HALL, T. SIMIN, Ph.D. Improving Self-Efficacy in Problem Solving: Learning from Errors and Feedback. (2007)
Directed by Dr. Terry A. Ackerman and Dr. Deborah J. Taub. 128 pp.

This study examined the social cognitive theoretical prediction that self-efficacy is enhanced by feedback that fosters problem solving skills. The anxiety addressed in this study was similar to low efficacy perceptions in solving statistics problems for adults whose background is far removed from the field of statistics. The study employed an experimental process to compare the changes in efficacy, problem solving, anxiety, and satisfaction scores for 138 students in two groups of feedback and no feedback. The sample represented 23 majors in a regional public university in the South.

Students in the feedback group showed a statistically significant gain in their problem scores over the no feedback group; however, the mean efficacy scores were lower for both groups after the problem solving experiment. Both groups showed similar averages with respect to anxiety and satisfaction scores in regard to problem solving.

The incongruence in problem scores with efficacy and anxiety scores was attributed to students' over rating of their abilities prior to actually performing the tasks. The process of *calibration* was identified as an explanation for the statistically significant correlation between problem solving scores and post-efficacy scores for the feedback group.

The qualitative analysis of the contents of the feedback that students provided for each question indicated that those who provided more thoughtful self-explanations, and elaborated on the rationale for their choices showed higher gains in problem scores from

pre- to posttest over those who gave fewer comments or did not elaborate on their responses. The number of statistics and mathematics courses taken previously correlated significantly with students' gain in problem scores.

The findings in this study support the social cognitive theoretical prediction that feedback can impact self-efficacy positively when students are provided with real time evaluation and assessment indicators. Therefore, this study needs to be implemented with similar problems over a longer period of time for students to learn how to monitor their works and peers' work and how to integrate peers' comments in deriving the solutions and receive timely feedback from the teacher on their progress.

IMPROVING SELF-EFFICACY IN PROBLEM SOLVING:

LEARNING FROM ERRORS AND FEEDBACK

by

T. Simin Hall

A Dissertation Submitted to
the Faculty of The Graduate School at
The University of North Carolina at Greensboro
in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Greensboro
2007

Approved by

Terry A. Ackerman
Committee Co-Chair

Deborah J. Taub
Committee Co-Chair

To my husband, M. Keith Hall, to my two children, Meghan Sabba Hall and Bryan Emmon Hall, to the memory of my father, Mohammad Shayan, who undoubtedly planted the seeds of individual advancement though education in all his children, especially his five daughters, and to my mother, Najibeh Shayan, who along with my father for the sacrifices they initially made to secure my education in U. S.

APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of The Graduate School at The University of North Carolina at Greensboro.

Committee Co-Chair Terry A. Ackerman

Committee Co-Chair Deborah J. Taub

Committee Members Dale H. Schunk

Edwin D. Bell

December 10, 2007
Date of Acceptance by Committee

December 10, 2007
Date of Final Oral Examination

ACKNOWLEDGMENTS

First, I would like to thank my Co-Chairs, Dr. Deborah Taub and Dr. Terry Ackerman. Dr. Terry Ackerman has consistently been by my side throughout my doctoral training. I must also pay special tribute to Dr. Edwin Bell from Winston Salem State University who provided invaluable support and helpful comments throughout the inception of the course design for the pilot study, numerous projects, papers, and then the dissertation.

I am most grateful to Dr. Dale Schunk with his incredible knowledge as he guided me through the process of learning and testing the theory he has authored in so many great books. I am greatly indebted to Dean Schunk for his detailed and insightful suggestions as I have written this dissertation and for other papers based on the theoretical approach in this dissertation.

Special thanks to Dr. Scott Richter from the Statistics and Mathematics Department at UNCG for his willingness to share his vast knowledge, helpful references, and his insistence in adherence to scientific approaches in the process of conducting research through his exemplary teaching and consulting efforts.

I must pay special praise to Dr. Hamid Nemati, from ISOM department at UNCG for his invaluable support and comments with the experimental design of the data collected for this dissertation. He has offered countless hours of helpful comments not only for this dissertation but also for other scholarly papers using the theoretical focus of this dissertation.

I am thankful to Dr. John Eatman for his expert help with the on-line pilot test and operation of the data collection for this dissertation. Dr. Kwasi Amoako-Gyampah the Chair of ISOM department and the faculty at ISOM department at UNCG were the most willing in the process of data collection and in support of my research.

I would like to thank Ms. Tomi Register, Dean's secretary, for her prompt responses, her expert organization, and her encouragement.

TABLE OF CONTENTS

Page

Page

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

In this study, I explored the impact of feedback on statistics self efficacy and anxiety. The conceptual focus was social cognitive theory. My research focused on how students' anxiety in courses such as statistics may be modified through instruction that enables students to learn from providing and receiving feedback to each other. The statistics anxiety addressed in this research is associated with potential blocks students face in translating the contents and the concepts of statistics to the steps of deriving solutions (Bessant, 1992; Onwuegbuzie & Wilson, 2003). It is hypothesized that students' anxiety is moderated by feedback sources that enable students to actively participate in analyzing their own and their peers' mistakes.

According to social cognitive theory (Bandura, 1986/1997; Pintrich & Schunk, 2002), as students work on tasks they note their progress toward their learning goals, based on progress indicators that convey to students that they are performing well. This reciprocity enhances self-efficacy (perceived capabilities) for continued learning and influences students' emotion positively. This is the foundation of reciprocal interaction of social cognitive theory which is between (a) personal factors in the form of cognitions and affects, (b) behaviors in the form of cognitive strategies such as providing feedback, and (c) environmental influences such as peer feedback, teacher feedback and modeling (Bandura, 1986; Schunk & Pajares, 2005).

A networked portfolio or a Web-based feedback technology such as a wiki is used to enable students to interact with the teacher and each other by providing and receiving feedback. This system transforms the concept of technology to an environment for social interaction (Clark & Mayer, 2003) and also provides a medium for recording reflection from peers, instructor, and students themselves (Liu, Lin, Chiu, & Yuan, 2001). The main concept behind the Web-based feedback system (WBF) used in this study is that the teacher posts the homework assignments, individual or class projects on the system and each student prepares homework and uploads it to the WBF. Each student is then asked to make follow up revisions to the original work until the final solution is derived.

Each student receives a grade based on the quality comments and the number of quality comments they make to themselves and to peers toward the completion of the work. A comment is of high quality if it offers suggestions for modifying and fine tuning the next step (Chi, 1996). Wang et al.'s (2001) research indicated that the total number of students' comments correlated positively with students' final grade in the class. Research indicates that receiving immediate and plentiful feedback can prevent acquiring invalid procedures (Lovett et al., 2000).

The process of receiving grades on the number of quality comments to self as well as to peers enacts learning from monitoring—a metacognitive strategy (Wlodkowski, 1999). In this process students are not graded on their initial work which may contain errors but on their continued effort to monitor and fine tune until the correct solution is reached.

Students typically receive feedback on their completed work, or on tests. This is feedback on performance but not on the process of comprehension, evaluation, and execution. Feedback about reasons for an error does not provide any direction to correct the error nor motivates students to explore new alternatives for finding solutions (McKendree, 1990). Thus, it is of interest to analyze how this process impacts learning, efficacy and anxiety.

The focus in the present study is to analyze the impact of feedback and monitoring errors on learning statistics, efficacy, and anxiety. The question is whether students learn from giving and receiving feedback. How do monitoring one's steps and peer's steps to solving a problem impact learning? What is the impact on students' anxiety or low perceptions in statistics if they know they are not graded on errors but rather are expected to explicitly demonstrate their steps to finding solutions, monitoring errors or potential blocks to progress? What is the correlation between providing quality feedback and receiving quality feedback and the final grades?

According to social cognitive theory, students monitor their steps and errors, they note their progress toward the solution, and progress indicators convey to students that they are capable of solving statistical problems. This reciprocity enhances self-efficacy for continued learning and impacts students' emotion positively (Pintrich & Degroot, 1990; Pintrich & Schunk, 2002). The social cognitive interaction between personal, behavioral, and environmental influences is represented in Figure 1.1.

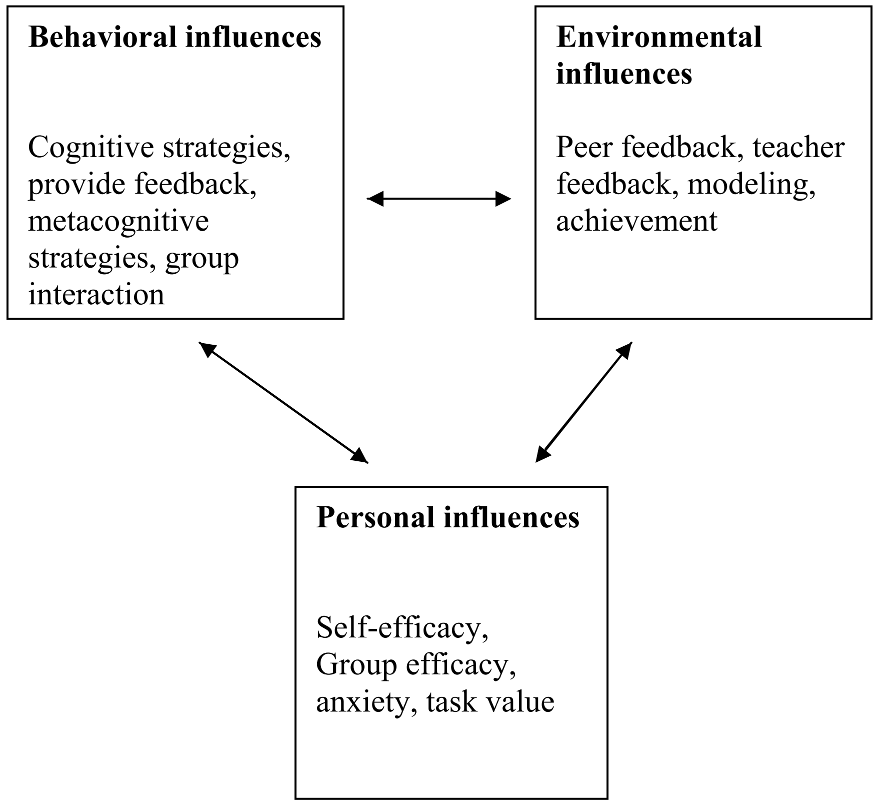

Figure 1.1. ***Social Cognitive Model of Learning***

Statement of the Problem

According to the National Center for Education Statistics (National Center for Education Statistics, 2006), the enrollment in graduate programs increased by 62% between 1976 and 2004. Many of these adults are pursuing their graduate degrees in social and behavioral sciences and are required to take at least one statistics course and a quantitative-based research methodology course as part of their degree requirements (Onwuegbuzie & Wilson, 2003). Many of these students come from diverse backgrounds, some students are far removed from the field of statistics or there may be a lag in time since they last took statistics courses (Pan & Tang, 2004). These factors may potentially increase students' anxiety level and induce undesirable emotional reactions which could in turn influence students' academic goal attainment (Lombardi & McCahill, 2004; Onwuegbuzie, 2003).

Onwuegbuzie (1997a) reported that statistics anxiety primarily affects a student's ability to understand research articles and to analyze and interpret statistical data as well. As a result of anxiety, students often delay enrolling in research methods and statistics courses for as long as possible, sometimes waiting until the final semester of their degree programs, which is clearly not the optimal time to undertake such courses (Onwuegbuzie, 1997a/ 1997b).

Onwuegbuzie et al. (1997c) illustrated that sometimes students' anxiety in statistics is not necessarily due to the lack of training or insufficient skills, but due to the lack of students' efficacy perceptions in statistics. These researchers found that students' efficacy perceptions in statistics kept students away from engaging in research work which impacted students' degree completion.

Bessant (1992/1995) argues that students experience anxiety in statistics due to many factors; however, one factor is students' lack of efficacy in problem solving which relates to typical statistics instructions. He emphasizes that most statistical instructions fragment and isolates statistical processes from the empirical research. Bessant (1992) reasons that students do not learn to integrate the statistical processes and research with quantitative reasoning. This could potentially create anxiety since students do not see the relevance of the subject to their education and, among graduate students, to their research (Bessant, 1992; Onwuegbuzie & Wilson, 2003).

Students may experience anxiety due to internal factors such as low self-perceptions in statistics or external factors such as instruction. Research (Bessant, 1992; Onwuegbuzie & Wilson, 2003; Pan & Tang, 2004) indicates that students in social sciences exhibit a great deal of statistics anxiety due to either lack of mathematical background or the motivation to learn statistics; however, statistics instruction with emphasis on computations rather than conceptual understanding is partly responsible for students' anxiety.

Schacht and Stewart (1990) point out that statistical instruction is perhaps the most anxiety-producing of the courses offered by any sociology department. Piotrowski et al. (2002) report the same concern for graduate-level statistics psychology. Onwuegbuzie et al. (2000) reported a high degree of statistics anxiety in graduate students in education. According to Forte (1995) many social work educators have acknowledged their students' phobic attitude toward statistics. Although many factors contribute to students' anxiety, according to Forte (1995) some that are applicable to social work students were minimal previous math preparation, late-in-career introduction to quantitative analysis, general anti-quantitative bias, lack of appropriation for the power of analytical models, and lack of mental imagery useful in thinking about quantitative concepts.

Bessant (1992) argues that typical instructional design stresses the learning of techniques in statistics as opposed to synthesizing a practical understanding of the subject. He asserts that instructions in statistics tend to fragment theory, statistical analysis, and empirical reality. This fragmentation results in students not learning problem solving skills, which according to Bessant (1992) and Stangle (2000) should be at the core of statistics curriculum.

Bessant (1992) points out problems with delivering statistical contents via the lecture methods that emphasize algorithmic teaching despite evidence that calls into question the effectiveness of this teaching format. Forte (1995) points out that teachers give in to anxious students by grading easy and expecting little. This remedy does not contribute to a satisfying or productive educational atmosphere. Caulfield and Persell (2006) argue that students do not appreciate scientific reasoning and do not develop skills for formulating questions, design research, and using quantitative and statistical skills to analyze data unless the instruction stimulate students' interest. They point out the deficiency in the lecture method that does not employ collaboration because it does not fully engage students in learning and reflecting on the stages of developing statistical skills.

This section has provided an overview of different sources of statistics anxiety. To summarize, students may experience anxiety due to internal factors such as low efficacy perceptions in statistics or external factors such as poor instruction (Bessant, 1992; Onwuegbuzie & Wilson, 2003; Pan & Tang, 2004). Low efficacy may be due to students' lack of requisite skills in quantitative courses and lack of mental imagery useful in conceptualizing quantitative concepts (Forte, 1995). Instructional design that emphasizes techniques as opposed to synthesizing a practical understanding of the subject, as well as an instructional format that does not engage students in learning and reflecting on the stages of developing statistical skills, enhances students' anxiety (Bessant, 1992; Stangl, 2000).

In the literature, statistics anxiety has been extensively studied for more than two decades (Onwuegbuzie & Wilson, 2003). Most studies have focused primarily on measurement of and factors contributing to statistics anxiety. Unfortunately, sparse studies have been found on how to reduce the anxiety in learning statistics for graduate students in the social sciences and specifically in education (Onwuegbuzie & Wilson, 2003). What is most lacking are innovations (Forte, 1995; Pan & Tang, 2004) that not only reduce the anxiety but also cultivate self-efficacy of graduate students in using statistics and research methods that these students in non-math-oriented disciplines are able to apply their newly acquired skills to their research as well as to their profession.

In the present investigation various aspects of the following research are combined to examine the impact of feedback on learning, efficacy and anxiety.

Pan and Tang (2004) modified instruction to remedy statistics anxiety through application oriented teaching methods with the instructor's attentiveness to students' anxiety. Lovett et al. (2000) applied cognitive theory to statistics instruction by emphasizing individual practice and providing real-time feedback from the instructor. Mejias (2006) researched the effectiveness of the social software or Network Portfolio system on student' learning, practical research skills, developing team effort skills, and engaging students in learning to learn.

Lin et al. (2001) researched the features of Web-based peer assessment on students' attitudes and achievement. Liu, Lin, Chiu, et al. (2001) investigated the impact of Web-based peer review on students' critical thinking and metacognitive skills. Wang and Lin (2006) studied self-regulated learning behaviors from the social cognitive perspective using a Web-based learning system. Wang and Shiu (2005) investigated the impact of networked group interaction on group efficacy and group performance.

Seifert and Hutchins (1992) demonstrated the influence of errors as opportunities for instruction and learning in a study of the cooperative system for the navigation of a large naval vessel. In their study, most learning occurred by observing others and following them as well as receiving multiple perspectives for error detection.

Clark and Mayer (2003) have researched the impact of collaborative learning on the Web and its impact on problem solving skills as well as metacognitive strategies of reflection extensively. Metacognition involves two separate processes of knowledge and regulation of an individual's cognition. Clark and Mayer emphasize the process of practice using the collaboration on the Web in learning and effectively using metacognitive strategies to become successful in problem solving.

One of the areas least researched in cognitive theory for adult students is the impact of feedback students provide on their work and their errors on efficacy and anxiety through its direct link to metacognitive skills of monitoring. Researchers have demonstrated the impact of efficacy on emotions due to goal attainment and its influence for continued learning (Schunk, 2006). However, there is not much research on the effect of feedback in general and feedback on errors in particular on efficacy due to fostering metacognitive strategies of monitoring and their subsequent impact on anxiety.

Statement of Purpose

The purpose of conducting this study was to investigate the impact of feedback on statistics anxiety using social cognitive theory. The feedback sources on the Web-based network portfolio system such as a wiki allows for peers to give and receive feedback on their work and on their errors. This study determines the impact of these processes on student learning, efficacy, and anxiety.

The specific questions of the study are: (a) Is the mean posttest achievement score significantly higher for the feedback group than the mean for the no feedback (control) group controlling for students' characteristics?; (b) Is the mean posttest efficacy score significantly higher for the feedback group than the mean for the no feedback (control) group controlling for students' characteristics?; (c) Is the mean posttest anxiety score significantly lower for the feedback group than the mean for the control group controlling for students' characteristics?; and (d) Is the mean satisfaction score significantly higher for the feedback group than the mean for the control group controlling for students' characteristics?

Research Design

This is a quasi-experimental design with two groups, one control and one treatment group. The control group will receive all instructions via Blackboard system, and the treatment group will use the Web-Based feedback system (WBF).

Web-Based Feedback System (WBF)

The feedback system will be enacted in a network portfolio system or in social software such as wiki. Wikis are collaborative management systems that allow any user to create or edit pages instantaneously; distributed classification systems that allow individual users to classify items by associating them with any number of keywords known as tags, which are then aggregated by the software for the benefit of the whole community; and then rich site summary (RSS) feeds which is a subscription system that alerts the user when new content is available. The system serves in the following roles during the study: (a) an as information distribution channel and management center for assignment submission and peer feedback; (b) as a media for peer interaction and knowledge construction; and (c) as a center for recording reflections and suggestions from peers, instructors and themselves.

Course Description for Treatment Group

The treatment group involves several activities: (a) the teacher posts the homework assignment, (b) each student prepares the homework and uploads it to the wiki, (c) for each assignment, the teacher assigns randomly three reviewers for each student, (d) each student views other works and must comment on the steps of how the solution is derived, and (e) each student must revise the original assignment in line with the comments received. The final solution has a brief description from each student to summarize their initial understanding of the problem and their final understanding.

I. Students receive a grade based on how effectively they incorporate the three reviewers' comments and feedback into deriving the solutions. This score is referred to as an assignment score. High assignment scores indicate students who strategically monitor and regulate their steps and adopt peers' feedback for self-improvement. Students have one week for each assignment to revise their initial solution and incorporate all feedback.

