAS system (SAS Institute, 1999).
CHAPTER 4
RESULTS

In this section, I provide descriptive statistics for the variables examined in the current study. Next, I describe the results of data analyses conducted to address each research question in the study. Finally, I address some additional findings that were evident in the data collected.

Descriptive Statistics

Table 1 shows means, standard deviations, and correlations for the variables in the study by setting (traditional and online).

In the traditional setting, engagement significantly correlated only with self-efficacy for self-regulation ($r = .24$). However, engagement in the online setting was associated not only with self-regulation ($r = .41$) but also with mastery goals ($r = .39$), computer self-efficacy ($r = .26$) and computer playfulness ($r = .23$). Engagement also differed significantly between the traditional and online groups, with online students predictably reporting higher levels of engagement ($M = 3.88$) than did traditional students ($M = 1.13$).
|                  | Traditional          |                      | 1 | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | Online          |                      |
|------------------|----------------------|----------------------|---|----|----|----|----|----|----|----|----|----|----|----|----|----------------|--|------------------|
|                  | Mean     | SD      | 1   | 2  | 3  | 4  | 5  | 6  | 7  | 8  | 9  | 10 | 11 | 12 | 13 | Mean     | SD      |
| 1 AG-Mastery     | 4.70     | 0.99    | 0.03 | -0.11 | 0.43** | 0.46*** | 0.24 | 0.14 | 0.39** | 0.13 | 0.40** | 0.19 | 0.02 | -0.04 | 4.59    | 1.09    |
| 2 AG-Approach    | 3.35     | 1.22    | -0.04 | 0.44*** | 0.30*  | 0.15 | 0.16 | 0.08 | -0.11 | 0.23* | 0.42** | 0.13 | 0.31 | -0.27* | 3.39    | 1.38    |
| 3 AG-Avoid       | 2.41     | 1.02    | -0.09 | 0.41**** | 0.02  | 0.09 | 0.10 | -0.22 | -0.11 | 0.33* | 0.17 | -0.16 | -0.02 | 2.42    | 0.97    |
| 4 Math Grade SE  | 4.13a    | 1.54    | 0.22* | 0.20 | -0.16 | 0.52*** | 0.07 | 0.04 | 0.21 | 0.47*** | 0.35* | 0.16 | -0.10 | -0.19 | 3.466   | 1.47    |
| 5 SE for Self-Reg| 4.35     | 0.94    | 0.02 | -0.18 | 0.42*** | 0.12 | -0.01 | 0.41** | 0.30* | 0.14 | 0.24* | 0.08 | 0.18 | 4.11    | 1.02    |
| 6 Computer SE    | 4.57a    | 1.18    | 0.19 | 0.10 | 0.10 | 0.29* | 0.54*** | 0.26* | 0.07 | 0.46*** | 0.16 | -0.13 | -0.18 | 5.276   | 0.88    |
| 7 Comp Playfulness| 4.43a   | 0.95    | 0.10 | -0.18 | 0.16 | 0.08 | 0.08 | 0.47*** | 0.23* | 0.06 | 0.22 | 0.29* | 0.09 | -0.13 | 4.806   | 0.80    |
| 8 Engagement     | 1.13a    | 1.64    | 0.10 | -0.13 | 0.08 | 0.05 | 0.24* | 0.12 | 0.09 | 0.13 | 0.13 | 0.28* | 0.11 | 3.886   | 1.44    |
| 9 Achievement    | 70.51a   | 16.85   | 0.25* | 0.00 | -0.23* | 0.46*** | 0.35** | 0.05 | -0.16 | -0.04 | 0.16 | -0.03 | 0.17 | 0.06 | 63.736  | 16.95   |
| 10 Masculinity   | 4.04a    | 0.80    | 0.28* | 0.32* | 0.28* | 0.28* | 0.27* | 0.34* | 0.12 | -0.02 | 0.11 | 0.05 | -0.20 | -0.34* | 4.336   | 0.87    |
| 11 Femininity    | 5.20     | 0.56    | 0.26* | -0.05 | 0.14 | 0.03 | 0.22* | 0.09 | 0.30* | -0.01 | -0.26* | 0.04 | 0.00 | 0.47*** | 5.21    | 0.61    |
| 12 Age           | 24.47a   | 6.86    | 0.02 | -0.23* | 0.07 | -0.31* | -0.16 | -0.13 | -0.08 | 0.13 | -0.04 | 0.09 | -0.05 | 0.19 | 28.746  | 7.78    |
| 13 Gender        | 0.22*    | -0.08   | -0.06 | 0.01 | 0.21 | -0.07 | 0.06 | 0.14 | 0.02 | -0.34* | 0.49*** | 0.06 | 0.05 | 0.06 | --      |         |

Note: Correlations below the diagonal are for students in traditional setting (N=88) and correlations above the diagonal are for online students (N=76). Means marked with different letters are statistically different.

*** $p<.0001$

** $p<.001$

* $p<.05$
In both traditional and online settings, achievement (as measured by exam score) correlated significantly with mathematics grade self-efficacy ($r = .46$ traditional, $r = .47$ online) and with self-efficacy for self-regulation ($r = .35$ traditional, $r = .30$ online). However, only in the traditional setting was achievement significantly positively associated with mastery goals ($r = .25$) and significantly negatively associated with performance avoid goals ($r = -.23$). In contrast, achievement was significantly associated with performance approach goals in the online group ($r = .23$), but no such correlation was apparent in the traditional group. Achievement was also significantly different between the traditional and online groups, with the traditional students on average scoring higher ($M = 70.51$) on the final exam than did the online students ($M = 63.73$).

Computer self-efficacy and computer playfulness were strongly associated in both settings ($r = .47$ in traditional setting, $r = .54$ in online setting). Computer self-efficacy also correlated significantly with masculinity in both settings, though the association was stronger in the online setting than in the traditional setting ($r = .34$ traditional, $r = .46$ online). Also, computer self-efficacy and self-efficacy for self-regulation showed a moderate but significant correlation in the traditional setting ($r = .29$), but were not significantly correlated in the online setting. Further, computer self-efficacy was moderately correlated with mastery goals ($r = .24$) in the online setting, but the corresponding association in the traditional setting ($r = .19$) was not significant. Finally, mean computer self-efficacy differed significantly between the traditional and online groups, with students in the online setting (not surprisingly) reporting higher computer self-efficacy ($M = 5.27$) than did the traditional students ($M = 4.57$).
In addition to being associated with computer self-efficacy, computer playfulness was also significantly associated with femininity in both settings (\( r = .30 \) traditional, \( r = .29 \) online). Further, as did the reported level of computer self-efficacy, the level of computer playfulness differed significantly between the traditional and the online groups (\( M = 4.43 \) traditional, \( M = 4.80 \) online).

Mathematics grade self-efficacy was significantly associated not only with achievement (as previously noted), but also with mastery goals, self-efficacy for self-regulation, and masculinity in both settings. Notably strong was the association between mathematics grade self-efficacy and self-regulation (\( r = .42 \) traditional, \( r = .52 \) online). Mathematics grade self-efficacy was also significantly correlated with performance approach goals in the online setting, although the corresponding association in the traditional setting was not significant. Students in the two settings also reported significantly different levels of mathematics grade self-efficacy (\( M = 4.13 \) traditional, \( M = 3.46 \) online).

No gender differences in engagement or achievement emerged in either course setting. Further, very few gender differences were apparent in other variables. A moderate significant association with mastery goals (\( r = .22 \), favoring women) was evident in the traditional setting, but not in the online setting. A moderate significant association with performance approach goals (\( r = -.27 \), favoring men) appeared in the online setting, but was weaker and not significant in the traditional setting.
Research Questions

**Question 1: Predictors of Engagement**

The first research question addresses to what degree course setting, gender, computer self-efficacy, computer playfulness, self-efficacy for self-regulation, and achievement goal orientation predict engagement with courseware. Table 2 shows the standardized regression coefficients obtained from the hierarchical multiple regression analysis conducted to answer this question. These results suggest that only course setting and self-efficacy for self-regulation significantly predicted student engagement with courseware.

Course setting was the strongest predictor of courseware engagement, with online students far more likely to engage than were traditional students ($\beta = -.69$ in Model 1 and $\beta = -.66$ in Model 2). Model 1, in which setting was the only significant predictor, explained 45% of the variance in engagement, $F(3,160) = 43.62, p < .0001$.

| Table 2. Standardized Regression Coefficients for Variables Predicting Engagement |
|---------------------------------|------------------|------------------|------------------|
|                                 | Model 1          | Model 2          | Model 3          |
| Setting                        | -.693***         | -.656***         | -.658***         |
| Gender                         | .075             | .059             | .044             |
| Setting * Gender               | .037             |                  |                  |
| Comp. Self-Efficacy            |                  | .055             | .065             |
| Comp. Playfulness              |                  | .077             | .058             |
| SE Self-Regulation             |                  | .210**           | .184*            |
| Mastery Goals                  |                  |                  | .064             |
| Perf. Avoid Goals              |                  |                  | -.051            |
| Perf. Approach Goals           |                  |                  | -.072            |
| $R^2$                          | .45***           | .51***           | .53***           |
| Change in $R^2$                | .06**            |                  | .02              |

*p < .01, **p < .001, ***p < .0001
In Model 2, self-efficacy for self-regulation was introduced as another significant predictor of engagement ($\beta = .21$). This model explained an additional 6% of the variance in courseware engagement, $F(5,158) = 32.97$, $p < .0001$. Model 3 did not achieve a significant increase in $R^2$ over that of Model 2.

