“The Effects of Software Disruption on Goal Commitment, Computer Self-Efficacy, Task Self-Efficacy and Test Performance in a Computer-Based Instructional Task”

Proposal Submitted for OSRA

By

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The societal value placed on the acquisition of computing skills is reflected by the increasing prevalence of computing technology in educational settings. Computers have purpose and value because they enable humans to accomplish valued tasks more efficiently. Fundamental to the decision to use technology is the natural corollary that all human action is determined by a combination of cognitive and motivational forces. These forces may be internal to the individual and difficult to distinguish.

Statement of the Problem

Computer technology has become an indispensable part of the classroom and the workplace. The amount of work produced using typewriters and carbon paper cannot compare to the amount of work produced using computers. While computers have improved human task efficiency, they have led to external and internal pressures to do more in less time. As a legal assistant in 1984, personal computers and fax machines were rarities in the workplace. Instead, we relied on dedicated word processors with limited command-based functionality to produce our documents and the U.S. mail to transmit them. The workload was consistent but not highly stressful. A mere two years later, the prevalence of the fax machine and the personal computer changed the very nature of the business workplace. Since the computer decreased the amount of time to produce documents, management's expectations in terms of product output rose higher and higher and so did the piles of paper on our desks! The results of these external pressures created internal pressure on those that used the technology to increase output without sacrificing quality. The value of task outcomes and the time to complete them remained constant, but external expectations and the rate of output increased, resulting in both physical and psychological ramifications to the user.

The stress placed on those dealing with technology on a daily basis is heightened when something goes wrong with the technology. Computer software sometimes has errors or bugs and, sooner or later, machines break down. The various ways that people handle these situations in the workplace has intrigued me. Even something as simple as a copy machine could throw a level-headed lawyer, capable of trying a complex legal case, into an illogical, raving maniac if the machine failed at the wrong time (i.e., ten minutes before a filing deadline). This kind of scenario is particularly true with computers because they often hold critical files and applications, such as financial and billing records for an entire firm. The results of a system crash at the end of a fiscal year in a major law firm produced a ripple effect of high stress levels throughout the organization. On an individual basis, I have seen people curse at their computers, pound their fists, and verbalize their frustration by talking to the machine as if it were alive. A recent workplace violence seminar at Texas Tech featured a video clip of a man filmed at his workplace cursing and destroying his computer after experiencing problems. While this may be an extreme case, frustration with computer technology is a common occurrence in business settings.

This scenario translates into educational settings, as well. As a graduate assistant, I have witnessed on numerous occasions student reactions to problems experienced when using computers, such as the feared "bomb" message on the Macintosh or the "blue screen of death" in Microsoft Windows. Many students openly express their lack of self-efficacy and distrust in using computers. They seem to expect computers to betray them. Whether in a business or educational settings, there is one recurring theme. The more personally valuable the product or outcome to the user, the more upset the person becomes when something goes wrong while using the technology. The trend in higher education is leading towards the use of more, not less, computer-based instructional environments. In the future, institutions will be increasingly pressured to offer more distance-based educational opportunities. Evidence of this situation was recently underscored at an Association of Teacher Educators conference held in Orlando, Florida. A speaker with NCATE stated in rather matter-of-fact terms that institutions of higher education would be required to provide online courses if they want to keep their NCATE certification. However, it is generally not known how technology-related problems experienced by learners affect the acquisition and transmission of knowledge, motivation and performance. The purpose of this study was to investigate the effects of software disruption on learner goal commitment, task self-efficacy, computer self-efficacy and performance during a computer-based learning task.