II. Students receive a grade on the quality comments student provide. This score is referred to as a review score. High review scores indicate students who make significant contributions to peers' works. Students are to provide at least three rounds of feedback to the student who is receiving the comments. If after three rounds of feedback from peers or self students are still not at the final solution, the teacher will provide additional feedback.

III. Students also receive a grade on the final project for which they do not receive any feedback from peers.

Table 1.1

Achievement Scores

Achievement Scores	Percentages
Review score	40%
Assignment score (with peer review)	40%
Final Examination (without peer review)	20%

Course Description for Control Group

Students receive the same assignment as the treatment group; however, it is in the assignment format of BlackBoard for which students cannot view each other's works. Moreover, students cannot retrieve and correct errors since they only receive feedback from the teacher on their final submissions. Students are encouraged to use the discussion board and emails to interact among themselves and with the teacher. However, there is no grade associated with these activities. Students' achievement scores in this system are from assignments and a final exam exactly like the treatment group.

Each group periodically will meet with the teacher face-to-face to answer questions and to discuss concerns that students may have about different aspects of the course.

Analysis

Research question one: Is the mean posttest achievement grades significantly higher for the feedback group than the mean for the no feedback (control) group controlling for students' characteristics? Students receive three achievement scores consisting of assignments and review which are with peer feedback and the final is without the peer feedback. A repeated measure analysis will be conducted with the achievement scores as within subject factor and the method as the between subject factor with students' characteristics (age, GPA, number of prior math or statistics courses taken) as covariates.

$H_0 : \boldsymbol{\mu}_1 = \boldsymbol{\mu}_2$ vs. $H_a : \boldsymbol{\mu}_1 \neq \boldsymbol{\mu}_2$ where μ\`=[μ_1, μ_2, μ_3].

Research question two: Is the mean posttest efficacy score significantly higher for the feedback group than the mean for the control group controlling for students' characteristics? H_0: $\mu_t = \mu_c$, the null hypothesis states that the difference in efficacy scores is the same for both groups. H_a: $\mu_t > \mu_c$.

The pre- and posttest scores of students on a questionnaire that measures students' confidence/competence with statistics and feedback system are compared using a repeated measure analysis similar to the analysis for question one. This questionnaire consists of ten items where students are asked to rate their confidence/competence on a five point scale from ‘not at all confident’ (scored 1) to ‘very much’ (scored 5). The validity and reliability of this survey were determined during pilot testing. Three items are from Frederickson et al.’s (2005) study and the rest of the items were added for the present study.

Research question three: Is the mean posttest anxiety score significantly lower for the feedback group than the mean for the control group controlling for students’ characteristics? H_0: $\mu_t = \mu_c$, the null hypothesis states that the difference in anxiety scores is the same for both groups. The alternative hypothesis is that the treatment group manages to reduce anxiety more than the control group. H_a: $\mu_t < \mu c$.

The pre- and posttest scores on statistics anxiety for both control and treatment groups are analyzed using a repeated measure analysis with the test scores as within subject effect and the intervention system as the between subject effect with students’ characteristics (age, GPA, number of prior math or statistics courses taken) as covariates. If the interaction effect between the two factors is significant, that indicates the change in anxiety scores is different across the levels of intervention (treatment versus control).

The instrument for anxiety is adapted from Fennema and Sherma’s (1976) mathematical anxiety rating scales. Betz (1978) replaced the word “mathematics” with “statistics.” The 10-item shortened version was developed specifically to measure class-related anxiety in statistics courses and hence is particularly appropriate for the purpose of the present study. This instrument was used in a similar study by Pretorius and Norman (1992) and Pan and Tang (2004). Pretorius and Norman (1992) reported alpha reliability of 0.90 and a correlation of 0.97 with the full scale MARS. Pan and Tang (2004) reported alpha reliability of 0.94 in pretest and 0.98 in posttest.

Research question four: Is the mean posttest satisfaction score significantly higher for the feedback group than the mean for the control group controlling for students' characteristics? H_0: $\mu_t = \mu_c$, the null hypothesis states that the difference in efficacy scores is the same for both groups. H_a: $\mu_t > \mu_c$. A one-way analysis of variance with satisfaction scores as dependent variable and the method as the independent variable with students' characteristics as covariates is analyzed.

The analysis determines if there is a significant difference in the means between two interventions at $\alpha=0.05$ controlling for the covariates. Students' satisfaction with the course format and their learning experience is assessed using a five item instrument on a five-point scale ranging from 'not at all' (scored 1) to 'very much' (scored 5). This instrument was used in Frederickson et al.'s (2005) study.

Significance of this Research

This study was conducted to investigate resources that increase students' efficacy through the process of feedback in learning statistics and the ability to do quantitative research. The network portfolio resources on the web provide facilities that make the feedback on steps to solution and errors monitoring possible. However, these resources could be used for a web course or as an addition to a face-to-face class. Theory and research have provided much evidence as the importance of efficacy beliefs on learning (Pintrich & De Groot, 1990; Schunk, 1982, 1984). However, there is not much empirical evidence as to the impact of sources of feedback using network technology on efficacy especially for adults in courses such as statistics.

Understanding efficacy beliefs should be helpful for teaching courses that traditionally have produced anxiety in students. According to Dorn and Papalewis (1997) and Bair and Haworth (1999), the decisions for doctoral students to persist may vary widely, however, the peer mentoring in the area of research were identified as a predictor for retention. This research may provide empirical evidence in regard to the effect of sources of feedback on efficacy in learning quantitative courses and thus research. Students' satisfaction with this intervention may lead university instructors to adopt the more advanced form of this technology, which provides instructors with tools for assessments (Wang & Lin, 2006).

Research claims that new technology provides more opportunities for adults to participate in graduate studies (Friedrich & Armer, 1999; Huang, 2002). However, there are inconsistencies in these findings with inconclusive evidence for any superiority of hypermedia. This study is intended to provide empirical evidence of an experiment to test the social cognitive theoretical prediction that self efficacy is enhanced by feedback that fosters problem solving skills. Thus, the findings here are intended to motivate additional investigation as how to use the facilities afforded by new technology in providing opportunities for increased access to higher education and research.

Bair and Haworth (1999) report a high attrition rate among doctoral students in the social sciences and humanities. Their study indicated a positive relationship between students' satisfaction with their academic programs including the perceived fulfillment of their doctoral expectations and their successful degree completion. Social science literature makes extensive use of quantitative methods, thus, mastery of quantitative techniques is essential to graduate students. Moreover, Vijverberg (1997) indicates that mastery of quantitative techniques creates new opportunities for graduate students in social sciences to pursue professional careers as well as it opens up topics for master's thesis or a dissertation. The present study is significant because efficacy about quantitative research should enhance students' satisfaction about their doctoral program and reduce attrition. Thus, the findings of this study may alert the administrators about additional support system such as statistical consulting that doctoral students may need for their degree completion.

CHAPTER II

REVIEW OF THE LITERATURE

This study explores how students' learning can be enhanced through instruction that builds self-efficacy. The conceptual framework of the study is social cognitive theory. This chapter presents a review of the relevant literature in social cognitive theory, instructional strategies that incorporate these theoretical perspectives, self-efficacy theory, co-effects of self-efficacy and anxiety, and the impact of feedback sources on learning, self-efficacy and anxiety.

The literature review serves to define the variables feedback and monitoring errors in the context of the present study. How did previous research employ feedback and monitoring errors to treat anxiety and foster efficacy? Lastly, the differences in the present investigation and the previous research are highlighted. The transition from social cognitive perspectives to instructional strategies that build self-efficacy incorporates ideas from the cognitive psychologist Mayer (1983, 1987, 1989, 1991, 2001, 2002) and Clark and Mayer (2003).

The first section presents the theoretical prediction of social cognitive theory of how students learn from providing and receiving feedback. This theoretical model is illustrated in Figure 1.1.

Social Cognitive Theory

Social cognitive theory views humans as cognitive, self-regulatory, and self-reflective beings (Bandura, 1986). Students are active seekers and processors of information in contrast to being empty vessels where knowledge deposits are being made (Freire, 1977).

Additionally, in social cognitive theory, humans adapt to their environment but they influence that ecology as well. Moreover, there is a reciprocal association of personal, behavioral, and environmental influences that impact human functioning; thus, humans are engaged in their own development.

The social cognitive model showing the interaction between personal, behavioral, and environmental influences is represented in Figure 1.1. This model indicates that as students work on tasks they note their progress toward their learning goals based on progress indicators that convey to students that they are performing well (Bandura, 1986/1997; Pintrich & Schunk, 2002). This reciprocity enhances self-efficacy for continued learning and influences students' emotion positively. This is the foundation of reciprocal interaction of social cognitive theory which is between (a) personal factors in the form of cognitions and affects, (b) behaviors in the form of cognitive strategies such as providing feedback, and (c) environmental influences such as peer feedback, teacher feedback and modeling (Bandura, 1986; Schunk & Pajares, 2005).

This theory profoundly influences the design of the instruction because it considers students capable to self-regulate, to self-reflect, to plan alternative strategies, and to learn by doing and by modeling. Bandura (1986) believes that humans possess cognitive means and capabilities to make sense of their own experiences, self-reflect, and thus, alter their thinking and behavior. He expands the concept of human agency to include collective agency. “People live their lives neither entirely autonomously nor entirely interdependently in any society,” Bandura (1997, p. 32) continues that, “They do many things independently but must also work together to achieve desired results.” This is a natural extension and the consequence of humans living in the society. Thus, the theory applies to human adaptation and change in collectively oriented societies.

Social learning theory explains human behavior in terms of continuous reciprocal interactions between cognitive, behavioral and environmental determinants (Bandura, 1986). This reciprocal interaction contrasts with the behavioral view (Skinner, 1953), which emphasizes only the environmental influences. Behavioral theories imply that teachers should arrange the environment so that students can respond properly to stimuli. The consequence of this view is that students are motivated by outside sources, whereas, in the social cognitive view, instruction and social variables impact and are affected by not only what students do but also by their thoughts, beliefs and emotions (Pintrich & Schunk, 2002).

Behavioral, Personal, and Environmental Influences

In behavioral theory (Skinner, 1953), motivation only applies to performance whereas in social cognitive theory motivation applies to both learning and performance (Schunk & Hanson, 1989b). Students with higher motivation (personal influence) apply more effective strategies (behavioral influences) and respond more appropriately to environmental influence (feedback) to improve performance (Pintrich & Schunk, 2002).

Thus, the overall orientation of social cognitive theory is contextual because it posits that behavior represents an interaction of people with their environments.

Personal influences include motivational factors such as self-efficacy and anxiety (see Figure 1.1). According to Pintrich and Schunk (2002), students' belief that they are capable of performing the task influences academic achievement positively. Self-efficacy, or students' perceptions of their capabilities to execute an action required to achieve a particular outcome (Bandura, 1986), has been found to have strong influences on choice of activities, effort expended, willingness to persist, and task accomplishments (Zimmerman, 1996). Students' emotional reactions to learning a subject that students in which students lack prerequisite skills could impact performance as well.

Behavioral influences include factors such as cognitive strategies of integrating (Clark & Mayer, 2003) and metacognitive strategies of monitoring and regulating (Wlodkowski, 1999). The use of these strategies enhances academic performance (Pintrich & De Groot, 1990; Wlodkowski, 1999). Providing feedback is another form of behavioral influence. Wlodkowski (1999) indicates that learning is more effective when students provide feedback because it allows them to participate in analyzing potential blocks to progress in learning.

Environmental influences include factors such as receiving feedback, and assessment from peers and teachers as well as review of others' efforts to improve performance. Feedback has been acknowledged as an effective social learning mechanism (Wlodkowski, 1999). Wlodkowski shows that feedback helps students to correct misconceptions, and grow in metacognitive skills of monitoring, as well as a sense of connection to the class. According to Wlodkowski, when learners participate in solving peers' learning problems, they are more aware of their role in the learning process. He continues that "adult learners frequently know better than we do where problems in learning are occurring" (Wlodkowski, 1999, p. 153).

Wang and Wu (2002) noted that feedback improves academic achievement and enhances motivation. Their research on the role of motivation on computer-supported learning behaviors and achievement supported the positive effect of feedback on achievement. Wang and Lin (2006) applied the social cognitive theory to web-based learning using Netports. This learning system allowed them to monitor and empirically analyze the reciprocal interaction between personal, behavioral, and environmental influences on students' cognitive growth and achievement. Their results indicated that the Netport system had positive effects on students' learning behaviors including better quality of feedback and learning strategies.

Summary of Research in Social Cognitive Theory

In summary, students are viewed as active seekers and processors of information in social cognitive theory (Bandura, 1986; Schunk, 1995). The reciprocal interaction between three influences suggest that students' motivation is not solely determined by students' internal forces or external stimuli, rather is determined by the dynamic interplay of the personal, behavioral, and environmental factors. The social cognitive model shown in Figure 1.1 is used for the following summary.

The arrow between behavioral and personal factors can be regarded as group interaction behaviors influencing both group motivation and group efficacy (Bandura, 1997). The arrow representing the reciprocal interactions between personal and environmental factors indicates that motivational beliefs exert a strong influence on academic achievement (Pintrich & Schunk, 2002). The reverse is also true. Schunk (1991) found that feedback and modeling significantly influence students' motivational beliefs. The arrow between behavioral and environmental influences indicates that learning strategies, group discussion and social interactions facilitate students' academic achievement. The reverse of this interaction indicate that feedback and modeling influence students' learning strategy choices (Pintrich & Schunk, 2002).

This section presented the framework of social cognitive theory's prediction on the impact of giving and receiving feedback on learning due to the interaction of personal, behavioral, and environmental factors. Anxiety and self-efficacy both are personal factors. Social cognitive theory predicts that the metacognitive strategy of monitoring (behavioral factor) interacts with receiving feedback (environmental factor) to impact efficacy (personal factor) to modify anxiety.

The model in Figure 1.1 is a theoretical prediction. To operationalize this prediction, Mayer's works are reviewed next. The question is how to strengthen students' efficacy beliefs through metacognitive strategies of monitoring? This leads to the question of how to design instruction such that improving efficacy through monitoring is likely to occur. In the next section the role of metacognitive strategies on learning and memory is discussed.

Cognitive Theory and Instruction—Mayer

The present study has employed Bandura's (1986) triadic reciprocality phenomenon to design a system of feedback for instruction. The full model for this study is represented in Figure 2.1. The top part of the model is the outcome and the bottom part is the feedback sources. It is hypothesized that this system impacts learning, anxiety, and efficacy positively by its direct link to metacognition. Thus, the performance of this system is of interest. For the present study, only part of this model is under investigation.

The part under investigation allows students to provide and receive feedback and learn from errors. This requires students to use the metacognitive skills of monitoring their and their peers' steps and errors and to integrate these responses and move forward. The performance of the system is determined by finding out how monitoring one's steps and peers' steps in solving a problem impact learning.

Learning through metacognition requires active engagement of the mind with new information (Clark & Mayer, 2003). This is not mindless processing of information which according to Clark and Mayer results in poor understanding, learning and memory. Rather learning through metacognition involves an explicit practice of skills of monitoring, reflection, and integration.

Mayer (2002) argues that there is a direct link between cognition and instruction. He points out that learning is the result of integrating new knowledge with existing knowledge in the long-term memory. "Effective integration requires the activation of prior knowledge in long-term memory" (Clark & Mayer, 2003, p. 34). Clark and Mayer (2003) argue that working memory is a powerful processor; however, it has limited capacity for processing information. Clark and Mayer stress the use of Internet technology as a tool to extend the human mind.

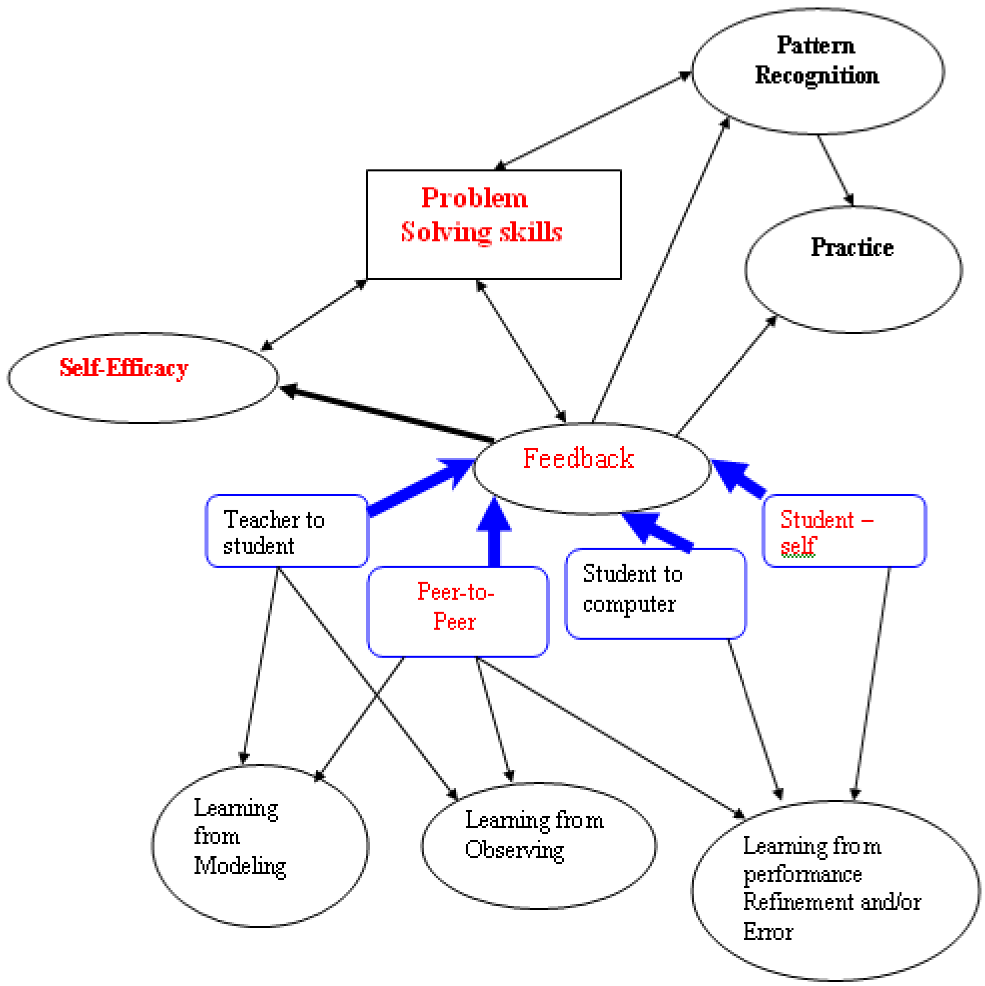

Figure 2.1. ***Full Feedback Model***

Clark and Mayer (2003) argue that technology could be adjusted to fit in with the way people learn. For the present study, a web-based feedback technology such as a wiki is used to enable students to interact with the teacher and each other by providing and receiving feedback. This system transforms the concept of technology to an environment for social interaction (Clark & Mayer, 2003) and also provides a medium for recording reflection from peers, the instructor, and students themselves (Liu et al., 2001).

According to Clark and Mayer (2003), instructional methods that overload working memory make learning difficult. Overloading the working memory is referred to as increasing the cognitive load beyond the optimum level. Cognitive load is the sum of the information working memory must hold plus the information it must process. Thus, Clark and Mayer show that instructional methods that free working memory for active processing of information and integrating new information foster learning.

The feedback sources in this study are intended to help students' cognition in two ways: First, to reduce individual cognitive loads, and second, to allow students to monitor and integrate the information with the help of peers. The question is then how these processes impact learning, efficacy and anxiety.

Mayer (2002) and Clark and Mayer (2003) emphasize the role of collaborative assignments because they maximize integration (encoding) and active processing (rehearsal) of the new information by the long-term memory. Clark and Mayer (2003) showed through many experiments that well-structured collaborative assignments maximized interaction among all participants, which in turn allowed for students to attend to important information in the lesson and integrate new knowledge with existing knowledge.