**Question 2: Predictors of Achievement**

The second research question addresses to what degree course setting, gender, mathematics grade self-efficacy, computer playfulness, self-efficacy for self-regulation, courseware engagement, and achievement goal orientation predict mathematics achievement. Table 3 shows the standardized regression coefficients obtained from the hierarchical multiple regression analysis conducted to answer this question. These results suggest that mathematics grade self-efficacy and self-efficacy for self-regulation were the most significant predictors of mathematics achievement.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>.124</td>
<td>.051</td>
<td>.049</td>
</tr>
<tr>
<td>Gender</td>
<td>-.056</td>
<td>-.012</td>
<td>-.008</td>
</tr>
<tr>
<td>Setting * Gender</td>
<td>.093</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math Grade Self-Efficacy</td>
<td></td>
<td>.401***</td>
<td>.375***</td>
</tr>
<tr>
<td>Comp. Playfulness</td>
<td>-.137</td>
<td>-.122</td>
<td></td>
</tr>
<tr>
<td>SE Self-Regulation</td>
<td>.149*</td>
<td>.131</td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td>-.020</td>
<td>-.038</td>
<td></td>
</tr>
<tr>
<td>Mastery Goals</td>
<td></td>
<td>.024</td>
<td></td>
</tr>
<tr>
<td>Perf. Avoid Goals</td>
<td></td>
<td>-.134</td>
<td></td>
</tr>
<tr>
<td>Perf. Approach Goals</td>
<td></td>
<td></td>
<td>.052</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.04</td>
<td>.28***</td>
<td>.29***</td>
</tr>
<tr>
<td>Change in $R^2$</td>
<td>.24**</td>
<td>.01</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05, **p < .01, ***p < .0001
No predictor in Model 1 reached significance, and the model itself was not significant, $F(3,160) = 2.26, p = .08$.

In Model 2, two predictors of achievement reached significance. These were mathematics grade self-efficacy ($\beta = .40$) and self-efficacy for self-regulation ($\beta = .15$). This model accounted for 28% of the variance in achievement, $F(6,157) = 10.17, p < .0001$. Model 3 did not achieve a significant increase in $R^2$ over that of Model 2.

**Question 3: Role of Gender Orientation**

The aim of the third research question was to determine if gender differences in engagement and/or achievement could be accounted for by gender orientation. However, because no gender differences were evident in engagement or achievement, no analyses were conducted to address this question.

**Additional Findings**

**Setting and Ethnicity**

Previous research has raised a question about the ethnic composition of online and traditional classes (Spence, 2002). However, the sample size in Spence’s qualitative study was not sufficient to establish whether online and traditional sections differed significantly by ethnicity. Therefore, ethnicity of participants was tracked in the present study so that the relationship between ethnicity and setting could be examined. Table 4 shows the distribution of participants by ethnicity for the online and traditional settings. Black and White participants comprised over 80% of the total sample. Therefore, because too few participants were in other ethnic categories, a valid chi-square test on the full sample was questionable. A second analysis was performed using only those
participants who identified themselves as Black or White. Table 5 shows the distribution of only the Black and White participants by setting.

Table 4. Distribution by Ethnicity in Online and Traditional Settings (All Participants)

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Frequency</th>
<th>Percent</th>
<th>Row Percent</th>
<th>Column Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Online</td>
<td>Traditional</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Asian</td>
<td>1</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.61</td>
<td>3.66</td>
<td>4.27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14.29</td>
<td>85.71</td>
<td>6.82</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.32</td>
<td>6.82</td>
<td>1.32</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>31</td>
<td>59</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18.90</td>
<td>35.98</td>
<td>54.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td>34.44</td>
<td>65.56</td>
<td>67.05</td>
<td></td>
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<td></td>
<td>40.79</td>
<td>67.05</td>
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<td>6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.00</td>
<td>3.66</td>
<td>3.66</td>
<td></td>
</tr>
<tr>
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<td>100.00</td>
<td>100.00</td>
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<tr>
<td></td>
<td>0.00</td>
<td>6.82</td>
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<td></td>
</tr>
<tr>
<td>Native American</td>
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<td>2</td>
<td></td>
</tr>
<tr>
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<td>0.00</td>
<td>1.22</td>
<td>1.22</td>
<td></td>
</tr>
<tr>
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<td></td>
<td>0.00</td>
<td>6.82</td>
<td>6.82</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
<td>8</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.05</td>
<td>4.88</td>
<td>7.93</td>
<td></td>
</tr>
<tr>
<td></td>
<td>38.46</td>
<td>61.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>6.58</td>
<td>9.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>39</td>
<td>7</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>23.78</td>
<td>4.27</td>
<td>28.05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>84.78</td>
<td>15.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>51.32</td>
<td>7.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>76</td>
<td>88</td>
<td>164</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td>46.34</td>
<td>53.66</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Distribution of Black and White Participants in Online and Traditional Settings

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Frequency</th>
<th>Percent</th>
<th>Row Percent</th>
<th>Column Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Online</td>
<td>Traditional</td>
<td>Total</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>31</td>
<td>59</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.79</td>
<td>43.38</td>
<td>66.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>34.44</td>
<td>65.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>44.29</td>
<td>89.39</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>39</td>
<td>7</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td></td>
<td>28.68</td>
<td>5.15</td>
<td>33.82</td>
<td></td>
</tr>
<tr>
<td></td>
<td>84.78</td>
<td>15.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>55.71</td>
<td>10.61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>66</td>
<td>136</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td>51.47</td>
<td>48.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A chi-square test on both distributions suggested that course setting and ethnicity were not independent. In particular, a significantly greater percentage of online students were White, whereas a significantly greater portion of traditional students were Black. Further, Asian, Hispanic, and Native American students also appear to be better represented in the traditional setting than in the online setting, which contained no Hispanic or Native American participants and only one Asian participant.

**Contribution of Age**

Age was not a factor in any of the research questions or in the models used to address those questions. However, age was significantly associated with some variables in the study. Therefore, the means, standard deviations, and correlations shown in Table 1 include the age variable.

The mean age of participants in the online group ($M = 28.73$) was slightly higher than of those in the traditional group ($M = 24.47$), but the difference was statistically significant by Tukey’s HSD test.

Age was significantly inversely correlated with performance approach goals in both settings, suggesting that older students were less concerned with demonstrating their competence ($r = -.23$ traditional, $r = -.31$ online). Mathematics grade self-efficacy was significantly inversely correlated with age in the traditional setting ($r = -.31$), suggesting that older students had less confidence in their ability to perform well on the mathematics exam. However, this association was smaller and nonsignificant in the online group. Finally, age correlated significantly with engagement in the online group ($r = .28$), suggesting that among online participants, older students were more likely to engage with
the courseware. However, the association was weaker and not significant in the traditional group.

Because age correlated significantly with these variables and with engagement in particular, additional analyses were conducted, adding age as a predictor variable to the multiple regression analyses predicting engagement and achievement. Age and the interaction of age with setting were introduced to each of the analyses.

**Age as a predictor of engagement.** Table 6 shows the results of the modified multiple regression analysis conducted to predict engagement with courseware.

**Table 6. Standardized Regression Coefficients for Variables Predicting Engagement with Age Included as a Predictor**

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>-.535*</td>
<td>-.602***</td>
<td>-.608***</td>
</tr>
<tr>
<td>Age</td>
<td>.186*</td>
<td>.173*</td>
<td>.156*</td>
</tr>
<tr>
<td>Gender</td>
<td>.038</td>
<td>.039</td>
<td>.034</td>
</tr>
<tr>
<td>Setting * Age</td>
<td>-.146</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setting * Gender</td>
<td>.075</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comp. Self-Efficacy</td>
<td>.070</td>
<td>.075</td>
<td></td>
</tr>
<tr>
<td>Comp. Playfulness</td>
<td>.084</td>
<td>.073</td>
<td></td>
</tr>
<tr>
<td>SE Self-Regulation</td>
<td>.217**</td>
<td>.187*</td>
<td></td>
</tr>
<tr>
<td>Mastery Goals</td>
<td>.057</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perf. Avoid Goals</td>
<td>-.055</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perf. Approach Goals</td>
<td>-.030</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>.47***</td>
<td>.54***</td>
<td>.55***</td>
</tr>
<tr>
<td>Change in $R^2$</td>
<td>.07***</td>
<td>.01</td>
<td></td>
</tr>
</tbody>
</table>

* $p < .01$, ** $p < .001$, *** $p < .0001$

Model 1 in this analysis achieved an increase in $R^2$ over Model 1 in the corresponding analysis without age (shown previously in Table 2). The increase of .02 in $R^2$ was statistically significant, $F(2,158) = 3.29, p < .05$. The model still revealed setting
as a significant predictor of engagement with courseware ($\beta = -.54$). Further, this model
disclosed age to be another significant predictor of engagement ($\beta = .19$). The model
explained 47% of the variance in engagement, $F(5,158) = 28.09, p < .0001$.

Likewise, Model 2 yielded an increase in $R^2$ of .03 over the corresponding Model
2 in the previous analysis without age. The increase was again significant, $F(1,157) =
8.82, p < .01$. The significant predictors of engagement that emerged in Model 2 were
setting ($\beta = -.60$), age ($\beta = .17$), and self-efficacy for self-regulation ($\beta = .22$). This model
accounted for an additional 7% of the variance in engagement, for a total of 54%,
$F(6,157) = 30.38, p < .001$. As before, Model 3 did not yield an $R^2$ significantly higher
than that of Model 2.

**Age as a predictor of achievement.** Table 7 shows the results of the modified
multiple regression analysis conducted to predict achievement.