Rationale

Bandura (1997) discussed similar concerns regarding the educational impact of technological change. Bandura's (1986) Social Cognitive Theory defines human nature in terms of basic capabilities, such as symbol systems, forethought and self-regulatory capabilities. The theory views learning as a cognitive process relying on the abstract, reflective, and generative nature of human thought. Social Cognitive Theory postulates a critical role for self-regulation (Schunk & Ertmer, 1998; Bandura, 1991; Zimmerman, 1989). Learning is an associative process that typically requires effort and persistence over time to master concepts or skills. According to Bandura (1988), "cognized goals" are one of the most important cognitive motivators in learning (p. 37). Cognized goals evolve from value systems that guide actions through the exercise of forethought and self-regulatory mechanisms such as perceived self-efficacy. Goal theory is important to educational research in that sustaining goal-directed cognitions and behaviors contributes to self-regulated learning (Ertmer & Schunk, 1997; Zimmerman, 1989).

Goal Theory

Goals regulate motivation through indirect, self-referent processes that involve "the exercise of self-influence by personal challenge and the evaluative reaction to one's attainments" (Bandura, 1988, p.41). According to Locke (1996), goals have both internal and external attributes in that goals are internal ideas or desired ends which are externally referenced to an object or situational condition. Goals purposefully influence task performance by directing an individual's attention, effort and persistence towards the externally referenced objective or situation (Mone and Baker, 1992; Locke and Latham, 1990; Landy, 1985; Locke, Shaw, Saari and Latham, 1981). Further, Campbell, Dunnette, Lawler and Weick (1970) assert that goal-setting has cognitive benefits in that they help to clarify the task to be performed and give knowledge of where to direct one's effort.

The connection between goal-setting and performance

In goal-setting behavior, when a negative discrepancy occurs between one's performance level and the value standard sought, the resulting dissatisfaction operates as an incentive to enhance future effort. Bandura (1988) distinguishes between a performance and an outcome in that performance is considered an accomplishment or something that is done, whereas an outcome is something that occurs as the result of an activity. For example, letter grades indicate performance levels, not outcomes. Realized expectations of anticipated social benefits or other personal costs associated with the level of performance are outcomes. Goals, which operate as a mediator between expectancy variables and performance, are the most direct determinant of performance (Locke & Latham, 1990).

The role of feedback, cognitive appraisal and emotions in goal-directed behavior

Feedback is an integral part of goal-directed behavior in that goals serve as a mediator and key mechanism to translate feedback into action (Locke, Cartledge and Koeppel, 1968), as well as a moderator to goals in relation to regulation of performance (Locke, Shaw, Saari & Latham, 1981). Once an individual perceives feedback (an external event) he or she translates it into knowledge of the results (a cognitive appraisal). A value appraisal occurs concurrently with cognitive appraisal evidenced in the form of an emotional response. As a result of increasingly difficult tasks or goals, an individual may become unresponsive to all of the information presented in a response to overload condition (Miller, 1960). An overload condition may occur when an individual's appraisal process indicates that the path to a goal is blocked, resulting in an emotional response such as anxiety, frustration or anger. Research by Crable, Scherer and Jones (1994) on cognitive appraisal in computing tasks found a strong relationship between cognitive appraisal and computer anxiety (p. 337). Because goal-directed behavior involves valued, purposeful action, failure to attain goals may therefore result in highly charged emotional outcomes. The potential negative psychological effects on learners in computing tasks makes the study of goal-directed behavior an important issue in instructional design. The primary focus of this study involved the principles and research findings of goal commitment as applied to software disruptions in computer-based learning environments.

Significance of the study

Goal theory research grew out of the realm of industrial psychology and has shown that the mere act of setting goals increases performance. According to Bandura (1986, 1997) and Locke & Latham (1990), the underlying principles of goal theory are interwoven with theories of self-efficacy and motivation. Regardless of the medium used to deliver instruction (i.e., computer-based instruction or lecture-based), there has to be some level of learner commitment to an educational task for learning to occur. However, there appears to be little educational research on learner goal commitment. Further, there has been little research on goal setting in instructional technology. The lack of research is particularly puzzling given the emphasis on audience assessment in most instructional design models. Audience assessment typically involves assessing a learner's entry-level knowledge, skills, attitudes and efficacy levels. Audience assessment without consideration of learner commitment to achieving an educational goal task results in an incomplete picture of learner motivation. Inadequate audience assessment in the instructional design process may lead to negative learner attitudes and counter-productivity in educational and training environments. Without an understanding of the factors underlying learner commitment, appropriate and effective instructional design seems impossible.