Clark and Mayer (2003) postulated that confronting a problem and discussing the problem in a small group have independent positive effects on prior knowledge and subsequent learning. Their research compared the learning outcomes from online collaboration versus the quality of communication in a face-to-face environment. Their results reported a deeper pattern of communication in the online discussion. They attributed these results to greater accountability, visibility, and opportunities for reflection afforded by the written asynchronous online discussions.

Clark and Mayer (2003) presented empirical evidence that self-questioning skills and self-explaining skills aid learners to actively engage with processing of new information and integrating it with existing knowledge. Their research indicated that when learners were trained to generate questions of textual materials, significant learning gains occurred. The deliberate practice of these sub-skills allows for reflection, which is a desired skill for an expert problem solver.

Pintrich and Schrauben (1992) showed that the use of metacognitive strategies had positive effects on students' academic performance. Schraw and Nietfeld (1998) found a positive relationship between self-monitoring and academic achievement. Salovaara and Jarvela's (2003) research on computer-supported collaborative learning suggested that metacognitive strategies are important for inquiry-based knowledge construction.

Summary of Research in Cognitive Theory and Instruction—Mayer

In summary, this section provided an overview of research that supports the role of metacognition in cognition and memory. Mayer's research indicates that instruction needs to be designed to incorporate one's pattern of learning. His many empirical findings supports the idea that metacognition requires active engagement of the mind with new information. However, the processing of the new information is successful if the cognitive load is manageable. Mayer's research also explicates the proper use of technology to extend the human mind, which could allow for metacognition through collaboration and social support. Therefore, collaborative assignments using the proper technology allow students to practice monitoring, reflection, and integration of the new information by practicing the sub-skills of self-questioning and self-explaining.

This section served to incorporate Mayer's research on instruction and the role of practicing metacognitive strategies of monitoring on problem solving skills. Social cognitive theory indicates that students' motivation is the dynamic interplay of personal, behavioral, and environmental factors. Mayer's research shows how to design instruction to operationalize this dynamic interplay. The top half of Figure 2.1 is the outcome from the feedback sources. Using a technology with feedback sources facilitates providing and receiving feedback on problem solving and this skill impact self-efficacy due to the dynamic interplay of personal, behavioral, and environmental factors.

Self-Efficacy

This section reviews the literature on self-efficacy, its role on achievement outcomes, and how students' learning can be enhanced through sources that build self-efficacy.

Bandura (1986, 1997) defines self-efficacy or perceived capabilities as students' convictions to perform behaviors successfully at designated levels. Bandura's (1986) research asserts that students' abilities are important for learning; however, they do not account for learning in isolation of other factors such as students' perceptions of their abilities. Self-efficacy influences an individual's thought patterns and emotional reactions

(Bandura, 1997). Schunk's (1982, 1983, 1984) series of experiments documented that as students' self-efficacy perceptions strengthened, their performance also noticeably improved.

Pintrich and De Groot (1990) reported that academic self-efficacy beliefs positively related to intrinsic value and cognitive and self-regulatory strategy use, and correlated negatively with test anxiety. Self-efficacy also positively correlated with various outcome measures such as grades, scores on exams and quizzes, and quality of essays and reports.

Self-efficacy beliefs help determine the amount of effort people expend when confronting a difficult task (Schunk & Pajares, 2005). High self-efficacy helps create feelings of serenity in approaching difficult tasks and activities. Conversely, people with low self-efficacy may believe things are tougher than they really are. This kind of belief fosters anxiety and a narrow vision of how best to solve a problem (Bandura, 1997).Thus, there is a reciprocal relation between self-efficacy and anxiety. Students who do not have high efficacy beliefs may readily experience feelings of anxiety. Conversely, anxiety about a subject such as math or statistics may induce low efficacy perceptions in students.

Theory predicts that students with higher motivation (high efficacy beliefs) apply more effective strategies and respond more appropriately to environmental demands (Pintrich & Schunk, 2002). The converse is also true. However, Schunk (1995) indicates that no amount of self-efficacy feelings will produce a competent performance when requisite skills are lacking. A novice problem solver with high efficacy beliefs may experience feelings of anxiety in a statistics course if the instruction does not improve his requisite skills in statistical problem solving.

Sources of Self-efficacy

The rest of this section discusses the sources of efficacy and how the feedback sources shown in Figure 2.1 implicate these sources of efficacy shown in Figure 2.2. Bandura (1997) predicted that the most powerful source of people's efficacy is their previous performance. Students who decide to participate in graduate studies base their decisions on their previous mastery performances. According to Bandura (1997), students develop perceptions of their capabilities based on their interpretations of their previous activities and thus engage in subsequent tasks of learning new skills. If they interpret their outcomes in math or statistics courses as successful events, their efficacy perceptions are raised, and if they interpret them as failures, their efficacy perceptions are lowered.

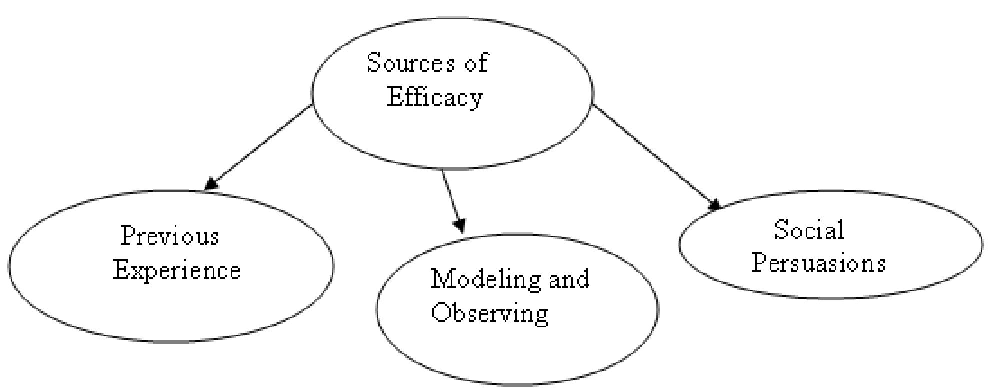

Figure 2.2. ***Sources of Efficacy***

Another source of self-efficacy is formed through observing others performing the task (Pintrich & Schunk, 2002). For example, students in Liu et al.'s (2001) study were asked to load their project on the web and then provide review comments to each other. The peer review system allowed students to observe peers' work and provided examples of how to use comments to complete their projects. The researchers reported students' increasing efficacy in completing assignments due to observing examples from peers.

According to Bandura (1997, p. 93), "seeing effective problem-solving strategies modeled raises the performance attainment of groups partly be enhancing their members' collective sense of efficacy." Cognitive rehearsal strengthens self-beliefs more than just modeling alone, and modeling alone surpasses verbal instruction in the same strategies.

In Lin et al.'s (2001) research students reported that they benefited from reviewing other works; for example, obtaining critical insights from other peers' work allowed them to improve their own performance during the review process. These researchers reported empirical evidence that modeling significantly impacted students' academic performance.

In the feedback system shown in Figure 2.2 students have the opportunity to learn from self-modeling as well. The wiki keeps a record of students' reflection and correction of their own errors. Schunk and Hanson's (1989b) research showed higher efficacy for students who observed their own performance. These researchers attributed these gains to students observing their progress in skill acquisition.

Another source of self-efficacy is social persuasion (Schunk & Pajares, 2005). This process is effective when it confirms individual's beliefs in their own capabilities and encourages them to continue to extend effort to improve. Bandura (1997) argues that the most resilient individuals often find themselves struggling with self-doubts. Visser (1998) found that motivational messages had a positive effect on students' motivation. She compared the retention of students in the section where they received motivational messages to the other sections that did not receive any messages and found that stimulating feelings that affects students' motivation appeared to help with performance.

In Wang and Lin (2006)'s study, peer feedback affected students' attitudes positively. By reducing the risk of making mistakes and having the opportunities to correct one's work students felt secure. The influence on confidence and attitude resulted in higher motivation to learn.

Wang and Lin (2006) used a questionnaire to collect data on self-efficacy and used this data to assign students into heterogeneous teams. Their experimental results indicated that groups consisting of a mix of high, middle and low self-efficacy members generated more meaningful interactions than groups whose members were all at the same efficacy level. One of the implications of their study was that teachers take self-efficacy into consideration when forming learning teams.

Summary of Research in Self-efficacy

In summary, self-efficacy beliefs impact motivation and performance (Pintrich & Schunk, 2002). This theory is a consequence of Bandura's (1986) emphasis on the role of self processes in human functioning. This section presented theoretical and research findings of the impact of efficacy beliefs on academic functioning and how strengthening self-efficacy perceptions can improve students' performances.

The sources of efficacy discussed in this section are: (a) students' previous performance, (b) observing and modeling, and (c) social appraisal. People form efficacy beliefs from observing a model without having to actually perform the task. Students may observe peer's works and consequently be able to perform the task themselves. The ability to perform by observing others' work can help create a sense of self-efficacy.

It was shown that lack of prerequisite skills would not produce mastery performance even if the individual possesses high efficacy beliefs. However, instruction that employs the sources of efficacy impacts skills attainment positively and can raise self- efficacy. In the next section the literature on the impact of feedback sources on learning is reviewed. The present research employs four sources of feedback in instruction because they elucidate the four sources of efficacy illustrated in Figure 2.2. The question is how do feedback sources impact learning and efficacy? For the present research the focus is on providing and receiving feedback and learning from errors.

Feedback Sources

Feedback sources in this study consist of feedback from teacher to student, student to student, student to computer, and student to self. The question is whether students learn from providing and receiving feedback on their steps of deriving solutions to homework problems. How do providing and receiving feedback from peers and monitoring errors impact learning and efficacy? Do students perceive to benefit from feedback sources? Do students express negative attitudes toward feedback system?

Feedback is a method of communication. Feedback during learning is critical for evaluating new skills (Wlodkowski, 1999). Wiggins (1998) asserts that feedback is information about what exactly resulted from the learner's action. It reflects the learner's actual performance as opposed to the learner's ideal performance. Students typically receive feedback on their completed work or on tests. This is feedback on performance (McKendree, 1990) but not on the process of comprehension, evaluation, and execution. Feedback about reasons for an error does not provide any direction to correct the error nor motivates students to explore new alternatives for finding solutions (McKendree, 1990).

The feedback on performance does not allow students to self-adjust or monitor the steps of formulating solutions (Clark & Mayer, 2003). Allowing students to participate in analyzing their mistakes or in finding the potential blocks to their progress helps them grow in metacognitive skills of monitoring (Wlodkowski, 1999). This sense of control enhances students' personal responsibility in the process of learning (Wlodkowski, 1999). This strategy could potentially impact self-efficacy positively.

For the present study, the four levels of feedback are enacted in a system of networked portfolio technology, which research claims allows students some control over monitoring and regulating their postings (Liu et al., 2001; Wang & Lin, 2006; Mejias, 2006; Lin et al., 2002). In this study, students received grades from providing quality feedback to peers, from incorporating feedback from peers to finish their assignments, and from the final project in which they did not receive any feedbacks from peers. Lovett et al. (2000) indicated that receiving feedback during the learning process minimizes acquiring invalid procedure or making wrong connections. These researchers noted that when students receive feedback during the initial formulation of the problem incorrect knowledge is not strengthened. Research also indicates that specific feedback is much more beneficial than global feedback (Lovett et al., 2000).

When students participate in correcting their errors, they are participating in the learning process. This self-assessment gives learner a sense of control in the learning act (Wlodkowski, 1999). Additionally, this constant back-and-forth dialogue and correcting each other's errors creates social interaction among learners (Wlodkowski, 1999). The learners have the opportunity to practice the steps of planning, monitoring and regulating, which are metacognitive strategies (Pintrich & Schunk, 2002) involved in problem solving.

The process of receiving feedback on one's work reduces student's cognitive load and allows students to integrate new information with the existing knowledge. Additionally, the process of giving and receiving feedback and learning from errors allows them to explicitly practice the process of monitoring, reflection and integration. Moreover, the feedback sources create a social environment for peer interaction (Clark & Mayer, 2003).

The hardware and software technology in a networked Portfolio system (Wang & Lin, 2006; Mejias, 2006; Lin et al., 2002) allowed students to use technology to work on projects and problem-solving activities outside of the classroom and to receive focused feedback from the instructor or their peers. Feedback in this situation serves as information and as a modeling tool. The work of a student with higher skill serves as a model or standard for less skilled students without creating undue pressure due to social comparison. Research by Wang and Lin (2006) indicates a positive effect of peer review in the web-based learning system and especially on students' higher level of thinking.

Seifert and Hutchins (1992) demonstrated the influence of errors as opportunities for instruction and learning in a study of the cooperative system for the navigation of a large naval vessel. In their study, most learning occurred by observing others as well as by receiving multiple perspectives for error detection.

Research suggests that students who provide high-quality feedback to their peers are also critical thinkers (Wang & Wu, 2002). For example, a study indicates that students who apply more critical-thinking strategies tend to give high-quality feedback (e.g. elaborated feedback) while those who use rehearsal strategies only provide lower quality feedback (e.g. knowledge of results) in the web-based environment (Wang & Wu, 2002). According to Wang and Wu's (2002) research students who are more actively involved in their learning, such as by providing high-quality feedback, are more likely to demonstrate better learning behaviors and academic performance.

It is of interest to examine the correlation between students' assignment scores, review score, and final score (no peer feedback). It is also of interest to see whether students perceive benefits from peer feedback. What is their attitude toward peer feedback? According to social cognitive theory (Pintrich & Schunk, 2002), there is a reciprocal relation between anxiety and efficacy; therefore, it is of interest to know the configurations of the groups based on scores due to achievement, efficacy, anxiety, and perceptions of the course and to check these with predictions from social cognitive theory.

Summary of Research in Feedback Sources

In summary, the sources of feedback allow students to learn from analyzing potential blocks to progress in the presence of social support from peers (Wlodkowski, 1999). Moreover, students are able to process information and integrate it with existing knowledge due to the time technology afforded for reflection (Clark & Mayer, 2003). However, responsibility to peers for providing quality comments creates an environment for deliberate practice of monitoring strategies (Mayer, 2002). Moreover, deeper pattern of communication may emerge due to greater accountability, visibility, and opportunities for reflection due to providing feedback to peers (Clark & Mayer, 2003). Feedback sources minimize the occurrence of overloading of the working memory since students have the opportunity to correct errors and yet receive feedback whether their steps to correcting their initial attempt were on target or they may need further adjustment (Clark & Mayer, 2003). As seen in Figure 2.2, feedback sources explicate efficacy sources.

How Do Feedback Sources Influence Efficacy?

The sources of feedback investigated in this research affect efficacy through their direct link to the metacognitive strategies of planning, monitoring, regulating, and integrating (Clark & Mayer, 2003). The underlying assumption is that when individuals practice planning, monitoring, regulating, and integrating, which are critical to developing problem solving skills, they can accomplish a task that they perceived as difficult. The performance attainment affects their perceived efficacy (Schunk, 2006). With respect to the reciprocal interaction between beliefs and actions, research shows that student' self-efficacy beliefs influence choice of tasks, persistence, effort, and achievement. In turn, students' actions modify their self-efficacy beliefs (Schunk, 2006). Therefore, it is of interest to know how efficacy scores correlate with anxiety and achievement scores.

Pintrich and Schunk (2002) assert that although outcome expectations and self-efficacy need not be related, the former often are dependent on the latter: "If you control for how well people judge they can perform, you account for much of the variance in the kinds of outcomes they expect" (Bandura, 1986, p. 393). According to Bandura (1986, p. 394), "How one behaves largely determines the actual outcomes and, in the same way, beliefs about outcome expectations are dependent on self-efficacy judgment."

For instance, students may perceive solving a statistics problem as a difficult task, thus they may dread the task and may procrastinate reading the instructions or even looking at examples (Onwuegbuzie & Wilson, 2003). In most cases, this behavior is disjoined from individuals' actual capabilities. If the learners do not feel confident about their mathematical or statistical skills, they may conjure up the images of failure and dwell on negative images (Bandura, 1997). The motivational impact of self-efficacy can be dramatic. Individuals who grossly underestimate their efficacy limit their potential for learning (Bandura, 1997).

In a portfolio system, where a student who is anxious about asking for help but could view other people's work, the student has the opportunity to learn the missing steps (Lin et al., 2001). This scaffolding occurs due to the modeling effect. Here technology, as a source of feedback, allowed greater anonymity to students, and with this resource the students could continue on with the process of learning. This results in higher efficacy through its direct link to task accomplishment (Lin et al., 2001).

Lin, Liu, and Yuan's research (2001) supported the claim that offering quality feedback enhanced high-level cognitive strategies, which were constructed in a group setting. In Liu, Lin, and Yuan's (2001) study, students with high assignment scores were those who could strategically adopt peers' critique for self-improvements.

Summary of Research in Feedback Sources and Efficacy

In summary, the four levels of feedback impact efficacy through their direct link to the metacognitive strategies of planning, monitoring, regulating, and integrating (Clark & Mayer, 2003; Pintrich & Schunk, 2002; Wlodkowski, 1999). The sources of feedback enable the learners to develop these strategies, which are the components of problem solving skills. Feedback facilitates developing these skills due to the processes of control and social interaction. The opportunity to plan, regulate, integrate and monitor steps of solving a problem gives the learner the control over the process of learning (Wlodkowski, 1999). However, feedback from peers or the teacher provides the social support, which is a source of efficacy as shown in Figure 2.2. Moreover, observing other students' works provides a modeling effect, and correcting one's errors provides a recovery strategy, which is a significant skill in problem solving (Bandura, 1997). This performance attainment affects group efficacy as well as self- efficacy. According to Schunk (2006), students' performance attainment interacts with their perceived self-efficacy such that students experience positive emotions.

Feedback sources impact efficacy because they elucidate the sources of efficacy: (a) students' previous performance, (b) observing and modeling, and (d) social persuasion (Schunk & Pajares, 2005). The efficacy sources are represented in Figure 2.2. In the previous sections the relationship between the effect of modeling and observing on learning was established by reviewing the literature as well as citing research evidence (Lin et al., 2001). Also, the impact of modeling (Wang & Lin, 2006), observing (Liu et al., 2001), and social appraisal (Visser, 1998) on efficacy was reviewed from the literature. Previous research also provided evidence on the impact of feedback on monitoring and regulating strategies (Wang & Lin, 2006). Moreover, the feedback sources allow for integrating new knowledge and existing knowledge. Clark and Mayer's (2003) research indicated that this integration process takes place in the long term memory where students retrieve and interpret their previous mastery performance. According to the theoretical prediction, feedback sources enable students to master the task, i.e., problem solving; the triadic interaction would enhance their efficacy beliefs.

Statistics Anxiety

According to Onwuegbuzie et al. (2000), between 75% to 80% of graduate students in non-math-oriented disciplines appear to experience uncomfortable levels of statistics anxiety. Many of these students do not necessarily have backgrounds in statistics or mathematics from their undergraduate degree or other graduate training (Pan & Tang, 2004). For many of these students, there is a lag in time since they last took statistics courses (Onwuegbuzie et al., 2000).

Onwuegbuzie (1997a) reported that statistics anxiety primarily affects a student's ability to understand research articles and to analyze and interpret statistical data as well. As a result of anxiety, students often delay enrolling in research methods and statistics courses for as long as possible, sometimes waiting until the final semester of their degree programs, which is clearly not the optimal time to undertake such courses (Onwuegbuzie, 1997a/1997b).

Onwuegbuzie et al. (1997c) illustrated that sometimes students' anxiety in statistics is not necessarily due to the lack of training or insufficient skills, but due to the lack of students' efficacy perceptions in statistics. These researchers found that students' efficacy perceptions in statistics kept students away from engaging in research work, which impacted students' degree completion.