<table>
<thead>
<tr>
<th></th>
<th>Model 1</th>
<th>Model 2</th>
<th>Model 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>.512</td>
<td>.063</td>
<td>.068</td>
</tr>
<tr>
<td>Age</td>
<td>.183</td>
<td>.163*</td>
<td>.167*</td>
</tr>
<tr>
<td>Gender</td>
<td>-.093</td>
<td>-.026</td>
<td>-.016</td>
</tr>
<tr>
<td>Setting * Age</td>
<td>-.403</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Setting * Gender</td>
<td>.139</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Math Grade Self-Efficacy</td>
<td>.433***</td>
<td>.400***</td>
<td></td>
</tr>
<tr>
<td>Comp. Playfulness</td>
<td>-.119</td>
<td>-.122</td>
<td></td>
</tr>
<tr>
<td>SE Self-Regulation</td>
<td>.153*</td>
<td>.136</td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td>-.066</td>
<td>-.080</td>
<td></td>
</tr>
<tr>
<td>Mastery Goals</td>
<td></td>
<td>.017</td>
<td></td>
</tr>
<tr>
<td>Perf. Avoid Goals</td>
<td></td>
<td>-.135</td>
<td></td>
</tr>
<tr>
<td>Perf. Approach Goals</td>
<td></td>
<td>.087</td>
<td></td>
</tr>
<tr>
<td>$R^2$</td>
<td>.06</td>
<td>.30***</td>
<td>.32***</td>
</tr>
<tr>
<td>Change in $R^2$</td>
<td>.24**</td>
<td>.02</td>
<td></td>
</tr>
</tbody>
</table>

*p < .05, **p < .01, ***p < .0001
As with the initial regression analysis predicting achievement (shown in Table 3), no predictor reached significance in Model 1, and the model itself was not significant, $F(5,158) = 1.92, p = .09$.

However, Model 2 in the modified analysis produced an increase of .02 in $R^2$ over Model 2 in the initial analysis. This increase was significant, $F(1, 156) = 4.92, p < .05$. Further, Model 2 revealed age as a significant predictor of achievement ($\beta = .16$), in addition to same predictors yielded by Model 2 in the initial analysis, mathematics grade self-efficacy ($\beta = .43$) and self-efficacy for self-regulation ($\beta = .15$). The model was significant, $F(7,157) = 9.64, p < .0001$. Finally, as with the initial analysis predicting achievement, Model 3 did not yield an $R^2$ significantly higher than that of Model 2.

Factors Associated with Late Attrition

Based on the instructor rolls of participating classes, 35-50% of students in every class dropped the course before mid-semester and received a grade of ‘W’ indicating their withdrawal. Those students were not included in the original sample of 182 participants because they did not complete all of the surveys, some of which were given after the midterm. Students who dropped early may have done so for any number of reasons and did not suffer particularly adverse consequences.

However, those students who stayed in the class past the semester midpoint and then chose not to finish the course were given a grade of F, which adversely affected their academic record. It should be noted that tests and midterm exams were given, scored, and returned to students before the semester midpoint, giving students who performed poorly an opportunity to withdraw before the mid-semester deadline without receiving an F in
the class. Of the original sample of 182 participants who remained in the course past mid-
semester, 18 students chose not to take the final exam, thereby receiving an F in the class. These participants represent those students who did not drop the course early, but who chose not to finish some time after mid-semester. According to their instructors, these students did not request an alternate exam date to accommodate extenuating circumstances; rather, they simply did not show up for the exam. Because a course grade is at stake, a 10% attrition rate after mid-semester seems high and is cause for concern.

Therefore, all variables in the study were compared between those students who completed the course and those who chose not to finish after mid-semester. Table 8 shows the mean and standard deviation of each variable for those who finished and those who did not.

Table 8. *Means and Standard Deviations of Variables in the Study for Students Finishing and Not Finishing Course After Mid-Semester Withdrawal Deadline*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Students Finishing</th>
<th></th>
<th>Students Not Finishing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Masculinity</td>
<td>4.17</td>
<td>0.84</td>
<td>4.07</td>
<td>0.76</td>
</tr>
<tr>
<td>Femininity</td>
<td>5.21</td>
<td>0.58</td>
<td>5.22</td>
<td>0.52</td>
</tr>
<tr>
<td>Mastery Goals</td>
<td>4.65</td>
<td>1.04</td>
<td>4.29</td>
<td>1.08</td>
</tr>
<tr>
<td>Performance Avoid Goals</td>
<td>2.42a</td>
<td>0.99</td>
<td>2.94b</td>
<td>1.09</td>
</tr>
<tr>
<td>Performance Approach Goals</td>
<td>3.37</td>
<td>1.30</td>
<td>3.38</td>
<td>1.51</td>
</tr>
<tr>
<td>Mathematics Grade Self-Efficacy</td>
<td>3.82</td>
<td>1.54</td>
<td>3.22</td>
<td>1.47</td>
</tr>
<tr>
<td>Self-Efficacy for Self-Regulation</td>
<td>4.24a</td>
<td>0.98</td>
<td>3.57b</td>
<td>1.19</td>
</tr>
<tr>
<td>Computer Self-Efficacy</td>
<td>4.89</td>
<td>1.11</td>
<td>5.11</td>
<td>0.99</td>
</tr>
<tr>
<td>Computer Playfulness</td>
<td>4.60</td>
<td>0.90</td>
<td>4.46</td>
<td>0.91</td>
</tr>
<tr>
<td>Engagement</td>
<td>2.40</td>
<td>2.07</td>
<td>2.44</td>
<td>1.98</td>
</tr>
<tr>
<td>Age</td>
<td>26.45</td>
<td>7.58</td>
<td>27.50</td>
<td>9.61</td>
</tr>
</tbody>
</table>

Note: Means marked with different letters are statistically different ($\alpha < .05$) according to Tukey’s HSD Test.
Students who chose not to finish the course after mid-semester had significantly higher performance avoid goals (M = 2.94) than did their classmates who finished the course (M = 2.42). Further, students who did not finish had significantly lower self-efficacy for self-regulation (M = 3.57) than did those who finished (M = 4.24).

Although these figures are revealing, they omit setting and gender, which were also examined. Table 9 shows the distribution by setting of students who did and did not finish, and table 10 shows the distribution by gender of those who did and did not finish.

Table 9. Distribution of Online and Traditional Participants Who Finished or Did Not Finish Course After Mid-Semester Withdrawal Deadline

<table>
<thead>
<tr>
<th></th>
<th>Finished</th>
<th>Did Not Finish</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Online</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>76</td>
<td>10</td>
<td>86</td>
</tr>
<tr>
<td>Percent</td>
<td>41.76</td>
<td>5.49</td>
<td>47.25</td>
</tr>
<tr>
<td>Row Percent</td>
<td>88.37</td>
<td>11.63</td>
<td></td>
</tr>
<tr>
<td>Column Percent</td>
<td>46.34</td>
<td>55.56</td>
<td></td>
</tr>
<tr>
<td><strong>Traditional</strong></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>88</td>
<td>8</td>
<td>96</td>
</tr>
<tr>
<td>Percent</td>
<td>48.35</td>
<td>4.40</td>
<td>52.75</td>
</tr>
<tr>
<td>Row Percent</td>
<td>91.67</td>
<td>8.33</td>
<td></td>
</tr>
<tr>
<td>Column Percent</td>
<td>53.66</td>
<td>44.44</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>164</td>
<td>18</td>
<td>182</td>
</tr>
<tr>
<td>Frequency</td>
<td>90.11</td>
<td>9.89</td>
<td></td>
</tr>
</tbody>
</table>

Table 10. Distribution of Male and Female Participants Who Finished or Did Not Finish Course After Mid-Semester Withdrawal Deadline

<table>
<thead>
<tr>
<th></th>
<th>Finished</th>
<th>Did Not Finish</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Male</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>37</td>
<td>6</td>
<td>43</td>
</tr>
<tr>
<td>Percent</td>
<td>20.33</td>
<td>3.30</td>
<td>23.63</td>
</tr>
<tr>
<td>Row Percent</td>
<td>86.05</td>
<td>13.95</td>
<td></td>
</tr>
<tr>
<td>Column Percent</td>
<td>22.56</td>
<td>33.33</td>
<td></td>
</tr>
<tr>
<td><strong>Female</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>127</td>
<td>12</td>
<td>139</td>
</tr>
<tr>
<td>Percent</td>
<td>69.78</td>
<td>6.59</td>
<td>76.37</td>
</tr>
<tr>
<td>Row Percent</td>
<td>91.37</td>
<td>8.63</td>
<td></td>
</tr>
<tr>
<td>Column Percent</td>
<td>77.44</td>
<td>66.67</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>164</td>
<td>18</td>
<td>182</td>
</tr>
<tr>
<td>Frequency</td>
<td>90.11</td>
<td>9.89</td>
<td>100.00</td>
</tr>
</tbody>
</table>
These figures seem to suggest that students who chose not to finish the course were evenly divided between the traditional and online settings. The division by gender is more difficult to interpret because women participants so heavily outnumbered men participants. Although twice as many women elected not to finish after mid-semester as did men, the total number of women participating was over three times that of men. Nevertheless, a chi-square test did not reveal a significant association between gender and the decision to finish.

However, further examination of the data revealed a potential imbalance when the participants who elected not to finish were examined by both setting and gender simultaneously. Tables 11 and 12 show the distribution by gender of students who did or did not finish in the online and traditional settings, respectively. Tables 13 and 14 show the distribution by setting of students who did or did not finish for men and women, respectively.