Additionally, there appears to be little research on the effects of software disruptions on performance in computer-based instruction. A 1987 study by Heinssen, Glass & Knight used a computer interaction measure featuring a sequence of interruptive events to investigate computer anxiety and task completion. However, the tasks used to measure performance time were data entry and file-editing tasks, not learning tasks. Further, the study only investigated participant time to complete a performance task and not the level of task performance attained. There is some evidence indicating that anxiety is increased when learning is mediated by technology (Garrison, 1989). This may relate to the nature of software. Its complexity taxes users' cognitive abilities and has the greatest potential for creating learner frustration. In a learning task scenario, problems with software may produce negative affective outcomes that lead to decreased learner motivation or avoidance of technology.

The research undertaken by this study attempted to clarify the effects of software disruptions on goal-directed behavior, computer self-efficacy, task self-efficacy and performance. It is hoped that the results of this study will contribute to an understanding of cognitive and attentional interference in learning tasks. Further, investigation of the variables of this study may shed light on the effects of unpleasant computing experiences on learner motivation and performance to guide software developers, instructional designers and institutions of higher education.

Research Questions

This study addressed the following questions:

1. What are the effects of software disruption on participants' goal commitment levels?

2. What are the effects of software disruption on participants' test performance levels?

3. What are the effects of software disruption on participants' task self-efficacy?

4. What are the effects of software disruption on participants' computer self-efficacy?

Hypothesis

The hypothesis in this study concerned assessing the effects of software disruption on users engaged in a computer-based instructional task. Goal setting has been found to be related to performance in that when a negative discrepancy occurs between one's performance level and the value standard sought, dissatisfaction enhances future effort (Locke & Latham, 1990). Self-efficacy and goal commitment are considered to be direct and indirect determinants of performance in that actions involving choice of action determine personal efficacy judgments (Theodorakis, 1996). Research by Ertmer & Schunk (1997) and Schunk & Ertmer (1998) has also found significant differences in computing self-efficacy due to goal setting. Self-efficacy relates to one's judgment of total capability of performing a task. This study involved a computer-based learning task. It is possible that a participant could be computer self-efficacious, but not task self-efficacious, or vice versa. Therefore, task self-efficacy was assessed to determine self-efficacy judgments regarding the learning task and computer self-efficacy was assessed to determine self-efficacy judgments regarding the use of computer technology. The hypothesis for this study is that there are no significant main effects on goal commitment, task self-efficacy, computer self-efficacy and performance as a result of software disruption. Based on the literature review conducted as part of the research, it was expected that the null hypothesis would be rejected under the assumption that the experimental manipulations would be significantly disruptive.

Assumptions

For purposes of this study, it was assumed that no actual hardware failures occurred during the treatment sessions. Additionally, it was assumed that the participants were unaware of the true nature of the study or the true purpose of the software program. It was also assumed that participants accurately reflected the average college student population in terms of verbal ability. Finally, it was also assumed that the target words, which were generated from GRE study guides, were unfamiliar to the participants.

Limitations of the Study

Limitations regarding this study include the availability of a large, representative sample of subjects of varying ages and educational backgrounds. These limitations may have affected the generalizability of the study beyond university undergraduate populations. Due to constraints beyond the control of the researcher, this study utilized convenience-sampling techniques. Although convenience sampling is not the ideal situation in inferential statistics, repeated replication of any significant findings of this research may provide evidence of the validity and generalizability of results.

The treatment conditions were limited to the assessment of the effects of software disruptions on participants. No attempt was made to assess the effects of hardware disruptions on participants. Another possible limitation is that the software disruptions were not sufficient to produce quantifiable changes in pre-test and post-test scores on the dependent variables.

Literature Review

This study investigated the effects of software disruption on goal commitment, task self-efficacy, computer self-efficacy and performance within the framework of Bandura's (1986) Social Cognitive Theory.