Bessant (1992/1995) argues that students experience anxiety in statistics due to many factors; however, one factor is students' lack of efficacy in problem solving which relates to typical statistics instruction. He emphasizes that most statistical instruction fragments and isolates statistical processes from the empirical research. Bessant (1992) reasons that students do not learn to integrate the statistical processes and research with quantitative reasoning. This could potentially create anxiety since students do not see the relevance of the subject to their education and, among graduate students, to their research (Bessant, 1992; Onwuegbuzie & Wilson, 2003).

Students may experience anxiety due to internal factors such as low self-perceptions in statistics or external factors such as instruction. Research (Bessant, 1992; Onwuegbuzie & Wilson, 2003; Pan & Tang, 2004) indicates that students in social sciences exhibit a great deal of statistics anxiety due to either lack of mathematical background or the motivation to learn statistics; however, statistics instruction with emphasis on computations rather than conceptual understanding is partly responsible for students' anxiety.

Schacht and Stewart (1990) point out that statistics instruction is perhaps the most anxiety-producing of the courses offered by any sociology department. Piotrowski et al. (2002) report the same concern for graduate-level statistics in psychology. Onwuegbuzie et al. (2000) reported a high degree of statistics anxiety in graduate students in education. According to Forte (1995) many social work educators have acknowledged their students' phobic attitude toward statistics. Although many factors contribute to students' anxiety, some that are applicable to social work students were minimal previous math preparation, late-in-career introduction to quantitative analysis, general anti-quantitative bias, lack of appropriation for the power of analytical models, and lack of mental imagery useful in thinking about quantitative concepts (Forte, 1995).

Bessant (1992) argues that the typical instructional design stresses the learning of techniques in statistics as opposed to synthesizing a practical understanding of the subject. He asserts that instructions in statistics tend to fragment theory, statistical analysis, and empirical reality. This fragmentation results in students not learning problem solving skills, which according to Bessant (1992) and Stangl (2000) should be at the core of statistics curriculum.

Bessant (1992) points out problems with delivering statistical contents via the lecture methods that emphasize algorithmic teaching despite evidence that calls into question the effectiveness of this teaching format. Forte (1995) points out that teachers give in to anxious students by grading easy and expecting little. This remedy does not contribute to a satisfying or productive educational atmosphere. Caulfield and Persell (2006) argue that students do not appreciate scientific reasoning and do not develop skills for formulating questions, designing research, and using quantitative and statistical skills to analyze data unless the instruction stimulates students' interest. They point out the deficiency in lecture method that does not employ collaboration because it does not fully engage students in learning and reflecting on the stages of developing statistical skills.

Summary of Research on Statistics Anxiety

This section has provided an overview of different sources of statistics anxiety. To summarize, students may experience anxiety due to internal factors such as low efficacy perceptions in statistics or external factors such as poor instruction (Bessant, 1992; Onwuegbuzie & Wilson, 2003; Pan & Tang, 2004). Low efficacy may be due to students' lack of requisite skills in quantitative courses and lack of mental imagery useful in conceptualizing quantitative concepts (Forte, 1995). Instructional design that emphasizes techniques as opposed to synthesizing a practical understanding of the subject, as well as an instructional format that does not engage students in learning and reflecting on the stages of developing statistical skills, enhances students' anxiety (Bessant, 1992; Stangl, 2000).

Summary of Research on Treatment of Statistics Anxiety

In the literature, statistics anxiety has been extensively studied for more than two decades (Onwuegbuzie & Wilson, 2003). Most studies have focused primarily on measurement of and factors contributing to statistics anxiety. Few studies have concentrated on how to reduce the anxiety in learning statistics by modifying the instruction.

Pan and Tang (2004) modified instruction to remedy statistics anxiety through application oriented teaching methods with the instructor's attentiveness to students' anxiety. They offered their intervention to 21 social science graduate students at a Midwest university in a traditional lecture class. They reported a reduction in students' anxiety; however, they did not have a control group nor did they measure students' growth in learning and application of statistics.

Lovett et al. (2000) applied cognitive theory to statistics instruction by emphasizing individual practice and providing real-time feedback from the instructor. They reported a significant gain in students' learning from pretest to posttest compared with a control group. These gains were reported on 75% of the test items and little or no improvements on other 25% of the items. These researchers concluded that these results indicate the inherent difficulty of statistical concepts and the potential need for additional guidance in improving instruction.

Frederickson et al. (2005) compared the effects of the web version of a statistics course with a traditional lecture version using a counterbalancing method. They reported improvements in knowledge and reduction in anxiety in both versions. Their findings also indicated that course members (16 graduate students in educational psychology) showed less satisfaction with the teaching input on the web-based version but more satisfaction with the peer collaboration.

Caulfield and Persell (2006) suggest using peer collaboration and engaging students actively in giving and receiving peer assistance in order to develop quantitative reasoning skills. They argue that problem solving activities and active engagement of students with statistics enable students to develop the language of the discipline.

In the literature, researchers have adopted numerous approaches to reduce anxiety in statistics ranging from the use of humor, applying statistics to real-world situations, encouraging students to work in cooperative groups, and open book and open notes for testing (Wilson, 1996), as well as the use of examples to help students with schema construction theory (Quilici & Mayer, 1996). Larreamendy-Joerns et al. (2005) examined six online instructional materials involving learning from examples, problem solving potential, the use of interactive learning objects and feedback. They emphasize the interactivity and learning from examples that is possible with the on-line technology. However, they point out that feedback and scaffolding tailored to the students' individual needs could complement the online courses such as statistics.

Mejias (2006) researched the effectiveness of the social software or Network Portfolio system on students' learning, practical research skills, developing team effort skills, and engaging students in learning to learn in a course in education. He points out several advantages in regard to student acquiring research skills. Liu et al. (2001) used a networked system to facilitate web-based peer review to assess metacognitive gains in students in a computer science course. Wang and Shiu (2005) investigated the impact of networked group interaction on group efficacy and group performance.

Wang and Lin (2006) applied social cognitive theory to web-based learning through a network portfolio system. They noted their system promoted self-regulated learning behavior because of the effect of feedback sources, which supported learning due to the practice of metacognitive skills of planning, monitoring, regulating, and integrating. They also observed and reported increases in personal and group efficacy. They used Netports, a web-based learning system that allowed them to empirically analyze the interactions between the three personal, environmental, and behavioral factors.

Wang et al. (2001) compared the non-intimidating characteristics, such as anonymity in asking questions, of various technologies such as electronic chat rooms on the web in a statistics course. Some students may experience more anxiety in the traditional classroom compared to the electronic chat room. According to their findings these technologies facilitated social learning and co-construction of knowledge. Students' final grades correlated positively with the total number of students' responses and comments. Wang and Lin (2006) used a Networked Portfolio web-based learning system to enact the feedback so that students could self-regulate their learning.

Teachers' monitoring is not as direct in the web-based learning situations as it is in the classroom; thus, there are potential losses due to free riding, social loafing, and diffusion of responsibility (Benbunan-Fich & Hiltz, 1999). Some students tend to lack focus or willingness to participate or the discipline for the web-based environment. Moreover, Lin, Liu, & Yuan (2001) indicated that some students experienced greater peer pressures in the peer assessment. These researchers also pointed out that some students disliked peer assessment because raters were at the same time competitors. Thus, collaborative learning behaviors or processes may determine the success of web-based collaborative learning. Web-based learning requires greater reliance on students' collaboration and self-regulated learning behavior (Wang & Lin, 2006).

Summary

In the literature, statistics anxiety has been extensively studied for more than two decades (Onwuegbuzie & Wilson, 2003). Few studies have concentrated on how to reduce the anxiety in learning statistics by modifying the instruction. The purpose of the present study is to enhance learning statistics through instruction that builds efficacy and reduces anxiety.

Statistics anxiety and lack of self-efficacy in statistics may be attributed to instruction and students' lack of prerequisite skills in problem solving (Bessant, 1992). The research findings cited earlier indicate that technology could be adjusted to fit with how people learn (Clark & Mayer, 2003). The resources on the network portfolio system such as wiki offer advantages for interactive learning such as providing students opportunities to learn from feedback and monitoring their errors that students naturally make in solving statistics problem (Mckendree, 1990).

One of the areas least researched in cognitive theory for adult students is the impact of feedback students provide on their work and their errors on efficacy and anxiety through feedback's direct link to metacognitive skills of monitoring. Researchers have demonstrated the impact of efficacy on emotions due to goal attainment and its influence for continued learning (Schunk, 2006). However, there is not much research on the effect of feedback in general and feedback on errors in particular on efficacy due to fostering metacognitive monitoring strategies and their subsequent impact on anxiety.

The network technology in previous research offered features that facilitate giving and receiving feedback (Liu, Lin, & Yuan, 2001; Liu, Lin, & Yuan, 2002; Wang & Lin, 2006). Wang and Lin (2006) designed the NetPorts web-based learning system to facilitate the reciprocal interactions of the three influences of social cognitive theory in learning. However, in their study, no statistical findings are reported to quantify the metacognitive gains of learners in planning, monitoring, and regulating.

In Liu et al.'s (2001) study, 143 computer science undergraduate students participated in a web-based learning peer review course. They reported that students displayed higher level of thinking skills such as critical thinking, planning, monitoring, and regulating. Moreover, these students perceived peer review as an effective strategy that promoted their learning motivation. Their study did not have a control group, thereby not showing causal effects of peer review.

In Lin, Liu, & Yuan's (2001) study, the authors focused on the attitudes of computer science students toward web-based peer assessment using NetPeas, an interactive channel and management center. Their results demonstrated that students were significantly more satisfied with this new learning strategy and those students with positive attitudes toward web-based peer assessment outperformed those with negative attitudes. Their study concentrated on peer assessment; however, their results were inconclusive in regard to students' attitudes and their performance because they reported a very low internal consistency for the loadings on the factor representing the negative attitude.

Liu, Chiu, Lin, & Yuan (1999) used an experimental design to identify what types of individual benefit most from peer assessment activity. They concentrated on two kinds of specific and global comments that 58 computer science students provided to each other in their homework assignments. In this study students graded peer work and each student had two rounds of opportunity to accept other ideas and to improve their assignments. They used a questionnaire to identify the strength of an individual executive tendency. According to Sternburg (1997), a person with high executive ability is willing to mould his or her efforts to fit the requirement of teacher assignment. Their study indicated the effectiveness of peer assessment as a pedagogical strategy to improve student learning. Also, their study indicated that students learn more when they continued to refine their work and specific comments can enhance students' level of achievement especially those with low executive tendency.

In the studies cited, students' performance in peer review or peer assessment indicated gains in learning and metacognitive strategies of refining one's work based on peer comments. However, there is not much empirical evidence on the impact of sources of feedback using network technology on efficacy especially for adults in courses such as statistics. This study is intended to provide empirical evidence of an experiment to test the social cognitive theoretical prediction that self efficacy is enhanced by feedback that fosters problem solving skills. In the present study, the skills of logical progression to deriving the solution are demonstrated and students provide feedback within a well defined context.

Students typically do not provide comments to peers to help each other in deriving solutions to problems. Thus, the instruction is designed so that the students practice these skills using the interactive technology. Thus, the findings here are intended to motivate additional investigations on how to use the facilities afforded by the new technology to practice the skills of monitoring, planning, and regulating.

CHAPTER III

METHODOLOGY

Purpose of the Study

This chapter presents the methodology used to explore how students' learning can be enhanced through instruction that builds self-efficacy. The conceptual framework is social cognitive theory of learning which is displayed in Figure 1.1. Social cognitive theory explains human behavior in terms of a continuous reciprocal interaction between cognitive, behavioral, and environmental determinants (Bandura, 1986). For the present study, a networked portfolio or a web-based feedback technology such as a wiki is used to provide empirical evidence of an experiment to test the social cognitive theoretical prediction that self efficacy is enhanced by feedback that fosters problem solving skills.

The full model for this study is represented in Figure 2.1. The top part of the model is the outcome and the bottom part is the feedback sources. The bottom part or the feedback sources are simulated in the network technology. The web-based feedback system transforms the concept of technology to an environment for social interaction (Clark & Mayer, 2003) and also provides a medium for recording reflection from peers, instructor, and students themselves (Liu, Lin, & Yuan, 2001).

The web-based feedback technology is the medium to test instruction that improves efficacy through monitoring, modeling, and learning from errors. The collaborative assignments (Clark & Mayer, 2003) are designed to maximize integration and active processing of the new information in the long term memory through the feedback sources. This technology makes the continuous reciprocal interaction between three personal, environmental, and behavioral influences possible (Wang & Lin, 2006). The web-based feedback technology enables students to interact with the teacher and each other by providing and receiving feedback (Wang & Lin, 2006) and also to learn by monitoring their errors (McKendree, 1990).

The instruction in this study emulates Clark and Mayer' (2003) research. Their research indicates that technology could be adjusted to fit in with the way people learn. The feedback sources in this study are intended to help students' cognition in two ways: First, to reduce individual cognitive loads, and second, to allow students to monitor and integrate the information with the help of peers. Thus, the feedback resources and the interactive technology accommodate students' differences in regard to their information processing rate.

What Do Students Achieve during the Feedback Process?

The instruction via web-based feedback system facilitates explicit practice of skills of monitoring, reflection, and integration (Clark & Mayer, 2003). These skills are modeled with examples. Students learn through these models the steps of problem solving (Schunk, 1987). In completing the assignments, a student may plan the steps to the solution, the procedures to be shown in the solution, and finally execute the plan. In reviewing peer homework, student must read, compare, or question ideas, suggest modification, or even reflect how well students work is compared with others. These cognitive processes involve monitoring the adequacy of steps adopted. However, if student receives a message that a step is not adequate, then the student must regulate the cognitive function and employ other alternatives.

Pintrich and Schrauben (1992) showed that students with low motivation and achievement are unwilling to do mindful work such as executing higher level cognitive processes. Liu, Lin, Chiu, and Yuan (2001) showed that learners involved in peer review execute higher level cognitive processes because peer pressure as a motivating factor may push students to perform higher level cognitive functions than they would only from receiving feedback from the teacher.

The question is then how processes of receiving and providing feedback and monitoring errors impact learning, efficacy and anxiety. This chapter is devoted to describe the design of the experiment, the questions this study addresses, the variables being measured, the methodology by which data is collected, the analyses techniques, and how these techniques are the most appropriate to address the questions of the study.

Research Design

The present experiment was set up to test the social cognitive theoretical prediction that self efficacy is enhanced by feedback that fosters problem solving skills. The experiment was pilot tested in a course format that was taught twice: Once in spring 2007 and once during a two-week intensive workshop in summer 2007. However, the data for this dissertation were collected using an experimental design in fall 2007. In this experimental design students were assigned randomly to feedback and no feedback (control) groups.

Variables

To determine the impact of feedback on problem solving, a set of theory-driven assessment indices was used. These indices represent the social cognitive variables of self-efficacy (pre and post), anxiety (pre and post), problem scores, and satisfaction. These assessment indices were chosen following previous research on the impact of feedback in improving students' learning in the web-based environment (Frederickson et al., 2005; Lin, Liu, & Yuan, 2001; Liu, Lin, Chiu, & Yuan, 2001; Schunk & Pajares, 2002; Wang & Lin, 2006; Wigfield et al., 1996).

Research Questions

The specific questions of the study are: (a) Is the mean efficacy score significantly higher for the feedback group than the mean for the no feedback (control) group controlling for students' characteristics?; (b) Is the mean anxiety score significantly lower for the feedback group than the mean for the control group controlling for students' characteristics?; (c) Is the mean grade significantly higher for the feedback group than the mean for the control group controlling for students' characteristics?; and (d) Is the mean satisfaction score significantly higher for the feedback group than the mean for the control group controlling for students' characteristics? These questions are displayed in Tables 1 through 4 in Appendix A.

The course format and its implementation for the pilot test are described next, followed by the design of the experiment for the data for this dissertation.

Feedback Course Format: Pilot Study

The focus of the course is for students to understand variation and probability through summarizing and presenting data. The course covers topics in data analysis in regard to distributions, relationship, probability and randomness, introduction to inference for distributions and for count data, parametric and nonparametric tests. The course syllabus is attached in Appendix B. Students learn these topics and their application to their research by practicing four skills via collaborative assignments. These four skills consist of mathematical steps to deriving the solutions, logic models, data analysis using computer software and presentation of the results, and reading and summarizing the research materials. The feedback process is implemented with students practicing modeling these four skills (Schunk, 1987).

The first skill involves students learning problem solving skills through pattern recognition. This is accomplished by working through problems which have similar surface features but different structural features (Quilici & Mayer, 1996). Initially students learn three types of problems which are grouped by t-test, correlation, and chi-square. The problems for pattern recognition are included in Appendix C. Students solve these twelve problems collaboratively by practicing the four skills mentioned earlier for six weeks. The same routine is repeated for another four weeks, however, the problems in these four weeks involve nonparametric procedures.

Students are provided with examples of the mathematical steps to arrive at the solutions. For each category of the problems - t-test, correlation, and chi-square - students are provided with examples to derive the solution using the logic model.

Students are provided with examples for learning how to use the software to analyze data, summarize results, and report the findings. The fourth skill that enhances pattern recognition is reading and organizing research publications. Students are provided with examples for this skill as well. Students turn in eight assignments and a final project that has four parts corresponding to the four skills of pattern recognition, logic model, computer analysis, and research summary.

In summary, students do collaborative assignments for ten weeks - six weeks are devoted to learn parametric and four weeks to nonparametric procedures. They spend two additional weeks to prepare their final project for which they do not receive peer feedback. Their feedback to each other is structured around learning the mathematical steps, the logic model, the data analysis using software, and learning from the research publications. Students are provided with examples for each of these four skills.

Feedback Course Implementation

(a) The teacher posts the homework assignment. (b) Each student prepares the homework and uploads it to the wiki. (c) For each assignment, the teacher assigns randomly three reviewers for each student. (d) Each student views others' works and must comment on the steps of how the solution is derived. (e) Each student must revise the original assignment in line with the comments received. The final solution has a brief description from each student that summarizes their initial understanding of the problem and their final understanding.

I. Students receive a grade based on how effectively they incorporate the three reviewers' comments and feedback into deriving the solutions. This score is referred to as the assignment score. High assignment scores indicate students who strategically monitor and regulate their steps and adopt peers' feedback for self-improvement. Students have one week for each assignment to revise their initial solution and incorporate all feedback.

II. Students receive a grade on the quality comments they provide. This score is referred to as the review score. High review scores indicate students who make significant contributions to peers' works. Students are to provide at least three rounds of feedback to the student who is receiving the comments. If after three rounds of feedback from peers or self students are still not at the final solution, the teacher will provide additional feedback.

III. Students also receive a grade on the final project for which they do not receive any feedback from peers. The duration of the final project is two weeks. The final project includes one data set with the statement of the problem, variables measured, appropriate analysis, and report of the findings. A logic model must be included to show how students' knowledge of a decision tree has been used to derive the solution. Each student will turn in summary, questions, answers, and opinion sections that they have created from three published research papers with accompanying newspaper articles. This exhibits students' mastery of the four skills that is practiced through the term.

Experiment to Collect Data for this Dissertation

For this dissertation, the research questions were answered using an experimental design format displayed in Table 3.1. Students completed an on line survey comprising of three parts. The survey measured students on variables discussed earlier and are listed below:

- Initial student comparability variables.
- Students' self-competence/confidence in statistical problem solving, giving and receiving feedback (pre and post).
- Student statistics anxiety scores (pre and post).
- Problem solving scores (pre and post for feedback).
- Students satisfaction (post)

Both groups completed the demographic, self-efficacy and anxiety questions. Students in the control group proceeded to solve three problems comprising of five questions each. In the last part of the survey students completed the posttest on efficacy and anxiety measures, as well as a five item survey concerning their satisfaction with the problem solving activity. Students in the feedback condition were assigned randomly to groups of three to solve the same problems in a discussion forum environment in Facilitate Pro-5, which is an interactive on line system. In Facilitate Pro-5 students worked collaboratively in groups of three, provided and received feedback to solve the 15 questions. When all group members finished the problems, each student solved the same problem in the survey format individually. Table 3.1 shows the design of the study.