Table 11. Distribution of Male and Female Online Participants Who Finished or Did Not Finish Course After Mid-Semester Withdrawal Deadline

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Row Percent</th>
<th>Column Percent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Finished</td>
<td>Did Not Finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>17</td>
<td>1</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>19.77</td>
<td>1.16</td>
<td></td>
<td>20.93</td>
</tr>
<tr>
<td></td>
<td>94.44</td>
<td>5.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22.37</td>
<td>10.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>59</td>
<td>9</td>
<td></td>
<td>68</td>
</tr>
<tr>
<td></td>
<td>68.60</td>
<td>10.47</td>
<td></td>
<td>79.07</td>
</tr>
<tr>
<td></td>
<td>86.76</td>
<td>13.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>77.63</td>
<td>90.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>76</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>88.37</td>
<td>11.63</td>
<td></td>
<td>100.00</td>
</tr>
</tbody>
</table>
Table 12. Distribution of Male and Female Traditional Participants Who Finished or Did Not Finish Course After Mid-Semester Withdrawal Deadline

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Row Percent</th>
<th>Column Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Finished</td>
<td>Did Not Finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>20</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>20.83</td>
<td>5.21</td>
<td>80.00</td>
<td>26.04</td>
</tr>
<tr>
<td></td>
<td>22.73</td>
<td>62.50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>68</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>70.83</td>
<td>3.13</td>
<td>95.77</td>
<td>73.96</td>
</tr>
<tr>
<td></td>
<td>77.27</td>
<td>4.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>88</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>91.76</td>
<td>8.33</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>

Chi-square tests for independence reached significance for the distribution shown in table 12 ($p = .01$), but not for that shown in table 11. The results suggest that gender and the decision to finish were not independent in the traditional setting. In other words, among traditional students, the proportion of men who elected not to finish after the semester mid-point was significantly higher than the proportion of women who did so.

Table 13. Distribution of Online and Traditional Male Participants Who Finished or Did Not Finish Course After Mid-Semester Withdrawal Deadline

<table>
<thead>
<tr>
<th></th>
<th>Frequency</th>
<th>Percent</th>
<th>Row Percent</th>
<th>Column Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Finished</td>
<td>Did Not Finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Online</td>
<td>17</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>39.53</td>
<td>2.33</td>
<td>94.44</td>
<td>41.86</td>
</tr>
<tr>
<td></td>
<td>45.95</td>
<td>16.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional</td>
<td>20</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>46.51</td>
<td>11.63</td>
<td>80.00</td>
<td>58.14</td>
</tr>
<tr>
<td></td>
<td>54.05</td>
<td>83.33</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>37</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>86.05</td>
<td>13.95</td>
<td>100.00</td>
<td></td>
</tr>
</tbody>
</table>
Table 14. Distribution of Online and Traditional Female Participants Who Finished or Did Not Finish Course After Mid-Semester Withdrawal Deadline

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Percent</th>
<th>Row Percent</th>
<th>Column Percent</th>
<th>Finished</th>
<th>Did Not Finish</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online</td>
<td></td>
<td></td>
<td></td>
<td>59</td>
<td>9</td>
<td>68</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>42.45</td>
<td>6.47</td>
<td>48.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>86.76</td>
<td>13.24</td>
<td>100.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>46.46</td>
<td>75.00</td>
<td>91.37</td>
</tr>
<tr>
<td>Traditional</td>
<td></td>
<td></td>
<td></td>
<td>68</td>
<td>3</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>48.92</td>
<td>2.16</td>
<td>51.08</td>
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<td>95.77</td>
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<td></td>
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<td></td>
<td></td>
<td>53.54</td>
<td>25.00</td>
<td>78.54</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td>127</td>
<td>12</td>
<td>139</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>91.37</td>
<td>8.63</td>
<td>100.00</td>
</tr>
</tbody>
</table>

Again, chi-square tests for independence reached significance for the distribution shown in table 14 ($p = .05$), but not for that shown in table 13. The results suggest that setting and the decision to finish were not independent among female participants. In other words, among women participants, the number of online students who elected not to finish after mid-semester was significantly higher than the number of traditional students who did so. Both sets of results suggest that the interaction of setting and gender may be a factor in students’ decisions about whether to finish the class.

A number of factors seemed to be associated with students’ decisions to finish or not finish the course. The factors of self-efficacy, performance avoid goals, and the interaction of setting with gender were all associated with students’ decisions to finish the course. These findings resonated with prior research in many ways. First is the contention that low self-efficacy prompts students to give up more easily on a task (Bandura, 1986). Researchers have also suggested that performance avoid goals influence student behavior.
(Pintrich & Schunk, 1996) and that a performance avoid orientation inhibits student achievement (Urdan & Maehr, 1995). Finally, the pattern of women participating in high technology settings less frequently than do men is well established (e.g., Bundersen & Christensen, 1995; Temple & Lips, 1989). Related to this pattern are findings that male students benefit from computer-based learning environments more than do female students (Light et al., 2000; Salerno, 1995). These findings paired with the observations about the data in the current study indicated that these variables (self-efficacy, performance avoid goals, and the gender-setting interaction) were likely to be significant predictors of students’ decisions to finish the course. However, a multiple regression was not appropriate to assess these variables as predictors because the outcome (the student’s decision) was binary—either to finish or not to finish. Therefore, a binary logistic regression analysis was performed to estimate the effect of these factors on the odds of a student deciding to finish the course. The results of this analysis are shown in Table 15.

Table 15. Standardized Logistic Regression Coefficients for Variables Affecting Odds of Students’ Decisions to Finish Course

<table>
<thead>
<tr>
<th>Logistic Regression Model</th>
<th>β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting</td>
<td>-.508</td>
</tr>
<tr>
<td>Gender</td>
<td>-.304</td>
</tr>
<tr>
<td>Setting * Gender</td>
<td>.749*</td>
</tr>
<tr>
<td>SE Self-Regulation</td>
<td>.358*</td>
</tr>
<tr>
<td>Computer Self-Efficacy</td>
<td>-.201</td>
</tr>
<tr>
<td>Math Grade Self-Efficacy</td>
<td>.038</td>
</tr>
<tr>
<td>Perf. Avoid Goals</td>
<td>-.208</td>
</tr>
<tr>
<td>$R^2_f$</td>
<td>.17*</td>
</tr>
<tr>
<td>$\Gamma$ (Gamma)</td>
<td>.61</td>
</tr>
</tbody>
</table>

*$p < .05$
The interaction of setting with gender did significantly affect the odds that a student would finish the course \( (\beta = .75) \). As expected, a student’s odds of finishing were increased for traditional female students over those of traditional male or online female students. Higher self-efficacy for self-regulation also significantly increased the odds that a student would finish the course \( (\beta = .36) \). However, the other self-efficacy measures (computer self-efficacy and mathematics grade self-efficacy) did not reach significance, nor did performance avoid goals.

The logistic regression model was significant, with a chi-square likelihood ratio of 16.70 \( (p < .05) \). Because the outcome of logistic regression analysis is binary, the \( R^2 \) statistic of .17 for the model cannot be interpreted as a proportion of variance explained by the model. However, the ratio may be taken as a measure of predictive value analogous to the \( R^2 \) statistic used for multiple regression (DeMaris, 1992). The gamma statistic also suggests that the model decreases prediction error by 61% over that of random prediction.
The primary objectives of this study were to examine factors that contribute to student engagement with courseware and to student mathematics achievement in learning environments where computer-based instruction is available to students. An additional objective was to examine the contribution of gender and gender orientation to engagement and achievement specifically. Although no meaningful analysis could be run to fulfill the third objective, the findings of the study suggest many patterns relevant to the research questions, to the complex relationships among several variables in the study, and to prior research. Implications for future research, as well as for instructional practices and policies, are also evident.

Research Questions

**Engagement**

The fact that course setting was the strongest predictor of engagement with courseware is not surprising. Students in the online setting had no other source of instruction and were required to use the courseware at least for assessment, whereas students in traditional sections had personal instruction and were not required to use the courseware at all.

Aside from the obvious factor of course setting, it is particularly interesting to note that engagement with courseware was predicted by another significant factor– self-
efficacy for self-regulation. The association with engagement is consistent with the notion that self-regulation is an indicator of engagement (Greene & Miller, 1996). In fact, self-efficacy for self-regulation was the only variable significantly associated with engagement in the traditional setting. Belief in the ability to regulate and monitor one’s own learning was a stronger force even than belief in one’s ability to work on a computer (computer self-efficacy). This result highlights the nature of the online learning environment in particular: Even more important than a student’s attitudes about computer-based work are the student’s attitudes about approaching the course with discipline and working well independently. This finding reinforces prior observations about the nature of online classes (Spence, 2002).

Age also emerged as a significant predictor of engagement. The findings suggest that older students were more likely to engage with the courseware than were younger students. It is possible that older students simply approach the course with more mature habits and are therefore more likely to engage with the courseware than are younger students. However, the lack of significant association between age and self-efficacy for self-regulation sheds doubt on whether this explanation fully captures the trend. In fact, the nonsignificant correlation between age and self-regulation in the traditional setting was negative. Further, when age was added to the regression models predicting engagement, age and self-regulation each made a significant independent contribution to the model. Therefore, the association between age and engagement cannot be attributed to self-regulation.
Similarly, age and computer self-efficacy were not significantly correlated in either setting. Thus, the data do not suggest that older students merely felt more comfortable with computers, thus leading them to engage more fully with the courseware. Likewise, no significant association between age and computer playfulness appeared in either setting, making it doubtful that older students engaged more with the courseware because they had greater cognitive spontaneity while working on computers.