Social Cognitive Theory

Social Cognitive Theory (Bandura, 1986), defines the nature of humans in terms of basic capabilities, such as symbol systems and forethought, vicarious, self-regulatory and self-reflective capabilities. Social Cognitive Theory (SCT) views learning as a cognitive process relying on the abstract, reflective, and generative nature of human thought. According to Bandura (1997), the ability to predict the probable outcomes of prospective courses of action is a way in which "anticipative mechanisms contribute to human motivation and adaptation" (p.35). Thus, cognized goals and personal standards that evolve from value systems guide action via self-regulatory mechanisms such as perceived self-efficacy. The next section contains a brief discussion of goal theory.

Goal Theory

Goals are something people consciously desire to obtain that are external to the individual. Goals regulate motivation through indirect, self-referent processes that involve "the exercise of self-influence by personal challenge and the evaluative reaction to one's attainments" (Bandura, 1988, p.41). Goals affect task performance in that they give people direction towards actions and create self-incentives to persist in effort until their performance matches their goals. According to Locke & Latham (1990), goals have two main attributes: content and intensity. Goal content is related to the object or result that is sought, whereas goal intensity is related to goal commitment and goal valence (or value of achievement). When a negative discrepancy occurs between one's performance level and the value standard sought, the resulting dissatisfaction operates as an incentive to enhance future effort. As discussed previously, Bandura (1988) makes a distinction between a "performance" and an "outcome." According to Bandura (1988), provides clarification on the difference between a performance and an outcome. A "performance" is considered an accomplishment or something that is done. An outcome is something that occurs as a result of an activity. Goals serve as cognitive motivators to guide action through the exercise of forethought. The potential negative psychological effects of software disruptions in a learning environment make the study of goal-directed behavior an important issue in instructional design. Two particular aspects of goal-setting behavior relevant to this study are goal choice and goal commitment, as discussed below.

Goal Choice

Values, motives and attitudes are involved in an individual's goal choice or decision to accept a goal and goals define the conditional requirements for positive self-evaluation. Individuals choose goals based on what is important to them and what they think they are capable of (Locke, 1996). The act of setting a goal is indicative of one's value standard in relation to the desired level of performance on a task. "By making self-satisfaction conditional on matching adopted goals, people give direction to their actions and create self-incentives to persist in their efforts until their performance matches their goals" (Bandura. 1988, p.41).

This study utilized specific, self-set goal conditions as a predicate to goal commitment. Self-set goals are also referred to as personal goals in the goal-setting literature and require the individual to set specific learning or performance goal outcomes. Goals enhance performance only when an individual accepts them and they are personally meaningful. Therefore, self-set goals may have certain advantages over assigned goals because assigned goals may be unclear or rejected (Locke, et al., 1981; Malone, 1981; Erez and Zidon, 1984). Specific, self-set goal conditions are significant predictors of performance (Wood, Atkins and Bright, 1999) and result in consistently higher performance versus no goals or "do-best" goal conditions (Locke & Latham, 1990; Locke, et al., 1981; Mento, Locke and Klein, 1991). According to past research, studies where participants are told to do their best on a task are not as effective because they are inherently vague. Following goal choice, an individual must commit to the goal level chosen in order to proceed to goal attainment.

Goal Commitment

A goal is a means to create a standard for evaluating one's performance. "If one does not use a goal in this way, it is not a real goal or one is not really committed to it" (Locke & Latham, 1990, p. 78). Therefore, "it is virtually axiomatic that if there is no commitment to goals, then goal setting will not work" (Locke, Latham and Erez, 1988, p. 23). Goal commitment reflects the determination to try for and persist in pursuing a goal over time. Further, goal commitment generally implies an unwillingness to abandon or lower a goal (Campion and Lord, 1982). Research reflects that high commitment to goals is attained when an individual believes that the goal is important and that it is attainable (Locke, 1996). Self-efficacy is intertwined in goal theory and is one of the variables of interest in this study. A brief discussion of self-efficacy follows below.