Table 3.1

Schematic Representation of the Design of the Study

Group	Survey Pretest	Facilitate-Pro Solve Problems in Groups of Three	Problems	Survey Posttest
Feedback	X	X	X	X
No feedback	X		X	X

Subjects

One hundred thirty-eight (138) undergraduate students in a business computing course representing 23 majors at a university in the southeast United States in fall 2007 took part in the present experiment. Students were informed that their participation in the experiment allowed the researcher to evaluate how effectively students used feedback sources on the web environment to exchange, share their ideas and collectively solve problems. Their participation was voluntary. No remuneration was provided, but most instructors provided course credit. 97% of the students participated in the study. The sample was an opportunity sample, i.e., the subjects were not randomly selected for the sample, but they were randomly assigned to either feedback (F) or control (N_F) groups.

The data were collected over 15 course sessions. Students' information is broken down by gender and class in Table 3.2. Statistics summarizing participants' age and number of math or statistics courses taken are displayed in Table 3.3.

There were 40 females and 29 males in feedback group with the mean age of 21.0 and mean number of previous math courses or statistics taken of about 2.99. There were 31 females and 38 males in no feedback group with the mean age of 20.55 and mean number of previous math courses or statistics taken of about 3.07. This information is broken down further in Tables 3.2 and 3.3.

Instruments

The instruments used in these surveys are listed below and are included in Appendix D through H.

Table 3.2

Student Information Broken Down by Gender and Class

Method			Class				
			Freshman	Sophomore	Junior	Senior	Total
F	Gender	Female	14	11	8	7	40
		Male	6	13	9	1	29
		Total	20	24	17	8	69
N_F	Gender	Female	13	6	10	2	31
		Male	10	11	16	1	38
		Total	23	17	26	3	69

Table 3.3

Statistics Summarizing Participants' Age and Number of Math or Statistics Courses Taken

Method		**Age**	**Number of Math or Statistics Courses Ever Taken**
F	Mean	21.07	2.99
	N	69	69
	Std. Deviation	5.97	1.85
N_F	Mean	20.55	3.07
	N	69	69
	Std. Deviation	3.61	1.67

(a) Students' Academic background

(b) Students' Perceived confidence/competence (self-efficacy-pre and post)[1]

(c) Statistics Anxiety Scale (pre and post)[2]

(d) Problems (pre and post for feedback)[3]

(e) Students' perceptions of their learning experiences (Satisfaction-post)[4]

Problems

Students solved three statistical problems shown in Display-1 (see Figure 3.1). These three problems share a common set of surface features or story line in that each involves the experience of typists as the independent variable and typing speed as the dependent variable and is derived from a cover story about experience and typing speed (Quilici & Mayer, 1996). The difference between them is the scale measurements of the variables or the structural features. These problems help to exemplify the surface and structural similarities in the domain of introductory statistics.

Quilici and Mayer (1996) used these problems to test the cognitive process of analogical reasoning. They found that people often fail to recognize structural similarities between a problem they know and a new problem. Inexperienced problem solvers usually are more concerned with the surface features (story line) of the problem than the structural features of the problem that involve the shared relations between the objects in

---

[1] The first three items were from Frederickson et al. (2005) study, the rest were added for this study. The instrument had a reliability coefficient of 0.92 in two pilot studies prior to this experiment.

[2] Bertz (1978) The last five items are negatively coded, scores associated with them were reverse coded before the analysis.

[3] Quilici and Mayer (1996)

[4] Frederickson et al(2005)

the problem. Their solutions are derived through their understanding these structural features. Quilici and Mayer's (1996) research indicated that the more experienced problem solvers sort problems based on their structural features than their surface features.

Display-1

(1) A personnel expert wishes to determine whether experienced typists are able to type faster than inexperienced typists. Twenty experienced typists (i.e., with 5 or more years of experience) and 20 inexperienced typists (i.e., with less than 5 years of experience) are given a typing test. Each typist's average number of words typed per minute is recorded.

(2) A personnel expert wishes to determine whether or not experienced typists are likely to be fast typists and inexperienced typists are more likely to be slow typists. Twenty experienced typists (i.e., with 5 or more years of experience) and 20 inexperienced typists (i.e., with less than 5 years of experience) are given a typing test. Based on the test, each typist is classified as fast or slow.

(3) A personnel expert wishes to determine whether typing experience goes with faster typing speeds. Forty typists are asked to report how many years they have worked as typists and are given a typing test to determine their average number of words typed per minute.

Figure 3.1. ***Display-1***

Recker and Pirolli (1995) modeled individual differences in students' learning strategies and found that self-explanation significantly affected students' initial understanding and their subsequent problem solving performance. Chi (1996) studied the effect of self-explanations and scaffolded explanations in co-construction of knowledge in tutoring. Her study showed that tutor actions that prompt for co-construction of knowledge such as prompting for self-explanation may be the most beneficial in providing deep learning. She concluded that actions that triggered learning may be partially due to removing misconceptions.

For each problem students answered five questions: two questions tested students' surface understanding (story line), and three tested their structural understanding (scale measurement and recognition). When applicable, each question provided a short description as shown in Display-2 (see Figure 3.2).

Display-2

Questions were structured as shown below: first, the problem, then a short description and then the question.
A personnel expert wishes to determine whether experienced typists are able to type faster than inexperienced typists. Twenty experienced typists (i.e., with 5 or more years of experience) and 20 inexperienced typists (i.e., with less than 5 years of experience) are given a typing test. Each typist's average number of words typed per minute is recorded.

A response variable measures the outcome of a study.
In this problem the response variable is:
A. experience
B. 5 years
C. average number of words typed per minute
D. twenty experienced typists

Figure 3.2. ***Display-2***

Students in the feedback group worked in groups of three. The Students chose one of the multiple choice answers and then provided a rationale for their choice. After each group member provided their responses, students could change their answers and/or provide additional feedback to the group members. Thus, the experiment determined whether feedback on students' self-explanation influenced recognition of similarities between surface features and structural features of these problems.

Analysis

Quantitative

Research question one: Is the mean efficacy score significantly higher for the feedback group than the mean for the no feedback (control) group controlling for students' characteristics? A repeated measure analysis was conducted with the pre and post efficacy scores as within subject factors and the method as the between subject factor with students' characteristics as covariates.

Research question two: Is the mean anxiety score significantly lower for the feedback group than the mean for the control group controlling for students' characteristics? A repeated measure analysis was conducted with the pre and post anxiety scores as the within subject factor and the method as the between subject factor with students' characteristics as covariates.

Research question three: Is the mean grade significantly higher for the feedback group than the mean for the control group controlling for students' characteristics? A one-way analysis of variance with grades as the dependent variable, method as the independent variable and students' characteristics as covariates was performed.

Research question four: Is the mean satisfaction score significantly higher for the feedback group than the mean for the control group controlling for students' characteristics? A one-way analysis of variance with satisfaction scores as the dependent variable, method as the independent variable and students' characteristics as covariates was performed.

Qualitative

A content analysis was used to analyze research question three qualitatively. Students' comments in the feedback group to each other were analyzed in terms of quantity and kinds of self-explanations. Cognitive studies of analogical problem solving or thinking by analogy involves three processes of recognition, mapping, and abstraction (Quilici & Mayer, 1996). In this experiment, the focus was on recognition.

Did students' self-explanation indicate recognition of similarities between surface feature and structural features of these problems? How did group feedback impact this recognition? A table was created containing students' change in problem scores from pre to post, the counts of students' comments and the number of self-explanations they provided for each questions.

Pearson correlation coefficients were calculated between variable "growth," which is the difference from pretest to posttest in problem solving scores, number of comments, age, number of previous math or statistics courses, and efficacy scores.

CHAPTER IV

RESULTS

This chapter presents the results of various statistical analyses conducted to answer the research questions of the study. The present study and the research questions were designed to test the social cognitive theoretical prediction that self efficacy is enhanced by feedback that fosters problem solving skills. The statistical analyses were performed in SPSS© (Version 15.0, 2007).

Research Questions

Efficacy

Research question one: Is the mean efficacy score significantly higher for the feedback group than the mean for the no feedback (control) group? To answer this question, students' self-efficacy scores were measured twice, once in a pre-survey before students solved the problems, and then in the post survey after they solved the problems.

A repeated measure analysis was conducted with test (pre and post) as the within subjects variable, treatment (Feedback) versus control (No-Feedback) as the between subjects variable, and self-efficacy scores as the dependent variable. Table 4.1 presents the summary statistics for the dependent variable in question 1.

The mean score of self-efficacy scores at pretest and posttest were 33.22 and 30.51 with standard deviation of 5.37 and 7.42 for the feedback group. These scores at pretest and posttest were 34.39 and 31.94 with standard deviation of 5.39 and 7.11

respectively for the control group. The reliability coefficient for the self-efficacy instrument increased from pre- to posttest for both groups: 0.80 to 0.88 for the feedback group and 0.76 to 0.87 for the control group. The results of the repeated measures ANOVA for the change in self-efficacy scores due to feedback versus no feedback are shown in Table 4.2.

Table 4.1

Summary Statistics for Variable Self-efficacy, Pre and Post for Both Groups

Method		**Pre Efficacy**	**Post Efficacy**
F	Mean	33.22	30.51
	Median	33.00	30.00
	Std. Deviation	5.36	7.42
	Cronbach's α	0.80	0.88
	N	69	69
N_F	Mean	34.39	31.94
	Std. Deviation	5.38	7.11
	Cronbach's α	0.76	0.87
	N	69	69
	Median	34.00	31.94

The results indicate that there was a significant mean difference ($F_{1, 136}$=33.60, p = .0001) from pre- to posttest when the groups were combined. However, there was not a significant mean difference between the feedback and control groups ($F_{1, 136}$ =1.72, p = .19), nor was the interaction effect significant ($F_{1, 136}$ = .08, p = .77).

Table 4.2

Repeated Measures ANOVA for Self-efficacy Scores (n=138)

Source	df	F	η^2	Observed Power[a]
		Within Subjects		
Test	1	33.60*	0.19	1.0
Test*Method	1	0.08	0.001	0.06
Error (Test)	136			
		Between Subjects		
Method	1	1.72	0.01	0.26
Error	136			

[a] Computed using alpha=.05

*p<.05

The following options were investigated to determine why the mean efficacy scores on the posttest (30.53 for feedback and 31.94 for no feedback) were lower for both groups' than their mean pretest scores (33.22 for feedback and 34.39 for no feedback).

Joo et al. (2000) reported a positive association between students' self-efficacy for learning in a web-based environment and their academic self-efficacy or past mastery performance (Bandura, 1977, 1997). In Pan and Tang's (2004) study, age was a factor that affected students' efficacy. In the present study, the number of courses was the only covariate that indicated students' past experience. Therefore, the results of repeated measure ANCOVA with pre- and post efficacy as dependent variables and method as the independent variable were repeated controlling for the number of courses and age. The results are shown in Table 4.3.

Table 4.3

Repeated Measures ANCOVA for Statistics and Feedback Self-efficacy (n=138)

Source	df	F	η^2	Observed Power[a]
		Within Subjects		
Test	1	0.43	0.01	0.10
Test*Method	1	0.02	0.00	0.05
Test*Age	1	5.24*	0.04	0.62
Test*No_Courses	1	0.23	0.01	0.07
Error (Test)	134			
		Between Subjects		
Method	1	1.43	0.01	0.22
Age	1	2.97	0.02	0.40
No_Courses	1	2.14	0.02	0.31
Error	134			

[a] Computed using alpha=.05

*p<.05

These results did not indicate any statistical significance due to any effects except for the interaction between age and test. The significant interaction between efficacy test and age ($F_{1, 134} = 5.24$, $p = 0.02$) indicated that mean of efficacy was statistically different at posttest than pretest due to age. However, the effect size for this test is .04, thus the significance in the mean difference was most likely due to the sample size rather than the treatment effect.

Pan and Tang (2004) had studied the effect of age on efficacy in statistical courses; however, their study did not examine the impact of feedback. Therefore it was of interest to examine the correlation between age and efficacy perceptions in providing and receiving feedback in solving statistics problems in an on-line environment. The Pearson correlation coefficient between post-efficacy scores and age for the feedback group was ($\rho = -.23$, $p = 0.05$) and for the no-feedback group was ($\rho = -.10$, $p = .4$). This showed that the post-efficacy test was negatively correlated with age; thus for these data, older students after problem solving had a lower rating on efficacy than before problem solving. The correlations between pre- and post-efficacy scores were ($\rho = .76$, $p < .0001$) for the feedback group and ($\rho = .63$, $p < 0.0001$) for the control group.

Schunk and Pajares (2002) research state that the higher score for self-efficacy at pretest than posttest can be attributed to incongruence between self-efficacy beliefs and students' actual performance. According to these researchers, students may not fully understand what is required to execute a task successfully. However, as students gain experience in problem solving, their assessment accuracy of their capabilities improves. This process is referred to as *calibration* (Schunk & Pajares, 2002, 2005).

The discussion forum for the feedback group provided an opportunity for students to give and receive feedback. Statistically this gain in experience was further examined using Pearson correlation. The problem scores for the feedback group were their posttest scores which correlated positively with their post-efficacy scores ($\rho = 0.36$, p=0.0027). Whereas for the no- feedback group, the correlation between problem solving and post-efficacy was negative and was not statistically significant ($\rho = -0.065$, p=0.60).

Anxiety

Research question two: Is the mean anxiety score significantly lower for the feedback group than the mean for the control group controlling for students' age? Students' anxiety scores were measured twice, once in a pre-survey before students solved the problems and then in the post - survey after they solved the problems. Table 4.4 presents the summary statistics for anxiety scores for both groups.

A repeated measure analysis was conducted with the pre- and post-anxiety scores as within subjects factors (dependent variables), the method as the between subjects factor (independent variable), and age as covariate (Pan & Tang, 2004).

The mean anxiety scores at pretest and posttest were 30.55 and 31.26 with standard deviations of 8.53 and 7.87 for the feedback group. These scores at pretest and posttest were 30.84 and 30.49 with standard deviation of 8.02 and 8.71 respectively for no-feedback group. The reliability coefficients for anxiety ranged from .89 to 0.93 from pre- to posttest for the two groups (Table 4.4). The results of the repeated measures ANCOVA for the change in anxiety scores due to feedback versus no feedback are shown in Table 4.5.

Table 4.4

Summary Statistics for Variable Anxiety, Pre and Post for Both Groups

Method		**Pre Anxiety**	**Post Anxiety**
F	Mean	30.55	31.26
	Median	30.00	30.00
	Std. Deviation	8.53	7.87
	Cronbach's α	0.93	0.89
	N	69	69
N_F	Mean	30.84	30.49
	Std. Deviation	8.02	8.70
	Cronbach's α	0.90	0.92
	N	69	69
	Median	30.00	30.49

The results indicate that the change in anxiety from pre- to posttest due to method was not significant. The only significant effect was due to age ($F_{1, 135}$= 5.82, p=.017); however, the effect size was .04 indicating that the significance in mean difference due to age was attributed to sample size than the treatment effect.

Previous research (Pan & Tang, 2004; Onwuegbuzie, 1997a; Onwuegbuzie et al., 2000) obtained an association between statistics anxiety and age; however, this effect had not been examined in the presence of feedback. Therefore it was of interest to examine the correlation between age and statistics anxiety after providing and receiving feedback in solving statistics problems in an on-line environment. The Pearson correlation coefficient between post-anxiety scores and age for the feedback group was ($\rho = .38$, p = 0.001) and for the no-feedback group was ($\rho = .06$, p = 0.6).

Table 4.5

Repeated Measures ANCOVA for Statistics and Anxiety (n=138)

Source	df	F	η^2	Observed Power[a]
		Within Subjects		
Test	1	0.11	0.02	0.34
Test*Method	1	0.79	0.01	0.14
Test*Age	1	2.88	0.02	0.39
Error (Test)	135			
		Between Subjects		
Method	1	0.01	0.00	0.05
Age	1	5.82*	0.04	0.67
Error	135			

[a] Computed using alpha=.05

*p<.05

The Pearson correlation coefficient indicated that the post-anxiety test was positively correlated with age; thus for these data, older students after problem solving had a higher rating on anxiety than before problem solving. This correlation coefficient was significant (p=.001) for the feedback group. It was likely that older students felt more anxious in providing feedback in a subject that they did not perceive themselves as self-efficacious (Schunk & Pajares, 2002). This effect could also be attributed to the matching of ability with self-efficacy- students' efficacy declined after problem solving, their anxiety increased.

The Pearson correlation coefficient between pre-anxiety scores and age was not significant for either group.

Problem Solving

Research question three: Is the mean grade significantly higher for the feedback group than the mean for the control group controlling for students' age and number of math or statistics courses taken? A one-way analysis of variance with grades as the dependent variable and method as the independent variable controlling for students' age and number of math or statistics courses taken (Macpherson, 2002) was performed.

Students in control group solved three problems comprised of five questions each (Chapter III). Students in the feedback condition were assigned randomly to groups of three to solve the same problems in a discussion forum environment. This technology allowed students to work collaboratively. Students provided and received feedback on the 15 questions. When all group members finished the problems, each student solved the same problem in the survey format individually similar to the control group. Table 4.6 illustrates the summary statistics for the problem solving scores for the feedback group (post) and control group.

The impact of feedback on problem solving was analyzed quantitatively and qualitatively. The quantitative analysis is presented first followed by a qualitative analysis on the content of the feedback students provided and received.

Table 4.6

Summary Statistics for Variable Problem Solving Scores for Both Groups

Method		Problem Score
F	Mean	9.13
	Median	10.00
	Std. Deviation	3.00
	N	69
N_F	Mean	7.49
	Std. Deviation	2.95
	N	69
	Median	7.49

Quantitative Analysis for Problem Solving

The mean problem score was 9.13 with a standard deviation of 3.01 for the feedback group and 7.49 with a standard deviation of 2.96 for the no-feedback group (Table 4.6). Table 4.7 shows the results of the one-way analysis of covariance (ANCOVA) for the mean differences in problem solving scores due to feedback versus no-feedback controlling for students' age and number of courses taken.

The effect due to Method is significant ($F_{1, 134} = 8.95$, p=.003, $\eta^2 = .07$); groups differed significantly on predicted mean problem solving scores. The number of math or stat courses taken ($F_{1, 134}=10.47$, p=.002, $\eta^2 = .08$) and age ($F_{1, 134}=6.25$, p=.014, $\eta^2 = .05$) had significant effects on the mean problem solving scores. The effect sizes for testing the mean differences were small indicating that the sensitivity of the statistical tests could be attributed to the sample size rather than the treatment effect.

Table 4.7

ANCOVA for Problem Scores (n=138)

Source	df	F	η^2	Observed Power[a]
Test	1	8.95*	0.07	0.843
Test*Method	1	10.47*	0.08	0.894
Test*Age	1	6.25*	0.05	0.698
Error (Test)	134			

[a] Computed using alpha=.05

*p<.05

The Pearson correlation coefficients between problem solving scores, age, and number of courses taken were examined. Problem solving was negatively correlated with age: (ρ = -.13, p = 0.30) for the feedback group and (ρ = -.1, p = .4) for the no-feedback group. For these data, older students had lower problem solving scores. Problem solving was positively correlated with number of math or statistics courses taken (ρ = .25, p = 0.03) for the feedback group and (ρ = .30, p = 0.01) for the no-feedback group. Students who had taken more math or statistics courses had higher scores. For both groups this effect was statistically significant.