Another possibility is that older students have more consistent and reliable access to computers, either because better financial means more often allow older students to own computers, or because older students have access to computers at their workplace due to better employment situations than their younger colleagues might enjoy. Clearly, reasons for the association between age and engagement need to be investigated further.

**Achievement**

Not only was self-efficacy for self-regulation a predictor of courseware engagement, but it was also a primary factor in the study that predicted both engagement and achievement. The association with achievement supports previous findings that self-efficacy for self-regulation predicts achievement in mathematics (Pajares, 2001; Pajares & Graham, 1999). The role that self-efficacy for self-regulation plays in student learning and achievement seems undeniable.

Mathematics grade self-efficacy was another primary predictor of mathematics achievement. This result is consistent with many similar findings that mathematics self-efficacy predicts mathematics performance (Graham, 2000; Pajares, 1996; Pajares & Graham, 1999; Pajares & Kranzler, 1995; Pajares & Miller, 1994). The significant
association between mathematics grade self-efficacy and self-efficacy for self-regulation in both settings also illuminates the possibility that some students confident of their mathematics performance may have felt such confidence in part because they knew they would monitor their learning effectively. Nevertheless, self-efficacy for self-regulation and mathematics grade self-efficacy each made an independent contribution to achievement in the regression model.

Age also emerged in one regression model as a significant predictor of achievement, suggesting that older students were more likely to perform well. The fact that age reached significance as a predictor of achievement in the modified analysis is somewhat surprising, given that age did not significantly correlate with achievement in either setting. Further, the nonsignificant correlations between age and achievement were negative in the traditional setting but positive in the online setting, although no significant interaction was detected in the regression analysis predicting achievement.

The significance of age as a predictor of achievement is also surprising because a negative association appeared between age and mathematics grade self-efficacy in both settings and was significant in the traditional group. Another surprising result is that in the first regression model designed to include age in predicting achievement, age was not significant; yet age reached significance as a predictor of achievement after other variables were introduced in the next model. These factors raise questions about the nature of the association between age and achievement and about the contribution and value of age in predicting achievement. Further exploration of these questions is in order.
Noticeably absent from the significant predictors of achievement was courseware engagement. This result suggests that students who engaged with the courseware did not perform significantly better than did those students who did not engage. It should be kept in mind, however, that this result is highly dependent on the courseware used in the present study. The features of the courseware in these learning environments matched those of the tutorial and drill-and-practice genres, rather than the simulation genre, as described by several researchers (e.g., Jonassen, 1988; McCoy, 1996). A number of findings have indicated that simulation programs foster higher levels of achievement than do drill-and-practice or tutorial programs (Connell, 1998; Khalili & Shashaani, 1994).

Moreover, evidence consistently suggests that courseware used in conjunction with traditional instruction yields higher student achievement than does courseware alone (Christmann & Badgett, 1999; Christmann et al., 1997b; Clariana, 1996). Because of the structure of the classes in the present study, this advantage was not leveraged. The students most likely to use the courseware were those who did not receive traditional instruction, whereas those who did receive traditional instruction were not required to use the courseware at all.

A related finding is that courseware is most effective in learning environments where an instructor provides direction and structure to the students’ use of the courseware (Edwards, 1991; Zehavi, 1995). In the present study, courseware use was completely optional and unstructured in the traditional environment. Likewise, in the online setting, courseware use was only required for assessment. Students in both settings received little guidance or direction, if any, in the use of the courseware. This pattern echoes
observations of participants in a prior study of the same environment; these participants noted that the courseware was not well integrated with the class (Spence, 2002). These factors likely mitigated the value of student engagement with the courseware and explain, at least in part, why engagement with courseware did not predict student achievement.

Relationships Among Variables

Achievement Goals

Many results regarding achievement goals in this study were consistent with previous findings. Mastery goals correlated significantly with engagement in the online setting ($r = .39$), supporting suggestions of numerous researchers (Elliot, McGregor, & Gable, 1999; Meece et al., 1988; Nolen, 1988; Nolen & Haladyna, 1990). However, mastery goals did not significantly correlate with engagement in the traditional setting, and the difference between correlations in the two settings was significant ($p < .05$). A likely explanation for the disparity is that students in the online setting with a strong desire to understand the material had fewer alternatives than did their counterparts in the traditional setting. Courseware was the primary learning source for online students, whereas an instructor’s explanations were a primary source for traditional students. Therefore, traditional students with strong mastery goals probably did not find the need to turn to the courseware for instruction as regularly as did the online students.

Performance-avoid goals correlated negatively with achievement in both settings, although the association was significant only in the traditional setting. A reasonable explanation for the association not reaching significance in the online setting is that avoiding the appearance of incompetence is likely to carry more weight in a traditional
classroom where a student can be seen by the instructor and by peers. In contrast, few
people witness an online student’s performance. Only the instructor, whom the student
rarely sees in person, knows the student’s performance. Nevertheless, the negative
association between performance-avoid goals and achievement in the traditional setting
supports prior findings that performance-avoid goals inhibit achievement (Pajares,
Britner, & Valiante, 2000; Urdan & Maehr, 1995).

Also not surprising is that performance-approach and performance-avoid goals
significantly correlated with each other in both settings, but mastery goals were not
positively associated with either type of performance goal. Given that mastery goals are
thought to enhance achievement, whereas performance-avoid goals constrain
achievement, this pattern makes sense.

It is also interesting to note that mastery goals were significantly associated with
self-efficacy for self-regulation in both settings, consistent with findings of Pintrich and
Garcia (1991). Likewise, mastery goals correlated significantly in both settings with
mathematics grade self-efficacy, also consistent with previous findings (Greene & Miller,
1996). However, although mastery goals were associated with both of these primary
predictors of achievement, mastery goals did not make a significant independent
contribution to achievement in the regression model. Further, the correlation of mastery
goals with achievement was noticeably stronger in the traditional environment than in the
online environment, and the association was significant only in the traditional setting.
This result may be related to prior observations about differences in the nature of
motivation between traditional and online settings (Spence, 2002). Students in the
traditional setting are face-to-face with an instructor at each class meeting, whereas online students answer in person primarily to themselves. It may be that mastery goals, or the desire to understand material for its own sake, is necessary but not sufficient motivation to persist in learning the material. However, the respect that students feel for an instructor may fuel that motivation to the point that it fosters higher student achievement.

However, given the significant association between mastery goals and engagement among online students, motivation may not be the sole factor at work; online students with strong mastery goals appear to have put forth effort in the form of engaging with the courseware. Another interpretation is that among students with similar mastery goals, the guidance offered by an instructor gives traditional students a performance advantage over their online counterparts, a possibility also suggested by Spence (2002) and examined in more detail below with the discussion of course setting. The association between mastery goals and achievement should be further examined and compared between the two settings.

**Course Setting**

A number of variables differed significantly between the traditional and online settings, including mathematics grade self-efficacy and achievement. Further, as described previously, correlations of certain variables with others varied significantly between the two settings as well. It seems likely that the difference in setting was a mediating factor, as discussed above.
Setting and achievement. In particular, some data seem to suggest that student performance was mediated by course setting. However, the results of analyses conducted are mixed on this point. On one hand, student achievement was significantly higher in the traditional group than in the online group. However, the contribution made by course setting was not significant in the regression models predicting achievement. Further research may clarify this issue.

Setting and gender. Another factor that deserves more attention is the possible interaction of gender and setting. Although the interaction of gender and setting was not a significant predictor of engagement or achievement, recall that these measures were predicted only for students who finished the course and took the final exam. Gender and setting together were associated with some students’ decisions late in the semester not to complete the class and to receive an F in the course. Such decisions do relate to students’ achievement and should not be overlooked. In particular, women were significantly more likely to complete a traditional class than they were to complete an online class. Similarly, traditional students who did not complete the class were significantly more likely to be men. These results suggest that gender and setting do interact in some way to govern student success, and the pattern should be explored in more depth.

Further, the correlation between gender and mastery goals differed noticeably in the two settings ($r = .22$ traditional, $r = -.04$ online, $p < .10$), suggesting that women in the traditional setting had stronger mastery goals than did women in the online setting. This finding may be related to the result that women in the online setting were less likely to finish the course than were women in the traditional setting.
Setting and engagement. As previously discussed, courseware engagement did not predict student achievement in any of the regression models. Closer examination of this result reveals that while no significant association was present between engagement and achievement in either setting, the negligible association in the traditional setting was negative \( r = -0.04 \), but a more sizable positive association was present in the online setting \( r = 0.13 \). Both associations were nonsignificant for the sample size in the current study; the correlations are based on sample sizes of 88 in the traditional setting and 76 in the online setting. The power of the current analysis to detect a correlation of 0.13 in the online setting with a sample this small was extremely low, \( 1 - \beta = 0.30 \). To achieve a significant association of this size would have required a sample of at least 630 online students. Likewise, to find the given correlations significantly different between the two groups would have required a total sample of over 1100 students; the power of the current study to detect a difference of this size was \( 1 - \beta = 0.28 \).

Nevertheless, a subsequent study with sufficient power may be in order; the disparity in correlations hints at a potential relationship that deserves more attention. If the contribution of engagement is mediated by course setting, such that using courseware is counterproductive for students in a traditional setting but helpful for students in the online setting, the regression models in the present study would not have detected the pattern. This scenario is not far-fetched: If an instructor in the traditional setting explains material one way, and the online tutorials approach the material in a different way, the traditional students may find the courseware confusing and receive little benefit from it. On the other hand, the courseware in the online setting does not compete or conflict with
another instructor’s explanations. An investigation into the interaction of setting and engagement could shed more light on this phenomenon.