Qualitative Analysis for Problem Solving

The median problem score values were 10.0 for the feedback group and 7.49 for no feedback group (Table 4.6). Moreover, 41 students of 69 in the feedback group scored 9 out of 15 possible points for problem scores compared to 26 students out of 69 in the no-feedback group (Table 4.8). This means that 59% of the students in the feedback group scored better than 60% (i.e., a grade of D) compared to 37% in the no-feedback group. Additionally, 18 of the 41 students in the feedback group who scored 60% or higher in solving problems also had no change or a positive change in self-efficacy from pre- to posttest compared to 11 students in no feedback group. This means 26% of the feedback students scored better than 60% in problems and had no change or positive change in their efficacy ratings compared to 15.9% in the no-feedback group. Thus, it was of interest to explore the strategies used by feedback group students that resulted in their problem post test median scores to be [(10-7.49)/7.49]= 33.5% higher than the no-feedback group's median scores.

The strategies used by the feedback group were also examined by analyzing students' comments. Specifically, students' comments in the feedback group to each other were analyzed in terms of quantity and kinds of self-explanations.

Students in the feedback group chose one of the multiple choice answers and then provided a rationale for their choice. Table 4.9 illustrates one student's response to a question.

Table 4.8

Frequency Distribution of Students with Scores Higher than D and Positive Change in Efficacy

Group	**Problem Scores ≥ 9 (Grades = D)**	**Problem Scores ≥ 9 and Δ efficacy ≥ 0**
F	41 (59%)	18 (26%)
N_F	26 (37%)	11 (15.9%)

Table 4.9

Example of Questions and One Student's Feedback

Questions were structured as shown below: first, the problem, then a short description and then the question.
A personnel expert wishes to determine whether experienced typists are able to type faster than inexperienced typists. Twenty experienced typists (i.e., with 5 or more years of experience) and 20 inexperienced typists (i.e., with less than 5 years of experience) are given a typing test. Each typist's average number of words typed per minute is recorded.

A response variable measures the outcome of a study.
In this problem the response variable is:
A. experience
B. 5 years
C. average number of words typed per minute
D. twenty experienced typists

One student wrote: "It's C because the response variable is something that is the result of the project, the avg. words per min is what tells us who are the better typers."

The above elaboration contains key words that draw similarities between the objects of the story. This student first defined the question in her own words, and then matched the key word from the story to her newly defined phrase to answer the question. Liu et al. (2001) showed that technology that provided an environment for students to record their reflection had a significant impact on their learning. This recording of reflection or students' self-explanation served as a model for other students in the group (Bandura, 1997). It was quite likely that one student's self-explanation help remove a misconception for another student in the group (Chi, 1996). The converse was also likely. The technology used for the discussion forum in this study allowed the instructor to monitor students' responses. However, during this experiment no intervention was made to avoid introducing biases in the results.

Chi (1996) discussed the pattern of dialogue that developed in her study as a result of co-construction of knowledge between tutee and tutor. The content analysis revealed that students who provided elaborations for each question achieved a higher gain in their post problem grades than those who did not engage in self-explaining. In the present experiment, there were students who had zero change in their problem scores but no one in the feedback group showed a decrease in problem solving from pre- to posttest.

Table 4.10 shows Pearson correlation coefficients between the differences in students' problem scores (growth), the number of comments they provided, age, number of previous math or statistics courses, and post efficacy scores.

The Pearson correlation coefficients between variable "growth" (the difference in students' problem scores) and number of comments was .28 (p <.05), with number of previous math or statistics courses was .29 (p <.05), and with post-efficacy scores is .26 (p <.05). Age did not have a significant association with growth in problem solving.

Students' classification in college did not appear to have as much association with students' growth in problem scores as did the number of math or statistics taken previously. The median number of feedback comments was 14.5. Those students with comments indicating evidence of elaborations, self-explaining and recognition of structural features also had above the mean problem scores and had positive change in efficacy scores.

Table 4.10

Pearson Correlation Coefficients between Growth, Comments, Age, Number of Math Courses Taken, and Post-efficacy Scores

	Growth	Comments	Age	No_Courses	Post_Efficacy
Growth	1.00	0.28*	-0.04	0.29*	0.26*
Comments	0.28*	1.00	-0.04	0.07	0.19
Age	-0.04	-0.04	1.00	0.03	-0.23
No_Courses	0.29*	0.07	0.03	1.00	0.02
Post_Efficacy	0.26*	0.19	-0.23	0.02	1.00

*$p<.05$

Satisfaction

Research question four: Is the mean satisfaction score significantly higher for the feedback group than the mean for the control group controlling for number of math or statistics courses taken? To answer this question, students' satisfaction scores were measured at the posttest. Table 4.11 presents the summary statistics for the measurements made to answer question 4. A one-way analysis of variance with satisfaction scores as the dependent variable, method as the independent variable and number of math or statistics courses taken as covariates was performed.

Table 4.11

Summary Statistics for Variable Satisfaction Scores for Both Groups

Method		**Satisfaction**
F	Mean	15.49
	Median	15.00
	Std. Deviation	5.13
	Cronbach's α	0.90
	N	69
N_F	Mean	16.83
	Std. Deviation	4.42
	Cronbach's α	0.88
	N	69
	Median	16.82

In this experiment students rated their satisfaction with the overall survey and problem solving activity on five items survey using a five point (1-5) Likert scale. Low scores indicated low satisfaction. The reliability coefficient for the satisfaction measure was .88 for the no-feedback condition and .90 for the feedback group (Table 4.11).

The mean satisfaction score was 15.49 with a standard deviation of 5.13 for the feedback group and 16.83 with a standard deviation of 4.43 for the no-feedback group. The results of the one-way analysis of covariance (ANCOVA) for the predicted mean difference in satisfaction scores due to feedback versus no feedback controlling for students' characteristics (Frederickson et al., 2005) are shown in Table 4.12.

There was no statistical evidence of a difference between the mean of satisfaction scores between the two groups. The only variable showing some association with satisfaction scores in this study was the number of math or statistics courses students taken prior to this experiment ($F_{1,135} = 4.79$, $p=0.03$, $\eta^2 =.04$). The effect sizes for testing the mean differences were small indicating that the tests were detecting differences that were attributed to the sensitivity of the sample size rather to the treatment.

Table 4.12

ANCOVA for Satisfaction Scores (n=138)

Source	df	F	η^2	Observed Power[a]
Method	1	0.26	0.002	0.08
No_Courses	1	4.79[*]	0.042	0.58
Error (Test)	135			

[a] Computed using alpha=.05
[*] $p<.05$

The formal discussion of the analyses performed in this chapter is presented in Chapter V.

CHAPTER V

DISCUSSION

The present study investigated whether feedback helped to foster self-efficacy in learning among adult students. Theory and research have provided much evidence on the importance of efficacy beliefs on learning (Pintrich & De Groot, 1990; Schunk, 1982, 1984). Using network technology, the present study provided empirical evidence on the impact of sources of feedback on the self-efficacy for adults based on controlled and experimental evaluations.

Feedback is both a vicarious and a persuasive source of self-efficacy information so it can influence self-efficacy; however, for that influence to be sustained students must develop skills and succeed (Schunk & Pajares, 2002). Thus, the impact of feedback on self- efficacy in the present research was based theoretically on Schunk's (1995) research on modifying instruction to allow learners to build self-efficacy based on experience and observing others successfully performing the task (Bandura, 1997; Pintrich & Schunk, 2002) and on Mayer's (2002) and Clark and Mayer's (2003) research on monitoring and adjusting learning through the use of technology.

Self-efficacy represents the key construct in Social Cognitive Theory (Bandura, 1977, 1986) which posits reciprocal interactions between behaviors (i.e., providing feedback), personal factors (i.e. cognition), and environmental variables (i.e. receiving feedback). The present study extends the body of research on the impact of feedback on self-efficacy in learning within a technology-driven learning environment for investigating the impact of feedback on problem solving during statistics learning by adult students. Learning in a technology-driven environment could be anxiety producing similar to face-to-face instruction in statistics for adults whose background is far removed from statistics.

Students may experience anxiety due to low efficacy perceptions in the subject (personal factor); however, their low efficacy may be due to poor instruction or poor technology (environmental factor). This study explored how students' anxiety (personal factor) toward statistics may be reduced by modifying instruction (environmental factor) that builds self-efficacy in problem solving through providing feedback.

Web instruction allows the learners opportunities for providing and receiving feedback. Feedback helps learners' cognition by reducing individual cognitive loads and by allowing the individual to monitor and integrate knowledge with the help of peers (Clark & Mayer, 2003). Feedback improves learning and problem solving through facilitation of interaction among learners. When learners are able to interact with one another they share and transfer knowledge, which allows for deeper understanding of the problem and enhanced learning.

The present experiment tested the social cognitive theoretical prediction that self-efficacy is enhanced by feedback that fosters problem solving skills. Problem solving skills were measured quantitatively and qualitatively. The problems were used in Quilici and Mayer's (1996) study to study the cognitive process of analogical reasoning. In the present experiment, students' scores indicated whether feedback had an effect on students' sorting the problems based on structural features rather than surface features.

The results indicated that students in feedback group showed statistically significant gains in problem solving; however, their self-efficacy scores after the experiment were lower than their pretest scores. This was true for both the feedback and the no-feedback groups.

Students rated their efficacy scores in this study. The females in the feedback group scored lower in pre- and post-efficacy than the females in the no-feedback group. The males in feedback group scored higher than the males in the no-feedback group. Thus, the combined effect resulted in a statistically significant interaction between method and some of the covariates, but the effect size for these interaction terms were less than 0.30 because the changes were in different directions.

Schunk and Pajares's (2002) research showed that gender differences were confounded by a number of factors such as previous achievement. Wigfield et al. (1996) indicated that males are more self- congratulatory, whereas females are more modest.

The higher score for self- efficacy on the pretest than on the posttest may be due to an incongruence between self-efficacy beliefs and students' actual performances (Schunk & Pajares, 2002). Previous studies indicate that students may not fully understand what is required to execute a task successfully. As students gain experience in problem solving, their calibration assessment accuracy of their capabilities improves (Schunk & Pajares, 2002, 2005).

This matching of efficacy ratings to actual performances was observed in the feedback group. They solved the problems first in a group setting, then individually with no feedback. Their post test problem scores correlated positively with their post test efficacy ratings and this association was statistically significant ($\rho = 0.36$, p=0.0027). For the no-feedback group, the correlation between problem solving and post test efficacy was negative and was not statistically significant ($\rho = -.065$, p=.60).

In this study, the self-efficacy instruments rated students on their confidence with solving statistical problems (see item 1, Appendix E), or their confidence with detecting their errors (see item 5, Appendix E) or their confidence with incorporating peers' comments in their work (see item 8, Appendix E). Previous research has shown that students tend to rate themselves high on these types of questions because of social desirability tendencies (Schunk & Pajares, 2002). Improving this instrument to reflect more task specific questions may improve the accuracy of the test (Schunk & Pajares, 2002). Task specific questions (i.e. How confidently could you describe the response or explanatory variables in a statistics problem?), would reduce students comparing themselves with peers and would measure students' self-efficacy about the task more accurately.

The pre-efficacy mean scores were 33.22 and 34.39 for feedback and control groups, respectively. These scores reflected about 60% of the total 50 possible points on this test. These high ratings might reflect students' social desirability tendencies more than their efficacy toward the questions they were asked during the problem solving sessions. The high scores did not leave any room for growth; as a result, it would have been difficult for the scores based upon this instrument to show much growth.

Pike (1999) discussed students' tendency of overrating their capability in terms of a halo effect and noted that seniors are better trained to rate their capabilities than freshman because since they have had more years of being evaluated they have a more realistic view of their capabilities. In the present experiment, in the feedback group the mean pre-efficacy score for freshman was 32.9 compared to 31.88 for seniors.

The result of the one-way analysis of covariance (ANCOVA) controlling for students' ages and number of math or statistics courses taken showed that method had a significant effect on the mean problem solving scores. However, the effect size was small indicating that the sensitivity of the statistical tests was likely due to sample size. In the present experiment problem solving scores and ages were negatively correlated.

Macpherson (2002) showed that there was a significant correlation between cognitive maturity and problem solving ability. In her study students over the age of 30 were better problem solvers than those under the age of 30. The difference between her study and the present experiment is the present study's emphasis on feedback and the use of technology. Therefore, the negative correlation in the present study between age and the problem solving scores may be confounded by either the feedback or the kind of technology used to provide the feedback.

The students' gain in problem solving in the feedback group is in fact in agreement with Clark and Mayer's (2003) research on the impact of collaborative learning on the web and its impact on problem solving skills. Clark and Mayer emphasize the process of practice using the collaboration on the Web in learning and effectively using metacognitive strategies to become successful in problem solving.

In the present study, students in the feedback group solved the problems first in the groups of three. Each student provided self-explanation (Recker & Pirolli, 1995) or a rationale for the answers they chose (Chi, 1996), and they gave and received feedback for each question. Then each student solved the problems with no feedback similar to the no-feedback group. Therefore, the feedback groups' gain in average problem solving scores may be attributed to the effect of feedback students gave and received or to the effect of practice.

In the present experiment, it is not likely that students' gain in problem solving scores was due to effective use of metacognitive strategies because metacognition requires practicing the skills of monitoring, reflection, and integration. Monitoring errors, reflecting on steps of deriving the solutions and integrating peer assessment in the solution steps improved learning in Liu, Chiu, Lin, and Yuan's (1999) study which lasted a term. Thus, the present study should be replicated in a learning setting in which the same students have the opportunity to practice together for a longer period of time than one class session. Then, it is likely to effectively separate the effects due to feedback from other effects.

The median problem solving scores for the feedback group was 10.0 versus 7.49 for the no-feedback group. Moreover, 41 students of 69 in the feedback group scored 9 out of 15 possible points for problem scores compared to 26 students out of 69 in the no-feedback group. This means that 59% of the students in the feedback group scored better than 60% (i.e. a grade of D) compared to 37% in the no-feedback group. Additionally, 18 of the 41 students in the feedback group who scored 60% or higher in solving problems also had no change or a positive change in self-efficacy from pre- to posttest compared to 11 students in no feedback group. This means 26% of the feedback students scored better than 60% in problems and had no change or positive change in their efficacy ratings compared to 15.9% in the no-feedback group. Thus, it was of interest to explore the strategies used by feedback group students that resulted in their posttest problem solving median scores to be [(10-7.49)/7.49]= 33.5% higher than the no-feedback group's median scores.

The qualitative analysis of the contents of the self-explanations that students provided for each question indicated that those who provided more thoughtful responses and elaborated on the rationale for their choices showed higher gains in problem scores from pre- to posttest than did those who gave fewer comments or did not elaborate on their responses. Moreover, students in the feedback group had higher scores in sorting the problems based on structural features than surface features.

The number of statistics and mathematics taken previously correlated significantly with students' gains in problem solving scores. The students who scored above the median in post test problem solving also had either a positive change or no change in their self-efficacy ratings from pre- to posttest. The Pearson correlation coefficient for the feedback group's mean posttest problem solving scores and their mean post test efficacy scores was statistically significant at the .05 level.

Measurement

There are a number of possible explanations offered in the literature for students' self-evaluations. Pike (1999) discusses students' tendency of over rating their capabilities in terms of a halo effect and notes that seniors are better trained to rate their capabilities than freshman because they have had more years of being evaluated and therefore a more realistic view of their capabilities. In the present experiment the total number of seniors were 11, there were 43 freshman, 41 sophomores and 43 juniors.

Although the problem solving scores were significantly different in the feedback and the no-feedback conditions, the effect size was less than 0.10. This study was performed with large sample size; thus, to have a practical effect size, this study needs to be replicated with a more homogeneous sample of students in terms of age, classification in college, and major.

Additionally, feedback influences self-efficacy in problem solving when the outcome is sustained. Therefore, this experiment needs to be replicated with similar problems over a period of time for students to learn how to monitor their works and peers' works and how to integrate peers' comments in deriving the solutions. According to social cognitive theory, for feedback to impact self-efficacy positively there must be progress indicators to convey to students the result of their efforts. In this experiment it was not feasible to use assessment tools to provide students with real time evaluation.

In Liu, Lin, Chiu, & Yuan's (2001) study students exchanged critical feedback and modified their works according to peer feedback. In their study students performed better on assignments when they received peer review than on assignments for which they did not receive any peer review. However, their study did not have a control group. These researchers had done a similar study earlier in an experimental setting and found that students tended to improve their work in the second round when they had the opportunity to incorporate peers' assessment in their work.

The results of the current study are in agreement with Liu, Lin, Chiu, & Yuan's (2001) study because on average the feedback group's post problem solving scores (no feedback) was higher from their pre scores (with peer feedback) by 1.53 points with a standard deviation of 1.03. The maximum points on the fifteen questions were 15 points.

Lin, Liu, & Yuan's (2001) study indicated that some students exhibited negative attitudes toward peer assessments and experienced more peer pressure. Their study showed that those with positive attitudes toward peer assessments outperformed those with negative attitudes. In the present study, students' attitudes about peer feedback were not checked with the same instrument as Lin, Liu, & Yuan's (2001) used. However, the pre-efficacy scores showed no significant correlation with problem solving scores for either group. The Pearson correlation coefficient between post test efficacy scores and problem solving scores was significant for the feedback group but not for the no-feedback group. This significant association for the feedback group agrees with Lin, Liu, and Yuan's (2001) study. It may be inferred that peer collaboration changed students' efficacy about problems from pre- to posttest.

The satisfaction instrument used in this study was used in Frederickson et al.'s (2005) study. Their analysis of quantitative feedback on satisfaction did not show any significant differences between web-based versus face-to-face learning environments for a statistics course for graduate students in educational psychology. However, students' qualitative feedback indicated greater satisfaction with web learning due to peer collaboration.

Frederickson et al. (2005) also compared students' gain in problem solving and perceived confidence/competence between the two learning environments. Their results showed a mean 30% increase over baseline in both conditions. However, there was little difference in the scores either before or after teaching across the two types of teaching. Also, their experiment did not show any statistically significant main or interaction effects for perceived confidence/competence from pre- to post-test.

In the present experiment, the baseline mean satisfaction score was higher for the no-feedback group than for the feedback group; however, there was no statistical significant difference in predicted mean satisfaction scores between groups. Pike and Killian (2001) argue that students' reported gain in learning depends on students' major in college. According to these researchers, students report their learning outcome differently depending on their majors. Pike (1999) also cautions using ratings of gains reported by students to differentiate among outcomes. Pike and Killian (2001) found that the impact of coursework on general learning outcomes, such as critical thinking and problem solving, is very limited.

In this experiment the change in mean anxiety from pre- to posttest due to method was not statically significant. Students' mean anxiety was lower after problem solving; however, the change was associated with the differences in the main effect of gender. Although the gender effect was statistically significant, the overall effect size less than .1

because the simple effect for males was in the different direction than the simple effect for females.

The Pearson correlation coefficient indicated that posttest anxiety test positively correlated with age; thus for these data, older students after problem solving had a higher rating on anxiety than before problem solving. This correlation coefficient was significant ($p=.001$) for the feedback group. It was likely that older students felt more anxiety in providing feedback in a subject that they did not perceive themselves as self-efficacious (Schunk & Pajares, 2002). This effect could also be attributed to the increased accuracy of self-efficacy. It is feasible that as students' efficacy was reduced after problem solving, their anxiety were increased. The Pearson correlation coefficient between pretest anxiety and age was not significant for either group.

Pan and Tang (2004) used the same statistics anxiety instrument that was used in the present experiment. In their study, statistics anxiety was lower at posttest than pretest. However, their study had no control group. All students were women and the study lasted the entire term. Therefore, students' lower anxiety average rating on the post than pretest may be attributed to acquired skills or receiving assessment feedback from the instructor (Schunk & Pajares, 2002).

Implications

The study has important implications for faculty, college administrators, and policy professionals who are planning to meet the growing demand for access to higher education. The National Center for Educational Statistics (2001) estimates that in the US, 43% of adults will be age 50 or older by 2010 and 50% of all college students will be over 21. Marklein (1997) reports that 75% of the current workforce will need to be retrained just to stay sufficiently qualified for employment.

Colleges and universities have attempted to expand their use of IT tools via online learning in recent years to meet this record demand for access. However, the on-line educational research on the benefits of IT tools either does not utilize the scientific rigor of an evaluative studies or reports weak and inconclusive evidence for any superiority of hypermedia in achieving learning outcomes (Dillon & Gabard, 1998). These inconsistencies in the literature may be attributed to the differential effectiveness of hypermedia for different learners and types of learning tasks.

The present study attempted to examine the effectiveness of web-based instruction in problem solving from a social cognitive perspective. The reciprocal nature of the determinants of human functioning in social cognitive theory makes it possible for teaching and learning efforts to be directed at personal, environmental, or behavioral factors (Pajares, 2002). Using social cognitive theory as a framework, instructors can work to improve students' low efficacy beliefs (personal factor) about a subject such as statistics or about learning in on-line environment. They can improve students' academic skills (behavioral factor) by providing them with efficient models and feedback. Those who construct web-based learning systems can alter technology (environmental factor) that may undermine student success and design learning systems that accommodate learners' needs.

This study also provides insights into problem-solving processes from an instructional design research and theoretical perspective. The study is significant because feedback promotes critical thinking skills, which are traits and learning outcomes colleges desire their undergraduates to develop (Macpherson, 2002).

Improving statistics self-efficacy is important to graduate students because the social science literature makes extensive use of quantitative methods; thus, mastery of quantitative techniques is essential to graduate students. Moreover, Vijverberg (1997) indicates that mastery of quantitative techniques creates new opportunities for graduate students in social sciences to pursue professional careers and topics for master's thesis or a dissertation. This study also has implications for peer mentoring, which prior research shows is a predictor of retention (Dorn & Papaleis, 1997).

Limitations

The instruments in this study were used in prior similar studies with valid reported reliability coefficients. The self-efficacy pretest for the no-feedback group had the lowest reliability coefficient of .76; the rest of the instruments had reliability coefficients of 0.80 (self-efficacy pretest for the feedback group) or higher. This study stressed the importance developing adequate measurement properties prior to conducting the intended statistical analysis. The instruments in this study were pilot tested; however, the sample sizes were small and the students were more homogeneous.

Improvements could be made to enhance the reliability of constructs to enhance the reliability of measures. For example, if self-efficacy measurements were improved, the change from pre- to posttest may become a significant predictor in the impact of feedback on problem solving between two methods of learning.

The improvement in self-efficacy instruments would increase the validity of the test. These students answered 15 questions in the problem solving test. Therefore, self-efficacy questions should reflect students' efficacy in regard to the questions in the problem solving sections. The domain specific questions would reduce students' tendencies to compare themselves to peers and would reflect their efficacy in regard to the specific task.

Improved accuracy in self-efficacy instrument may increase the measurements' accuracy for both groups: The self-efficacy ratings will be in line with the problem solving scores and in fact it may improve the effect size for both self-efficacy and problem solving tests.

The tests generally indicated small effect sizes; these may be attributed to the need for measuring other variables and factors that impact self-efficacy, anxiety, and problem solving in a web learning environment.

The variance in age and other demographic variables may have been too high to accurately measure such constructs as the impact of providing and receiving feedback on problem solving. Students' feedback quality directly correlates with their cognitive maturity (Macpherson, 2002). The students in the study were not traditional college students. However, the qualitative analysis indicated a large variance in students' self-explanations on the surface features and structures of the problems.

This study was a pioneer study in that it combined factors that were tested in other research individually. Therefore, there might have been variables that were left out that would help explain the variability in the data. Also, the measurements need improvement, which may be accomplished by refining the instruments or by blocking on some variables such as age or students' classification in college or students' major.

Future Directions

The present research extended Wang and Lin's (2006) study in the application of social cognitive theory to web-based learning through NetPorts—a network portfolio system. Wang and Lin did not report any statistical data. However, they indicated that NetPorts provided students with more opportunity and flexibility to work with peers and thus promoted students' learning. Their portfolio system allowed students to continue monitoring the progress of their work and regulate their learning.

Monitoring and regulating are essential features because they allow students to self-regulate their learning and their academic performance. According to Bandura's (1997) social cognitive model of learning, as students monitor their steps and errors they note their progress toward the solution, and progress indicators convey to students that they are capable of solving problems. This reciprocity enhances self-efficacy for continued learning and impacts students' emotion positively (Pintrich & Degroot, 1990; Pintrich & Schunk, 2002).

The current study should be replicated over a longer period of time to allow students to monitor their learning and their progress. Moreover, assessment tools need to be in place to convey regularly to students the result of their efforts.

The current study needs to be replicated with an improved instrument for self-efficacy test. A more valid test with questions in line with the problem solving questions would help demonstrate the impact of feedback in fostering problem solving skills, improved self-efficacy in problem solving and, in turn, reduce the anxiety that is typical in quantitative courses such as statistics.

This study took place in an online setting. The goal was to present a rich and interactive learning experience that had the added advantage of, once developed, being simple to replicate for both academic and corporate training needs. The network portfolio resources on the web provide facilities that make the feedback on steps to solution and monitoring of errors possible. However, these resources could be used for a web course or as an addition to a face-to-face class.

Theory and research have provided much evidence on the importance of efficacy beliefs on learning (Pintrich & De Groot, 1990; Schunk, 1982, 1984). However, the present study needs to be replicated to provide more empirical evidence on the impact of sources of feedback using network technology on self-efficacy especially for adults in quantitative courses such as statistics.

Too often student learning and instructional design are viewed by instructors as problems. However, the result of this study and other studies (Wang & Lin, 2006) suggest that a variety of persons should be involved in promoting students' self-efficacy in learning in on-line environments particularly in quantitative courses.

In closing, it is important to reiterate that this study was a pioneer study to use an experimental approach to compare and investigate the impact of feedback in a technology driven environment on improving self-efficacy for problem solving with a large sample of students representing 23 college majors. Replication of this study with similar and other student populations and types of technology is needed to more directly assess differences in how students respond to learning via technology.

REFERENCES

Alonso, F., López, G., Manrique, D., & Viñes, J. (2005). An instructional model for web-based e-learning education with a blended learning process approach, *British Journal of Educational Technology, 36,* 217.

Anderson, J. A. (1993). *Rules of the mind.* Hillsdale, NJ: Erlbaum.

Anderson, J. R., Farrell, R., & Sauers, R. (1984). Learning to program in LISP. *Cognitive Science, 8,* 87-129.

Bair, C. R., & Haworth, J. G. (1999). Doctoral attrition and persistence: A meta-synthesis of research. ASHE Annual meeting paper.

Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1986). *Social Foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York: Freeman.

Bandura, A. (2000). Exercise of human agency through collective efficacy. *Current Directions in Psychological Science*, *9,* 75–78.

Benbunan-Fich, R., & Hiltz, S. R. (1999). Impacts of asynchronous learning networks on individual and group problem solving: A field experiment. *Group Decision & Negotiation*, *8*(5), 409–426.

Bessant, K. (1992). Instructional Design and the Development of Statistical Literacy, *Teaching Sociology, 20,* 143-149.

Bessant, K. (1995). Factors associated with types of mathematics anxiety in college students. *Journal for Research in Mathematics Education*, *26*(4), 327-345.

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology, 25*(5), 441-448.

Caulfield, S. L., & Persell, C. H. (2006). Teaching social science reasoning and quantitative literacy: The role of collaborative groups. *Teaching Sociology, 34,* 39-53.

Cesari, J. P. (1990). Thesis and dissertation support groups: A unique service for graduate students. *Journal of College Student Development, 31,* 375-376.

Chi, M. T. H. (1996). Constructing self-explanations and scaffolded explanations in tutoring, *Applied Cognitive Psychology*, *10,* S33-S49.

Clark, R. C., & Mayer, R. E. (2003). *E-learning and the science of instruction.* Pfeiffer.

Cruise, R., & Wilkins, E. (1980). *STARS: Statistical Anxiety Rating Scale*. Unpublished manuscript. Berrien Springs, MI: Andrews University.

Dillon, A., & Gabbard, R. (1998). Hypermedia as an educational technology: A review of the quantitative research literature on learning comprehension, control and style, *Review of Educational Research, 68,* 322-349.

Dorn, S. M., & Papalewis, R. (1997). Improving Doctoral Student Retention. Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March 24-28).

Fennema. E., & Sherman, J. A. (1976). Fennema-Sherman Mathematics Attitudes Scale: Instruments designed to measure attitudes toward the learning of mathematics by males and females. *JSAS Catalog of selected Documents in Psychology, 6*(31) (Ms. No. 1225).

Flowers, C. P., & Algozzine, R. F. (2000). Development and validation of scores on the Basic Technology Competencies for Educators Inventory. *Educational and Psychological Measurement*, *60,* 411-418.

Forte, J. (1995). Teaching statistics without sadistics, *Journal of Social Work Education*, *31*(2), 15.

Frederickson, N., Reed, P., & Clifford, V. (2005). Evaluating web-supported learning versus lecture-based teaching: Quantitative and qualitative perspectives, *Higher Education, 50,* 645-664.

Freire, P. (2000). *Pedagogy of the oppressed*. (Trans. Myra Bergman Ramos). New York, London: Continuum.

Friedrich, K. R., & Armer, L. (1999). *The instructional and technological challenges of a web based course in educational statistics and measurement.* Paper presented at the Society for Educational Technology and Teacher Education 10th International Conference, San Antonio, TX. February 28 - March 4.

Gelman, A., & Nolan, D. (1998). Student Projects on Statistical Literacy and the Media, *The American Statistician, 52*(2), 160-166.

Huang, H-M. (2002). Towards constructivism for adult learners in online learning environments, *British Journal of Educational Technology, 33*(1), 27–37.

Jacobson, M. J., & Spiro, R. J. (1993). Hypertext learning environments, cognitive flexibility and transfer of complex knowledge: An empirical investigation.

Tech Report. Champagne, IL: Centre for the Study of Reading University of Illinois.

Joo, Y. J., Bong, M., & Choi, H. J. (2000). Self-efficacy for self-regulated learning, academic self-efficacy, and internet self-efficacy in web-based instruction. *Educational Technology Research Development, 48*(2), 5–17.

Katz, Y. J. (2002). Attitudes affecting college students' preferences for distance learning. *Journal of Computer Assisted Learning, 18,* 2–9

Knowles, M. (1990). The adult learner: A neglected species (4th ed.). Houston: Gulf Publishing.

Larreamendy-Joerns, J., Leinhardt, G., & Corredor, J. (2005). Six online statistics courses: Examination and review. *The American Statistician, 59*(3), 240-252.

Leinhardt, G. (2001). Instructional explanations: A commonplace for teaching and location for contrast. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed.) (pp. 333-357). Washington, DC: American Educational Research Association.

Lin, S. S., Liu, E. Z., & Yuan S. (2001). Web based peer assessment: Attitude and achievement. *IEEE.*

Lin, S. S., Liu, E. Z., & Yuan S. (2002). A pilot study of students' attitudes toward and desired system requirements of networked peer assessment system. *Proceedings of the International Conference on Computers in Education (ICCE).*

Liu, E. Z., Lin, S. S., & Yuan, S. (2001). Design of a networked portfolio system. *British Journal of Educational Technology, 32*(4), 492-494.

Liu, E. Z., Lin, S. S., & Yuan, S. (2002). To propose a reviewer dispatching algorithm for networked peer assessment system. *Proceedings of the International Conference on Computers in Education (ICCE).*

Liu, E. Z., Lin, S. S., Chiu, C., & Yuan, S. (1999). Student participation in computer science courses via Network Peer Assessment System (Netpeas). *Advanced Research in Computers and Communications in Education.* International Conference on Computers in Education. pp. 744-747.

Liu, E. Z., Lin, S. S., Chiu, C., & Yuan, S. (2001). Web-Based Peer Review: The learner as both adapter and reviewer. *Institute of Electrical and Electronics Engineers, 44*(3), 246-251.

Lombardi, J., & McCahill, M. P. (2004). *Enabling social dimensions of learning through a persistent, unified, massively multi-user, and self-organizing virtual environment.* [Online]. Retrieved July 3, 2006 from http://www.opencroquet.org/Site%20PDFs/2004%20Enabling%20Learning.pdf.

Lovett, M. C., & Greenhouse, J. B. (2000) Applying cognitive theory to statistics instruction. *The American Statistician, 54*(3), 196-211.

Macpherson, K. (2002). Problem-solving ability and cognitive maturity in undergraduate students. *Assessment & Evaluation in Higher Education, 27*(1), 5-22.

Marklein, M. B. (1997, November 17). Colleges not prepared to serve older learners. *USA Today,* p. 6D.

Mayer, R. E. (1983). *Thinking, problem solving, cognition*. New York: W. H. Freeman and Company.

Mayer, R. E. (1987). E*ducational Psychology*. Boston: Little, Brown and Company.

Mayer, R. E. (1989). Models for understanding. *Review of Educational Research, 59,* 43-64.

Mayer, R. E. (1991). *Thinking, problem solving, cogntion* (2nd ed.). New York: W.H. Freeman and Company.

Mayer, R. E., Sims, V., & Tajika, H. (1995). A comparison of how textbooks teach mathematical problem solving n Japan and the United States. *American Educational Research Journal, 32,* 443-460.

Mayer, R. E. (2001). Cognitive Constraints on Multimedia learning: When presenting more material results in less learning. *Journal of Educational Psychology, 93,* 187-198.

Mayer, R. E. (2002). Cognitive theory and the design of multimedia instruction: An example of the two-way street between cognition and instruction. *New Direction for Teaching and Learning, 89,* 55-71.

McKendree, J. (1990). Effective feedback content for tutoring complex skills. *Human-Computer Interaction, 5,* 81-413.

Mejias, U. (2006). Teaching social software with social software, *Innovate, 2*(5). [Online]. Available: http://www.innovateonline.info/index.php?view=articleid=260.

National Center for Education Statistics. (2006). [Online]. Available: www.NCES.ed.gov.

National Center for Educational Statistics. (2001). Projections of education statistics to 2011. Section 2: Enrollment in degree-granting institutions. [Online]. Retrieved August 15, 2007 from http://nces.ed.gov/pubs2001/proj01/Section2.asp.

Onwuegbuzie, A. J. (1997a). Writing a research proposal: The role of library anxiety, statistics anxiety, and composition anxiety. *Library Information Science Research, 19*(1), 5-33.

Onwuegbuzie, A. J. (1997b). The teacher as researcher: The relationship between enrollment time and achievement in a research methodology course. *Reflection and Research*, *3*(1).

Onwuegbuzie, A. J., Da Ros, D., & Ryan J. S. (1997c). The components of statistics anxiety: A phenomenological study. *Focus on Learning Problems in Mathematics*, *19*(4), 11–35.

Onwuegbuzie, A. J., Slate, J., Patterson, F., Watson, M., & Schwartz, R. (2000). Factors associated with underachievement in educational research courses. *Research in the Schools, 7,* 53–65.

Onwuegbuzie, A. J., & Wilson, V. (2003) Statistics anxiety: Nature, etiology, antecedents, effects, and treatments-a comprehensive review of the literature. Teaching in Higher Education, *8*(2), 195-209.

Onwuegbuzie, A. J. (2003). Modeling statistics achievement among graduate students. *Educational and Psychological Measurement*, *63*(6), 1020 -1038.

Pajares, F. (2002). *Overview of social cognitive theory and of self-efficacy*. [Online]. Retrieved September 13, 2007 from http://www.des.emory.edu/mfp/eff.html.

Pan, W., & Tang, M. (2004). Examining the effectiveness of innovative instructional methods on reducing statistics anxiety for graduate students in the social science. *Journal of Instructional Psychology*, *31*(2), 149-158.

Pike, G. R. (1999). The constant error of the halo in educational outcomes research. *Research in Higher Education, 40*(1), 61-86.

Pike, G. R., & Killian, T. S. (2001). Reported gains in student learning: Do academic disciplines make a difference? *Research in Higher Education, 42*(4), 429-454.

Pike, G. R. (2006). Students' personality types, intended majors, and college expectations: Further evidence concerning psychological and sociological interpretations of Holland's Theory. *Research in Higher Education, 47*(7), 801-822.

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82,* 33-40.

Pintrich, P. R., & Schunk, D. H. (1996). *Motivation in education: Theory, research, and applications*. Englewood Cliffs, NJ: Merrill/Prentice Hall.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and applications* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.

Pintrich, P. R., & Schrauben, B. (1992). Students' motivational beliefs and their cognitive engagement in classroom tasks. In D. Schunk & J. Meece (Eds.), *Student perceptions in the classroom: Causes and consequences* (pp. 149–183). Hillsdale, NJ: Lawrence Erlbaum Associates.

Piotrowski, C., Subhash, C. B., & Hemasinha, R. (2002). Development of a measure on statistics anxiety in graduate-level psychology students. *Journal of Instructional Psychology, 29*(2), 97-100.

Pirolli, P. L. (1991). Effects of examples and their explanations in a lesson on recursion: A production system analysis. *Cognition and Instruction, 8,* 207-259.

Quilici, J. L., & Mayer, R. E. (1996). Role of examples in how students learn to categorize statistics word problems. *Journal of Educational Psychology, 88*(1), 144-161.

Pretorius, T. B., & Norman, A. M. (1992). Psychometric data on the statistics anxiety scale for a sample of South African students. *Educational and Psychological Measurement, 52,* 933-937.

Recker, M. M., & Pirolli, P. (1995). Modeling individual differences in students' learning strategies. *The Journal of the Learning Sciences, 4*(1), 1-38.

Rethemeyer, R. K., & Helbig, C. H. (2005). By the numbers: Assessing the nature of quantitative preparation in public policy, public administration, and public affairs doctoral education. *Journal of Policy Analysis and Management*, *24*(1), 179-191.

Salovaara, H., & Jarvela, S. (2003). Students' strategic actions in computer-supported collaborative learning. *Learning Environments Research, 6,* 267–285.

Schacht, S., & Stewart, B. J. (1990). What's funny about statistics? A technique for reducing student anxiety. *Teaching Sociology, 18,* 52-56.

Schraw, G., & Nietfeld, J. (1998). A further test of the general monitoring hypothesis. *Journal of Educational Psychology, 90,* 236–248.

Schunk, D. H. (1982). Effects of effort attributional feedback on children's perceived self-efficacy and achievement. *Journal of Educational Psychology, 74,* 548-556.

Schunk, D. H. (1983). Ability versus effort attributional feedback: Differential effects on self-efficacy and achievement. *Journal of Educational Psychology, 75,* 848-856.

Schunk, D. H. (1984). Sequential attributional feedback and children's achievement behaviors. *Journal of Educational Psychology, 76,* 1159-1169.

Schunk, D. H. (1987). Peer-models and children's behavioral change. *Review of Educational Research, 57,* 149-174.

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist, 26,* 207-231.

Schunk, D. H. (1995). Self-efficacy and education and instruction. In J. E. Maddux (Ed.), *Self-efficacy, adaptation, and adjustment: Theory, research, and application* (pp. 281-303). New York: Plenum Press.

Schunk, D. H. (2006). *The effect of instructional factors on motivation and learning.* Paper presented at the Cognitive Remediation in Psychiatry Symposium, New York, June 2006.

Schunk, D. H., & Hanson, A.R. (1989a). Influence of peer-model attributes on children's beliefs and learning. *Journal of Educational Psychology, 81,* 431-434.