**Computer Self-Efficacy and Computer Playfulness**

The roles of computer self-efficacy and computer playfulness also merit attention. The two constructs were significantly correlated in both settings. Further, the online group had significantly higher levels of both computer self-efficacy and computer playfulness than did the traditional group. This result may be related to the fact that computer self-efficacy and computer playfulness each correlated significantly with engagement in the online setting but not in the traditional setting. As noted previously, engagement was a great deal higher in the online setting, likely in part because of the structure of the online class, which required more courseware use. The significant associations in the online setting among engagement, computer self-efficacy, and computer playfulness, all of which were significantly higher among online students, are not surprising. Moreover, the correlation between computer playfulness and engagement in the online environment supports the suggestion that those higher in computer playfulness are more likely to engage with software (Martocchio and Webster, 1992).

However, in the regression models predicting engagement, neither computer self-efficacy nor computer playfulness reached significance. It should be noted though, that these models were based on the full sample, rather than only on the online students. Recall that engagement correlated significantly with computer playfulness and computer self-efficacy in the online setting but not in the traditional setting. This disparity between results in the online setting and in the traditional setting suggests that a regression model
should be developed to predict engagement exclusively among online students. Such an analysis might tell a different story than did the analysis across both settings combined. It seems clear that computer self-efficacy and computer playfulness worked in different ways among online students than among traditional students.

However, computer playfulness made no contribution to achievement in any of the regression models, and neither computer self-efficacy nor computer playfulness were associated with achievement in either setting. It stands to reason that each student approached the course using strategies most consistent with his or her style, background, and ability. Those students who felt more inclined to work on a computer were probably more likely to use the courseware. However, using the courseware was only one of many possible ways to learn the material. Students less inclined to use a computer apparently were not disadvantaged with respect to achievement; rather, they relied on other learning strategies, such as reading the text, asking others for help, or in the case of the traditional students, going to class.

**Gender and Gender Orientation**

No significant gender differences were evident in engagement or achievement. It is worth noting that gender differences in mathematics are far more prominent among higher performers than among average or below average performers (Fan et al., 1997; Friedman, 1989; Hyde et al., 1990). Because the classes in the present study were remedial mathematics classes, the lack of gender differences among the participants is not surprising. Further, researchers have consistently suggested that although men outperform women in geometry, problem-solving, and tasks of high cognitive
complexity, women outperform men in computation and algebra (Langenfeld, 1997; Willingham & Cole, 1997). Because the courses in the present study were algebra courses, gender differences favoring men were even less likely. However, no significant gender differences favoring women were evident either.

Even though gender was not associated with either engagement or achievement, and few gender differences were evident among the variables in the study, gender orientation variables (masculinity and femininity) were associated with a number of other variables. One surprising significant correlation was evident between computer playfulness and femininity in both settings \( (r = .30 \text{ traditional}, \ r = .29 \text{ online}) \). A possible explanation for this phenomenon is that individuals higher in femininity may be more willing or likely to describe themselves using adjectives like those on the computer playfulness scale, such as “playful” and “spontaneous.”

Another gender orientation trend worth noting is that masculinity correlated significantly with computer self-efficacy in both settings, whereas femininity did not. Given that computers are often viewed as more of a male domain (Bunderson & Christensen, 1995), the association seems fitting.

Similarly, masculinity significantly correlated with mathematics grade self-efficacy in both settings, whereas femininity did not. This result is consistent with previous findings that masculinity is associated with mathematics self-efficacy (Hackett, 1985). As before, this result seems to fit with the trend that mathematics is often viewed as a masculine domain.
Masculinity also correlated significantly with all three achievement goal measures in both settings. By contrast, femininity only correlated significantly with mastery goals, and only in the traditional setting. This contrast may underscore a relationship between performance goals and competitive attitudes associated with masculinity (Burke, 1993).

Another noteworthy result is that self-efficacy for self-regulation correlated significantly with femininity in the online setting and with both masculinity and femininity in the traditional setting. Possibly those students most likely to have high self-efficacy for self-regulation are those with an androgynous orientation (high in both masculinity and femininity). This pattern could be similar to findings suggesting that androgyny is significantly associated with academic self-efficacy and other motivation constructs (Britner, 2002).

Another interesting pattern is that the association between femininity and performance avoid goals differed significantly by course setting \((p < .05)\). Among students of comparable femininity, traditional students were significantly more likely to have strong performance avoid goals. As discussed previously, this may reflect a difference between the two settings: The fear of appearing incompetent is likely to be much lower in an online setting.

The contribution of gender orientation to achievement deserves more attention and should be examined in each of the course settings individually rather than across the two settings combined. A significant negative association between femininity and achievement emerged in the traditional setting. The differences in gender orientation correlations between the two settings could easily have masked any contribution that
gender orientation might have made in either setting alone. Recall also that the online group had significantly higher masculinity than did the traditional group. Further, the present study only treated gender orientation as a possible factor to explain gender differences. However, gender orientation appears to be at work where key variables predicting achievement are concerned, such as self-efficacy for self-regulation, even though no explicit gender differences were present in those areas. Because gender orientation beliefs are largely learned (Burke, 1996; Bussey & Bandura, 1999), it would behoove researchers and educators to be aware of connections that exist between gender orientation beliefs and constructs that mediate achievement.

**Summary**

The more definitive findings of this study reveal factors clearly associated with engagement and with achievement. The fact that self-efficacy for self-regulation overshadowed computer self-efficacy as a predictor of courseware engagement reveals much about the nature of working with courseware and especially about the nature of working in online course settings. Students’ belief in their own discipline will carry them farther in these online course settings than will their belief in their computer skills.

Finally, the combined contribution of self-efficacy for self-regulation and mathematics grade self-efficacy comprised the most significant contribution to mathematics achievement. These results bolster the existing body of evidence that self-beliefs are among the strongest predictors of mathematics achievement. Likewise, these findings are consistent with the tenets of social cognitive theory, which maintain that self-efficacy beliefs predict and mediate student performance (Bandura, 1997).
Directions for Future Research

Clearly, this study leaves more questions open than questions definitively answered. The online and traditional settings may each require their own regression models to assess the predictors of engagement and achievement adequately. In particular, the contribution of computer self-efficacy and computer playfulness to engagement in the online environment merits another look. The role of achievement goals may also differ in an online learning environment and should be examined more closely. The value of courseware engagement may differ significantly between the two settings as well. The possible interaction between setting and gender should be investigated, with respect both to student achievement and to student retention. The relationship between age and other variables in the study should also be explored further, especially the association between age and engagement in the online setting. Finally, gender orientation beliefs may have value in predicting motivation and achievement, independently of their value in explaining gender differences. In particular, the role of gender orientation specifically in the online environment should be explored.

The results of this research also raise other questions which, although well outside the scope of this study, deserve further attention. The connection between course setting and ethnicity should be examined. The significantly higher proportion of White students in the online setting than in the traditional setting may reflect an issue of equity in access to computers; there may also be other factors at work, including differing attitudes or preferences across ethnic groups. These questions are ripe for examination.
Implications for Educators

These findings have implications for policy, advisement, and instruction. Schools may attempt to offer every advantage possible to students. However, unless educators become fully aware of the factors that will foster student achievement in different class settings and with different tools, these attempts could prove futile. Students need to be advised of the skills they will need and of their chances for success if they are given the option to take courses in an online setting. For example, it would be a simple task to give prospective online students the self-efficacy for self-regulation instrument, followed by an explanation to the student that the traits described are generally necessary for success in an online course. Many students who initially opt for the online setting are unaware of these factors or fail to give them due consideration when making their choice. The high rate of attrition in the online sections involved in this study (over 50%) points to the lack of preparation students had for taking on a course in an online environment. Unfortunately, these students’ sense of failure after dropping the class could have further eroded their self-efficacy beliefs.

Instructors also should keep in mind that the value of courseware to students depends on both the type of courseware and on its implementation in the course. Evidence suggests that simulation programs will offer greater benefit to students than will tutorial and drill-and-practice software. Even if pure simulation programs are not practical for the subject matter to be taught, courseware with a simulation component or a few simulation-style exercises may be worthwhile. Likewise, instructors need to integrate courseware more fully into their courses and provide more structured guidance in the use
of the courseware for their students. Instructors can accomplish this by giving specific required assignments on the courseware, linking particular courseware activities to other assignments, or in the traditional setting, occasionally holding an in-class session to help students get better acquainted with the courseware. These practices might increase the benefit of the courseware for students, particularly those students with lower levels of self-regulation.

Educators also need to maintain an awareness of the power of self-efficacy for their students. Recall that verbal persuasions are an important source of self-efficacy beliefs (Bandura, 1997). Clearly it is easier to deliver verbal persuasions to students in a traditional class setting, and instructors might prompt their students’ learning efforts by delivering such persuasions when appropriate. Online instructors have a greater challenge in this arena, but they may be able to develop techniques to electronically deliver persuasion to students. However, the effectiveness of such impersonal persuasions remains to be seen. Nevertheless, instructors would do their students a service by vigilantly watching for indicators of students’ self-efficacy beliefs, and intervening where possible to keep those beliefs strong enough to foster the persistence necessary for students to perform well.

The self-beliefs that need to be fostered in students must include not only mathematics grade self-efficacy–belief in one’s ability to score well on a given test or in a given class–but also self-efficacy for self-regulation–belief in one’s ability to do what it takes to learn the material. If both types of self-beliefs are fostered, mathematics students will gain far more from the courses they take, no matter which setting they choose.
REFERENCES


Spence, D. J. (2002). *Learner experiences with computer assisted instruction in mathematics: A case study.* Unpublished manuscript, Emory University, Atlanta, Georgia.


Appendix A.

Instruments Used in the Study
Gender: Male  Female  Age: ______
Course/Section: ___________________  Instructor: __________________________

Directions: Please use the following scale to answer the statements below. Remember that there are no right or wrong answers to these statements. Circle the letter that best describes how true or false each statement is for you.

<table>
<thead>
<tr>
<th></th>
<th>F A L S E</th>
<th>T R U E</th>
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<tbody>
<tr>
<td>F</td>
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<td></td>
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<tr>
<td>T</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Definitely False**  **Mostly False**  **A little bit False**  **A little bit True**  **Mostly True**  **Definitely True**

<p>| | | | | | |</p>
<table>
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<th></th>
<th></th>
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<td>1</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<td>2</td>
<td>F</td>
<td>F</td>
<td>F</td>
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<td>3</td>
<td>F</td>
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<td>T</td>
<td>T</td>
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<td>4</td>
<td>F</td>
<td>F</td>
<td>F</td>
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<tr>
<td>5</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<tr>
<td>6</td>
<td>F</td>
<td>F</td>
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<td>7</td>
<td>F</td>
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<td>8</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<tr>
<td>9</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<tr>
<td>10</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<tr>
<td>11</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>12</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<tr>
<td>13</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<tr>
<td>14</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<tr>
<td>15</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<tr>
<td>16</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
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<td>---</td>
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</tr>
<tr>
<td>1</td>
<td>I am a gentle person.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>2</td>
<td>I am good at understanding other people’s problems.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>3</td>
<td>When someone’s feelings get hurt, I try to make them feel better.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>4</td>
<td>I can usually tell when someone needs help.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>5</td>
<td>I am a kind and caring person.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>6</td>
<td>I like to do things that boys and men like to do.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>7</td>
<td>I am willing to take risks.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>8</td>
<td>I am a warm person and express these feelings to those I feel close to.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>9</td>
<td>I am an active, adventurous person.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>10</td>
<td>I like to figure out how mechanical things work.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>11</td>
<td>I care about other people’s feelings.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>12</td>
<td>I like activities where it is one person or group against another.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>13</td>
<td>I like building and fixing things.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>14</td>
<td>I like to compete with others.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>15</td>
<td>I like to do things that girls and women like to do.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>16</td>
<td>I like to show that I can do things better than others my age.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>17</td>
<td>If I have a problem, I like to work it out alone.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>18</td>
<td>I like babies and small children a lot.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>19</td>
<td>I enjoy science and math.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
<tr>
<td>20</td>
<td>I care about what happens to others.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
</tr>
</tbody>
</table>
**Directions:** Using the following scale from 1 (*not confident at all*) to 6 (*very confident*), answer the questions below. Remember that *you can circle any number from 1 to 6*.

<p>| | | | | | | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td><strong>Not confident at all</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Very confident</strong></td>
</tr>
</tbody>
</table>

1. *How confident are you that you will pass your mathematics class at the end of this semester?*  
   1 2 3 4 5 6

2. *How confident are you that you will finish your mathematics class this semester with a grade of C or better?*  
   1 2 3 4 5 6

3. *How confident are you that you will get a grade of B or better?*  
   1 2 3 4 5 6

4. *How confident are you that you will get an A?*  
   1 2 3 4 5 6

---

**Directions:** Read each question below very carefully and use the following scale to answer as honestly as you can. Remember that *you can circle any number from 1 to 6*.

<p>| | | | | | | |</p>
<table>
<thead>
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<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td><strong>Not well at all</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Very well</strong></td>
</tr>
</tbody>
</table>

1. How well can you finish your mathematics homework on time?  
   1 2 3 4 5 6

2. How well can you study mathematics when there are other interesting things to do?  
   1 2 3 4 5 6

3. How well can you concentrate on your mathematics school work?  
   1 2 3 4 5 6

4. How well can you remember information presented in mathematics class and in your mathematics books?  
   1 2 3 4 5 6

5. How well can you arrange a place to study mathematics at home where you won’t get distracted?  
   1 2 3 4 5 6

6. How well can you motivate yourself to do mathematics schoolwork?  
   1 2 3 4 5 6

7. How well can you participate in mathematics class discussions?  
   1 2 3 4 5 6
Directions: Please use the following scale to answer the statements below. Circle the letter that best describes how true or false each statement is for you.

<table>
<thead>
<tr>
<th></th>
<th>Definitely</th>
<th>Mostly</th>
<th>A little bit</th>
<th>Mostly</th>
<th>Definitely</th>
</tr>
</thead>
<tbody>
<tr>
<td>False</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
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<tr>
<td></td>
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</tbody>
</table>

1. I feel confident working on a computer.  
2. I feel confident getting software up and running.  
3. I feel confident using online help or a user’s manual when I need help using software.  
4. I feel confident understanding terms or words relating to computer hardware.  
5. I feel confident understanding terms or words relating to computer software.  
6. I feel confident learning to use a variety of software or computer programs.  
7. I feel confident learning advanced skills in a computer program.  
8. I feel confident making selections from a menu on a computer screen.  
9. I feel confident moving the cursor around on a computer screen.  
10. I feel confident troubleshooting computer problems.

Directions: Use the following scale to tell how well each adjective below describes you when you interact with a computer. Remember that you can circle any number from 1 to 6.

<table>
<thead>
<tr>
<th></th>
<th>Does not describe me at all</th>
<th>Describes me very well</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Spontaneous</td>
<td>1 2 3 4 5 6</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>2 Unimaginative</td>
<td>1 2 3 4 5 6</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>3 Flexible</td>
<td>1 2 3 4 5 6</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>4 Creative</td>
<td>1 2 3 4 5 6</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>5 Playful</td>
<td>1 2 3 4 5 6</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>6 Unoriginal</td>
<td>1 2 3 4 5 6</td>
<td>1 2 3 4 5 6</td>
</tr>
<tr>
<td>7 Uninventive</td>
<td>1 2 3 4 5 6</td>
<td>1 2 3 4 5 6</td>
</tr>
</tbody>
</table>
Please provide some additional background information by circling the appropriate response to each of the questions below.

What is your race/ethnicity?

Black  Asian  White  Hispanic  Native American  Other

Do you have a computer at home?  Yes  No

On average, how many hours *each week* do you use a computer?

<table>
<thead>
<tr>
<th>Less than one hour</th>
<th>1 to 5 hours</th>
<th>5 to 10 hours</th>
<th>10 to 15 hours</th>
<th>15 to 20 hours</th>
<th>more than 20 hours</th>
</tr>
</thead>
</table>

*Other than for e-mail*, how many hours *per week* on average do you use a computer?

<table>
<thead>
<tr>
<th>Less than one hour</th>
<th>1 to 5 hours</th>
<th>5 to 10 hours</th>
<th>10 to 15 hours</th>
<th>15 to 20 hours</th>
<th>more than 20 hours</th>
</tr>
</thead>
</table>

*Other than for e-mail*, how many hours *per week* on average do you spend using computer software (such as Word, PowerPoint, Excel, etc.)?

<table>
<thead>
<tr>
<th>Less than one hour</th>
<th>1 to 5 hours</th>
<th>5 to 10 hours</th>
<th>10 to 15 hours</th>
<th>15 to 20 hours</th>
<th>more than 20 hours</th>
</tr>
</thead>
</table>

How many hours *per week* on average do you spend using instructional or educational computer software?

<table>
<thead>
<tr>
<th>Less than one hour</th>
<th>1 to 5 hours</th>
<th>5 to 10 hours</th>
<th>10 to 15 hours</th>
<th>15 to 20 hours</th>
<th>more than 20 hours</th>
</tr>
</thead>
</table>

Thank you very much for your help with this research. I appreciate the time you’ve taken to complete this survey. Please take a moment to check each page and be sure you’ve completed each item.
Directions: Please respond to the statements below, using the following scale where indicated. Remember that there are no right or wrong answers to these statements. Circle the appropriate answer or the letter that best describes how true or false each statement is for you.

<table>
<thead>
<tr>
<th></th>
<th>FALSE</th>
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<th>TRUE</th>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>Definitely False</th>
<th>Mostly False</th>
<th>A little bit False</th>
<th>A little bit True</th>
<th>Mostly True</th>
<th>Definitely True</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I have used the MyMathLab video tutor. (If no, skip to question #2).</td>
<td>NO</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1a</td>
<td>When the video tutor is difficult for me to understand, I put more effort into it.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>1b</td>
<td>I will work as long as necessary to understand the video tutor.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>1c</td>
<td>When I find the video tutor difficult, I usually give up on it.</td>
<td>F</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>2</td>
<td>I have used the MyMathLab tutorial practice problems. (If no, skip to question #3).</td>
<td>NO</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2a</td>
<td>When a tutorial practice problem is difficult for me to solve, I put more effort into it.</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>2b</td>
<td>I will work as long as necessary to solve a difficult tutorial practice problem.</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>2c</td>
<td>When I find a tutorial practice problem difficult, I usually give up on it.</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>3</td>
<td>I have used the MyMathLab guided solutions. (If no, skip to question #4).</td>
<td>NO</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3a</td>
<td>When a guided solution is difficult for me to finish, I put more effort into it.</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>3b</td>
<td>I will work as long as necessary to finish a guided solution.</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>3c</td>
<td>When I find a guided solution difficult, I usually give up on it.</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>4</td>
<td>I have used the MyMathLab online tests (sample or assigned tests). (If no, skip to next page).</td>
<td>NO</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4a</td>
<td>When an online test problem is difficult for me to solve, I put more effort into it.</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>4b</td>
<td>I will work as long as necessary to solve a difficult online test problem.</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>4c</td>
<td>When I find an online test problem difficult, I usually give up on it.</td>
<td>F</td>
<td>F</td>
<td>T</td>
<td>T</td>
<td>T</td>
</tr>
</tbody>
</table>
**Directions:** Using the following scale from 1 (not confident at all) to 6 (very confident), answer the questions below. Remember that you can circle any number from 1 to 6.