Schunk, D. H., & Hanson, A.R. (1989b). Self-modeling and children's cognitive skill learning. *Journal of Educational Psychology, 81,* 155-163.

Schunk, D. H., & Pajares, F. (2002). The development of academic self-efficacy. In W. Wigfield & Eccles, J. S. (Eds.), *Development of achievement motivation* (pp. 15-31). San Diego, CA: Academic Press.

Schunk, D. H., & Pajares, F. (2005). Competence perceptions and academic functioning. In A. J. Elliot & C. S. Dweck (Eds.), Handbook of competence and motivation (pp. 85-104). New York: Guilford Press.

Seifert, C. M., & Hutchins, E. L. (1992). Error as Opportunity: Learning in a Cooperative Task. *Human-Computer Interaction, 7,* 409-435.

SPSS, Inc. (2007). SPSS for Windows, (Version 15.0) [Computer software]. Chicago: SPSS Inc.

Stangl, D. (2000). Design of an internet course for training medical researchers in Bayesian statistical methods. In C. Batenero (Ed.), *Training researchers in the use of statistics.* International Association for Statistical Education.

Skinner, B. F. (1953). *Science and human behavior.* New York: Free Press.

Utts, J., Sommer, B., Acredolo, C., Maher, M., & Matthews, H. (2003). A study comparing traditional and hybrid internet-based instruction in introductory statistics classes. *Journal of Statistics Education, 11*(3).

Vaughn, S., Schumm, J. S., & Sinagub, J. (1996). *Focus group interviews in education and psychology*. Thousand Oaks, CA: Sage.

Vijverberg, W. (1997). The quantitative methods component in social sciences curricula in view of journal content. *Journal of Policy Analysis and Measurement, 16*(4), 621-629.

Visser, L. (1998). *The development of motivational communication in distance education support.* Unpublished doctoral dissertation. Educational Technology Department, University of Twente, the Netherlands.

Wilson, V. A. (1997, November). Factors related to anxiety in the graduate statistics classroom. Paper presented at the annual meeting of the Mid-South Educational Research Association, Memphis, TN.

Wang, A. Y., Newlin, M. H., & Tucker, T. L. (2001). A discourse analysis of online classroom chats: Predictors of cyber-student performance. *Teaching of Psychology*, *28*(3), 222-226.

Wang, S. L., & Lin, S. L. (2006). The application of social cognitive theory to web-based learning through NetPorts. *British Journal of Educational Technology*.

Wang, S. L., & Shiu, S. (2005). *The impact of networked group interaction on group efficacy and group performance.* Paper presented at the 2005 international conference of learning, instruction and assessment, Taipei, Taiwan.

Wang, S. L., & Wu, P. (2002). *The role of motivation on computer-supported learning behaviors and achievement.* Paper presented at the 2002 Taiwan area network conference, Hsinchu, Taiwan.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*. New York: Cambridge University Press.

Wenger, E., McDermott, R., & Snyder, W.M. (2002), *Cultivating Communities of Practice: A guide to managing knowledge*. Boston: Harvard Business School.

Wigfield, A. (1994). The role of Children's Achievement values in the Self-regulation of their learning outcomes in D.H. Schunk and B. J. Zimmerman (eds.) Self-regulation of Learning and Performance. Hillsdale, N.J.: Erlbaum.

Wigfield, A., Eccles, J. S., & Pintrich, P. R. (1996). Development between the ages of 11 and 25. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 148-185). New York: Macmillan.

Wiggins, G. P. (1998). *Educative assessment: Designing assessments to inform and improve student performance.* San Francisco: Jossey-Bass.

Wlodkowski, R. J. (1999). *Enhancing adult motivation to learn.* San Francisco: Jossey-Bass.

Zimmerman, B. J. (1996). Enhancing student academic and health functioning: A self-regulatory perspective. *School Psychology Quarterly, 11,* 47-66.

Appendix A

Questions of the Study

Table-1

Research Questions	DATA								Analyses
	Self-Efficacy Scores – pretest	Self-Efficacy scores – post test	Age	# of math or stat courses ever taken	Major	Gender	Classification (Freshman, etc.)	Method (feedback vs. no feedback)	
Research question one: Is the mean efficacy score significantly higher for the feedback group than the mean for the no feedback (control) group controlling for students' characteristics?	X	X	X	X	X	X	X	X	Repeated measure analysis Dep var: Two Efficacy scores (pre and post) Ind var: Method Covariates are the students' characteristics.

H_0; $\mu_1 = \mu_2$ vs. H_a: $\mu_1 \neq \mu_2$ where $\mu` = [\mu_1, \mu_2]$.

Data source: ________ISOM-110-Fall 2007______________________________
Sample size: 69 students in each Group___________________________

Table-2

	DATA								Analyses
Research Questions	**Anxiety scores – pretest**	**Anxiety scores – post test**	**Age**	**# of math or stat courses ever taken**	**Major**	**Gender**	**Classification (Freshman, etc.)**	**Method (feedback vs. no feedback)**	
Research question two: Is the mean anxiety score significantly lower for the feedback group than the mean for the control group controlling for students' characteristics?	X	X	X	X	X	X	X	X	**Repeated measure analysis** **<u>Dep var</u>:** **Two Anxiety scores (pre and post)** **<u>Ind var</u>:** **Method** **Covariates are the students' characteristics.**

$H_0; \mu_1 = \mu_2$ vs. $H_a: \mu_1 \neq \mu_2$ where $\mu` = [\mu_1, \mu_2]$.

Data source: ________ISOM-110-Fall 2007______________________________
Sample size: 69 students in each Group____________________________

Table-3

Research Questions	DATA							Analyses
	Problem Solving scores	Age	# of math or stat courses ever taken	Major	Gender	Classification (Freshman, etc.)	Method (feedback vs. no feedback)	
Research question three: Is the mean grade significantly higher for the feedback group than the mean for the control group controlling for students' characteristics?	X	X	X	X	X	X	X	A one-way analysis of variance: ANCOVA Dep var: Problem scores Ind var: Method Covariates are the students' characteristics.

H_0: $\mu_1 = \mu_2$, Ha: $\mu_1 > \mu_2$

Data source: ________ISOM-110-Fall 2007_______________________________
Sample size: 69 students in each Group____________________________

Table-4

Research Questions	DATA							Analyses
	Satisfaction scores	Age	# of math or stat courses ever taken	Major	Gender	Classification (Freshman, etc.)	Method (feedback vs. no feedback)	
Research question four: Is the mean satisfaction score significantly higher for the feedback group than the mean for the control group controlling for students' characteristics?	X	X	X	X	X	X	X	A one-way analysis of variance: ANCOVA <u>Dep var</u>: Satisfaction scores <u>Ind var</u>: Method Covariates are the students' characteristics.

H_0: $\mu_1 = \mu_2$, Ha: $\mu_1 > \mu_2$

Data source: ________ISOM-110-Fall 2007______________________________
Sample size: 69 students in each Group____________________________

Appendix B

Syllabus for Pilot Study

DV-EDU6305: Statistics: Introduction to Quantitative Methods (3 units)
Web-based: http://siminh.pbwiki.com

Instructor: T. S. Hall
Email: hallt@wssu.edu
Office: 164 Carolina Hall

Course Description: This course introduces concepts that will provide the student with a solid understanding of statistical procedures. The goal of the course is to demystify statistics and enable students to comprehend the evidence and logic behind statistical analysis. After completing this course, students will: understand basic statistical concepts and the process of conducting research, read and understand the statistics-based research literature in education, and other social science research and analyze and interpret numerical information from data. The selected methodologies in this class focus on using both descriptive and inferential statistics to explore variables, test and evaluate claims, and identify and describe relationships. **Prerequisite:** Knowledge of high school algebra II, or equivalent.

Course Objective:
1) identify a statistical technique appropriate to address a given research question;
2) understand the implications of study design on the type of statistical inference;
3) understand the implications of violations of assumptions of statistical methods, and identify adjustments or alternative procedures when necessary;
4) carry out the statistical analysis, using computer software.;
5) communicate clearly and correctly the results of their analyses.
These objectives are accomplished by practicing four skills of pattern recognition, logic model, computer analysis, and summarizing published research using interactive web-tools. The first six weeks is devoted to learning parametric methods, the next four weeks is for nonparametric methods, and two weeks for students to prepare the final project.

I. Text: (or other instructional resources)

1. Moore, D. S. & McCabe G. P. (2006) *Introduction to the practice of Statistics 5^nd^ Edition* W.H. Freeman and Company.
2. "Upgrade Pack" includes all the Software Manuals (Excel, JMP, TI-83, SPSS, Minitab) on CD-ROM, the Printed Study Guide and the E-Stat Pack Media for no additional charge when ordered with the text. Upgrade - Isbn # **0716773791**

Course Requirements:

Homework: Homework assignments will consist of eight problems. These weekly assignments are posted in the Web-address given above. (1) The teacher posts the homework assignment. (2) Each student prepares the homework and uploads it to the wiki. (3) For each assignment, the teacher assigns randomly three reviewers for each student. (4) Each student views other works and must comment on the steps of how the solution is derived. (5) Each student must revise the original assignment in line with the comments received. This process is repeated three times. If after the third feedback from peers, students cannot derive the solution, then the teacher would provide feedback. The final solution has a brief description from each student to summarize their initial understanding of the problem and their final understanding. Your solution must include the logic map, the computer printout with pertinent sections and appropriate discussion of the results. Along with each homework assignment, a research paper with accompanying newspaper editorial is attached. Students prepare summary, question, answer, and opinion pages for each of these research papers collaboratively. Models for each of these assignments are attached.

Final Exam: In place of a final exam, students turn in a final project. The final project includes one data set with statement of the problem, variables measured, appropriate analysis, and report of the findings using computer software. A logic model must be included to show how students' knowledge of decision tree has been used to derive the solution. Each student will turn in summary, questions, answers, and opinion sections that they have created from three published research papers with accompanying newspaper articles.
Students do not receive feedback from peers for the final project. The duration for the final project is two weeks.

Grading Rubric:

Achievement Scores	Pattern recognition	Logic Model	Computer analysis	Research summary
Assignment Scores: 40% of the final grade (W/feedback)				
Review Scores: 40% of the final grade (w/feedback)				
Final project: 20% of the final grade (no feedback)				

Your grade will be determined by your performance on assignments and the final project. Your grade on assignments will be determined by the quality feedback you provide and receive as described under course requirements on eight assignments. Each assignment has four parts; each assignment is worth 50 points, for a possible total of 400 points. To receive full credit on each segment of the assignment, students must provide three comments to peer and comments must follow the models provided in each category.
Your final project is worth 100 points. Thus, the total number of possible points is 500.

Outline of Course Sequence:
Moore & McCabe
David S. Moore and George P. McCabe (1993): *Introduction to the Practice of Statistics* W.H. Freeman and Co., New York. ISBN 0-7167-2250-X

Topics

1. Looking at data: distributions
2. Looking at data: relationships
3. Producing data
4. Probability: the study of randomness
5. Probability to inference
6. Introduction to inference
7. Inference for distributions
8. Inference for proportions
9. Topics in Inference
10. Inference for regression
11. Nonparametric tests – Ch. 15 –See student resources

Appendix C

Problems[5] for Pattern Recognition Project

For each problem answer the following:

1. Identify the independent and dependent variables.
2. What are the scale measurements on these variables?
3. What is the problem about?
4. Categorize these problems according to the structural features and surface features and finish Table-4 below.

Table-4: Surface and Structural Features

	Surface features		Structural features	
Problems	Independent variable	Dependent variable	Independent variable	Dependent variable

Problems –set -1

Item	Problem
1	A personnel expert wishes to determine whether experienced typists are able to type faster than inexperienced typists. Twenty experienced typists (i.e., with 5 or more years of experience) and 20 inexperienced typists (i.e., with less than 5 years of experience) are given a typing test. Each typist's average number of words typed per minute is recorded.
2	After examining weather data for the last 50 years, a meteorologist claims that the annual precipitation is greater in years with below average temperature than in years with above average temperature. She notes the annual rainfall for each of 25 years that had above average temperatures as well as 25 years that had below average temperatures.
3	A psychologist tests the hypothesis that fatigue affects mental alertness. An attention test is prepared which requires subjects to sit in front of a blank TV screen and press a response button each time a dot appears on the screen. A total of 110 dots are presented during a 90-minute period, and the psychologist records the number of errors for each subject. Two groups of subjects are selected. The first group of 10 subjects is tested after they have been kept awake for 24 hours. The second group of 10 subjects is tested in the morning after a

[5] These problems were used in Quilici & Mayer (1996). They were used in this study with permission from Dr. Mayer.

	full night's sleep.
4	A college dean claims that good readers earn better grades than poor readers. The grade point averages (GPA) are recorded for 50 first-year students who scored high on a reading comprehension test and for 50 first-year students who scored low on a reading comprehension test.

Problem - set-2

Item	Problem
1	1 A personnel expert wishes to determine whether or not experienced typists are likely to be fast typists and inexperienced typists are more likely to be slow typists. Twenty experienced typists (i.e., with 5 or more years of experience) and 20 inexperienced typists (i.e., with less than 5 years of experience) are given a typing test. Based on the test, each typist is classified as fast or slow.
2	After examining weather data for the last 50 years, a meteorologist claims that the annual precipitation is more likely to be above average in years when the temperature is above average than when temperature is below average. For each of 50 years, she notes whether the annual rainfall is above or below average and whether the temperature is above or below average.
3	A psychologist tests the hypothesis that people who are fatigued also lack mental alertness. An attention test is prepared which requires subjects to sit in front of a blank TV screen and press a response button each time a dot appears on the screen. A total of 110 dots are presented during a 90-minute period, and the psychologist records the number of errors for each subject. Twenty subjects are selected; half are tested after being kept awake for 24 hours, and half are tested in the morning after a full night's sleep. Based on their number of errors on the test, each subject is also labeled as high or low in mental alertness.
4	A college dean claims that a group of good readers contains more honors students than a group of poor readers. For each of 100 first-year college students, a reading comprehension test was used to determine whether the student was a good or poor reader and grade point average (GPA) was used to determine whether or not the student was an honors student.

Problem - set-3

Item	Problem
1	A personnel expert wishes to determine whether typing experience goes with faster typing speeds. Forty typists are asked to report how many years they have worked as typists and are given a typing test to determine their average number of words typed per minute.
2	After examining weather data for the last 50 years, a meteorologist claims that the annual precipitation varies with average temperature. For each of 50 years, she notes the annual rainfall and average temperature.
3	A psychologist tests the hypothesis that fatigue is related to mental alertness. An attention test is prepared which requires subjects to sit in front of a blank TV screen and press a response button each time a dot appears on the screen. A total of 110 dots are presented during a 90-minute period, and the psychologist records the number of errors for each subject. Twenty subjects are given this test, each with a different number of hours since they woke up (ranging from 1 to 20).
4	A college dean claims that scores on a reading comprehension test predict college grades. The grade point averages (GPA) and reading comprehension scores are recorded for 100 first-year students.

Note. Each letter-number pair represents a sorting problem: t = *t* test, x = chi-square, r = correlation; 1 = cover story about experience and typing speed; 2 = cover story about temperature and precipitation; 3 = cover story about fatigue and mental alertness; 4 = cover story about reading skill and grade point average.

Appendix D

Instrument 1: Students' Academic Background

Instrument 1: Students' Academic background

1. Major
2. Gender
3. College Classification (freshman, etc.)
4. Class Time (Day, evening)
5. Age
6. Number of math or statistics courses ever taken

Appendix E

Instrument 2: Students' Perceived Confidence/Competence

Instrument 2: Students' Perceived confidence/competence (self-efficacy-pre and post)[6]

Response scale [to be applied to each part of each question]:

not at all confident very much

1 2 3 4 5

---

1. How confident are you with solving statistical problems?
2. How well do you feel you are understanding statistical problems?
3. How competently could you apply statistics in practice?
4. How confident are you with inspecting peers' work and posting feedback?
5. How confident are you with detecting your errors?
6. How confident are you with peers detecting your errors?
7. How confident are you with peers commenting on your work?
8. How confident are you with incorporating peers' comments in your work?
9. How confident are you with peers correcting your work?
10. How confident are you with the teacher correcting your work?

[6] The first three items were from Frederickson et al. (2005) study, the rest were added for this study. The instrument had a reliability coefficient of 0.92 in two pilot studies prior to this experiment.

Appendix F

Instrument 3: Statistics Anxiety Scale

Instrument 3: Statistics Anxiety Scale (pre and post)[7]

Response categories are as follows: 1 =strongly agree; or 2 = agree; 3 = undecided; 4= disagree or 5 = strongly disagree.

1. It wouldn't bother me at all to take more statistics courses.
2. I have usually been at ease during statistics tests.
3. I have usually been at ease in statistics courses.
4. I usually don't worry about my ability to solve statistics problems.
5. I almost never get uptight while taking statistics tests.
6. I get really uptight during statistics tests.
7. I get a sinking feeling when I think of trying hard statistics problems.
8. My mind goes blank and I am unable to think clearly when working statistics.
9. Statistics makes me feel uncomfortable and nervous.
10. Statistics makes me feel uneasy and confused.

[7] Betz (1978) The last five items are negatively coded, scores associated with them were reverse coded before the analysis.

Appendix G

Instrument 4: Problems Used in the Experiment in Fall 2007 for the Data Used in this Dissertation

Instrument 4: Problems used in the experiment in fall 2007 for the data for this dissertation

Problems:

(1) A personnel expert wishes to determine whether experienced typists are able to type faster than inexperienced typists. Twenty experienced typists (i.e., with 5 or more years of experience) and 20 inexperienced typists (i.e., with less than 5 years of experience) are given a typing test. Each typist's average number of words typed per minute is recorded.
(2) A personnel expert wishes to determine whether or not experienced typists are likely to be fast typists and inexperienced typists are more likely to be slow typists. Twenty experienced typists (i.e., with 5 or more years of experience) and 20 inexperienced typists (i.e., with less than 5 years of experience) are given a typing test. Based on the test, each typist is classified as fast or slow.
(3) A personnel expert wishes to determine whether typing experience goes with faster typing speeds. Forty typists are asked to report how many years they have worked as typists and are given a typing test to determine their average number of words typed per minute.

For each of these problems, students were provided with a short description and then a question as shown below.

A response variable measures the outcome of a study.

1. In this problem the response variable is:

- ☐ Experience
- ☐ 5 years
- ☐ average words typed per minute
- ☐ Twenty experienced typists

An explanatory variable explains or causes change.

2. In this problem the explanatory variable is

- ☐ Typing speed

- ☐ experience of typists
- ☐ 5 years
- ☐ average words per minute

Quantitative variables take on numerical values for which arithmetic operations such as adding and averaging make sense, categorical variables place an individual into one of several groups or categories.

3. In this problem the scale measurement of the response variable is:

- ☐ Categorical
- ☐ 5 years
- ☐ quantitative
- ☐ Twenty experienced typists

Quantitative variables take on numerical values for which arithmetic operations such as adding and averaging make sense, categorical variables place an individual into one of several groups or categories.

4. In this problem the scale measurement of the explanatory variable is:

- ☐ Quantitative
- ☐ categorical
- ☐ 5 years
- ☐ average words per minute

5. This problem is about:

- ☐ comparing two groups based on one variable
- ☐ comparing years of experience
- ☐ typing fast
- ☐ comparing two variables for one group

Appendix H

Instrument 5: Students' Perceptions of their Learning Experiences

Instrument 5: Students' perceptions of their learning experiences (Satisfaction-posttest)[8]

Response scale [to be applied to each part of each question]:

not at all Satisfied				very much
1	2	3	4	5

Learning Experience
Enjoyment
Interest
Motivation
Sense of achievement
Effectiveness of learning

[8] Frederickson et al. (2005)