1  2  3  4  5  6  

<table>
<thead>
<tr>
<th>1</th>
<th>How confident are you that you will pass your mathematics class at the end of this semester?</th>
<th>1  2  3  4  5  6</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>How confident are you that you will finish your mathematics class this semester with a grade of C or better?</td>
<td>1  2  3  4  5  6</td>
</tr>
<tr>
<td>3</td>
<td>How confident are you that you will get a grade of B or better?</td>
<td>1  2  3  4  5  6</td>
</tr>
<tr>
<td>4</td>
<td>How confident are you that you will get an A?</td>
<td>1  2  3  4  5  6</td>
</tr>
</tbody>
</table>

1  2  3  4  5  6  

<table>
<thead>
<tr>
<th>1</th>
<th>How confident are you that you will make a score of 60 or higher on your mathematics final exam this semester?</th>
<th>1  2  3  4  5  6</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>How confident are you that you will make a score of 70 or higher on your mathematics final exam?</td>
<td>1  2  3  4  5  6</td>
</tr>
<tr>
<td>3</td>
<td>How confident are you that you will make a score of 80 or higher on your mathematics final exam?</td>
<td>1  2  3  4  5  6</td>
</tr>
<tr>
<td>4</td>
<td>How confident are you that you will make a score of 90 or higher on your mathematics final exam?</td>
<td>1  2  3  4  5  6</td>
</tr>
</tbody>
</table>
Appendix B.

Items Corresponding to Scales Used in the Study
Mathematics Grade Self-Efficacy

1. How confident are you that you will make a score of 60 or higher on your mathematics final exam this semester?
2. How confident are you that you will make a score of 70 or higher on your mathematics final exam?
3. How confident are you that you will make a score of 80 or higher on your mathematics final exam?
4. How confident are you that you will make a score of 90 or higher on your mathematics final exam?

Computer Self-Efficacy

1. I feel confident working on a computer.
2. I feel confident getting software up and running.
3. I feel confident using online help or a user’s manual when I need help using software.
4. I feel confident understanding terms/words relating to computer hardware.
5. I feel confident understanding terms/words relating to computer software.
6. I feel confident learning to use a variety of programs or software.
7. I feel confident learning advanced skills in a computer program.
8. I feel confident making selections from a menu on a computer screen.
9. I feel confident moving the cursor around on a computer screen.
10. I feel confident troubleshooting computer problems.

Self-Efficacy for Self-Regulated Learning

1. How well can you finish your mathematics homework on time?
2. How well can you study mathematics when there are other interesting things to do?
3. How well can you concentrate on your mathematics school work?
4. How well can you remember information presented in mathematics class and in your mathematics books?
5. How well can you arrange a place to study mathematics at home where you won’t get distracted?
6. How well can you motivate yourself to do mathematics schoolwork?
7. How well can you participate in mathematics class discussions?
Computer Playfulness

Items marked with (R) are reverse scored. Participants will be instructed: Tell whether each adjective describes you when you interact with a computer.

1. Spontaneous
2. Unimaginative (R)
3. Flexible
4. Creative
5. Playful
6. Unoriginal (R)
7. Uninventive (R)

Achievement Goal Orientation

Mastery goals. These items measure the student’s mastery or task goals.

1. I like mathematics assignments I can learn from, even if I make a lot of mistakes.
2. An important reason I do my mathematics assignments is because I like to learn new things.
3. I like mathematics assignments that really make me think.
4. An important reason I do my mathematics assignments is because I want to become better at mathematics.
5. I do my mathematics assignments because I am interested in them.

Performance-approach goals.

1. I want to do better than other students in my mathematics class.
2. I would feel successful at mathematics if I did better than most of the other students in the class.
3. I would feel really good if I were the only student in class who could answer the teacher’s questions about mathematics.
4. I’d like to show my mathematics teacher that I’m smarter than the other students in my mathematics class.
5. Doing better than other students in mathematics is important to me.
Performance-Avoid Goals.

1. The reason I do mathematics assignments is so the teacher won’t think I know less than other students.
2. I do my mathematics assignments so others in the class won’t think I’m dumb.
3. One reason I might not participate in mathematics class is to avoid looking stupid.
4. One of my main goals in mathematics class is to avoid looking like I can’t do my work.
5. It’s important to me that I don’t look stupid in mathematics class.
6. An important reason I do my mathematics assignments is so I won’t embarrass myself.

Gender Orientation

Maculinity items.

1. I like to do things that boys and men like to do.
2. I am willing to take risks.
3. I am an active, adventurous person.
4. I like to figure out how mechanical things work.
5. I like activities where it is one person or group against another.
6. I like building and fixing things.
7. I like to compete with others.
8. I like to show that I can do things better than others my age.
9. If I have a problem, I like to work it out alone.
10. I enjoy science and math.

Femininity items.

1. I am a gentle person.
2. I am good at understanding other people’s problems.
3. When someone’s feelings get hurt, I try to make them feel better.
4. I can usually tell when someone needs help.
5. I am a kind and caring person.
6. I am a warm person and express these feelings to those I feel close to.
7. I care about other people’s feelings.
8. I like to do things that girls and women like to do.
9. I like babies and small children a lot.
10. I care about what happens to others.
Degree of Use

These items will be scored as either yes (1) or no (0).

1. I have used the MyMathLab video tutor.
2. I have used the MyMathLab tutorial practice problems.
3. I have used the MyMathLab guided solutions.
4. I have used the MyMathLab online tests (sample tests or assigned tests).

Engagement

Items marked with (R) are reverse scored.

1. When the video tutor is difficult for me to understand, I put more effort into it.
2. I will work as long as necessary to understand the video tutor.
3. When I find the video tutor difficult, I usually give up on it. (R)
4. When a tutorial practice problem is difficult for me to solve, I put more effort into it.
5. I will work as long as necessary to solve a difficult tutorial practice problem.
6. When I find a tutorial practice problem difficult, I usually give up on it. (R)
7. When a guided solution is difficult for me to finish, I put more effort into it.
8. I will work as long as necessary to finish a guided solution.
9. When I find a guided solution difficult, I usually give up on it. (R)
10. When an online test problem is difficult for me to solve, I put more effort into it.
11. I will work as long as necessary to solve a difficult online test problem.
12. When I find an online test problem difficult, I usually give up on it. (R)
Appendix C.

Participant Informed Consent Form
Student Use of Mathematics Courseware in Traditional and Online Learning Environments
Participant Informed Consent Form

Project Director: Dianna Spence, Ph.D. candidate
Project Advisor: Dr. Robert Jensen
Division of Educational Studies, Emory University

You are invited to participate in this research study. The following information is provided to help you make an informed decision whether or not to participate. If you have any questions about any aspect of this study, or the information on this form, please do not hesitate to ask. You are eligible to participate because you are enrolled in your current mathematics class at this college. The purpose of the study is to investigate student attitudes, beliefs, and achievement in mathematics classes that incorporate computer-based learning. Participation in this study will require one survey of approximately 20 minutes early in the semester and a second mid-semester survey of approximately 5 minutes. These surveys are not part of the mathematics course you are taking. Your teacher will also be asked to provide the researcher with your final grade in this mathematics course. Participation or non-participation will not affect the evaluation of your performance in this class. There are no known risks or discomforts associated with this study.

You may experience no direct benefits from this survey, or you may find the experience enjoyable and the information may help you to better understand your own attitudes about mathematics achievement and working in a computer-based learning environment. The information gained from this study may also help me to better understand factors that influence student use of computer-based mathematics learning tools. Your participation is voluntary. You are free to decide not to participate in this study or to withdraw at any time without adversely affecting your relationship with the researcher or with your instructor. If you do not wish to answer a question in the survey, you may skip the question. Your decision will not result in any loss of benefits to which you are otherwise entitled. If you choose to participate, you may withdraw at any time and for any reason by notifying Dianna Spence at djspenc@emory.edu, or at (770) 932-9497. Upon your decision to withdraw, all information pertaining to you in this study will be destroyed. If you choose to participate, all information will be held in strict confidence and will have no bearing on your academic standing or services you receive from your college. The information obtained in this study may be published in scientific journals or presented at scientific meetings, but your identity will be kept strictly confidential.

If you have any questions about this study, please contact me at (770) 932-9497 or djspenc@emory.edu, or my advisor, Dr. Robert Jensen, at (404) 727-0606. If you have questions about your rights as a participant in this study, you may contact Dr. Karen Hegtvedt, Chair, Social, Humanist, and Behavioral Institutional Review Board, which oversees the protection of human research participants. She can be reached at (404) 727-7517 or khegtv@emory.edu.

If you are willing to participate in this study, please sign the statement below and return it to Dianna Spence. Keep the extra unsigned copy. If you choose not to participate, you may return both copies of the agreement. Thank you for considering participating in this study.

Name (PLEASE PRINT)_________________________________________

Signature____________________________________  Date_____________