Self-Efficacy

Self-efficacy is related to the concept of expectancy of success, but is broader in scope in that it relates to a judgment of total capability of performing a task. Bandura (1986, 1988) found that self-efficacy plays a key role in keeping people committed to a course of action especially when that course of action involves failures or obstacles. If an individual decides that he or she is not in control of the situation or fails to understand the task, the resulting dissatisfaction may reduce self-efficacy and thus, affect future goal choice (Bandura & Cervone, 1983).

Self-efficacy judgments can be distinguished from response-outcome expectations in that perceived self-efficacy involves judgment of one's capability to accomplish a certain level of performance while an outcome expectation is a judgment of the possible consequence such behavior will produce. Self-efficacy appears to be highly related to goal-directed behavior since decisions involving choice of action determine personal efficacy judgment. Individuals avoid tasks they believe exceed their capabilities (Bandura, 1977).

Judgments of efficacy also determine how much effort a person will expend and how long he or she will persist. According to Salomon (1984), self-doubt creates an impetus for learning but hinders use of previously established skills. Research also shows that people who judge themselves as inefficacious in coping with demands of the environment will dwell on their deficiencies and think about potential difficulties as being formidable (Beck, 1976; Lazarus & Launier, 1978; Meichenbaum, 1977; Sarason, 1975). Thoughts such as these create stress and undermine competent thinking by diverting attention away from the best way to proceed on the task. Thus, people high in self-efficacy are more productive than those that are low in self-efficacy.

Perceived self-efficacy not only influences goal choice, but also the amount of effort and persistence expended in achieving the goal, and the level of stress experienced in the face of failure. (Bandura, 1982; 1986). Research by Bandura & Cervone (1983) and others reflects that, an individual who has self-doubts about capabilities in regards to a negative discrepancy between personal standard and attainment will experience discouragement, whereas individuals who are self-efficacious will be motivated to persist to successful performance. According to Locke & Latham (1990), self-efficacy also affects goal commitment, feedback, and performance in goal-directed behavior.

<u>Research on Self-Efficacy and Computers</u>

Computing self-efficacy was recently studied by Brosnan (1998) who found that perceived ease of use, perceived usefulness and attitudes in combination with self-efficacy theory accounted for 45% of the variance in self-reported computing behavior. Significant gender differences in computing self-efficacy have also been reported in several studies (Busch, 1995; Murphy, Coover & Owen, 1988; Miura, 1986). Also, the amount of computing experience people have with computers affects computing self-efficacy (Moroz & Nash, 1997; Kinzie & Delcourt, 1991).

As technology pervades our society, computing and/or technological self-efficacy assessment will become increasingly important. This study concerned the variables of task self-efficacy, computer self-efficacy, goal commitment and performance within the context of computer-based instruction. Issues concerning computer-based instruction are briefly discussed below.

Computer-Based Instruction

The prevalence of computer technology as an instructional tool in educational and corporate settings is widely acknowledged. In educational settings, computers are valuable because they provide educators and instructional designers a way to motivationally enhance instruction. Effectively designed computer-based instruction can produce positive learner achievement and attitudes (Thompson, Simonson and Hargrave, 1996). Applications of computer-based instruction include drill and practice, tutorials, simulations, educational games and just-in-time learning. According to Hoska (1993), one of the main advantages of computer-based instruction (CBI) is its ability to provide one-on-one interaction between the learner and a computer program, which functions as a coach. An advantage of multimedia-based CBI is that learners are actively engaged with the learning medium in terms of responses and feedback received. Multimedia is "multiple media or the integration of more than one medium into some form of communication" (Jonassen and Reeves, 1996, p. 703) and usually refers to integration of media such as text, sound, graphics, animation, and video. Multimedia presentations are multimodal in that they stimulate more than one sense at a time. This factor can provide an advantage in computer-based instruction over traditional instructional mediums by gaining and sustaining learner attention.

A tutorial is one of the five modes of computer-based instruction. Generally, a well-designed computer-based tutorial assumes the role of an instructor to provide information in small fragments. Tutorial testing segments evaluate how well the learner retains the information presented in the lesson portion of the program. Feedback in CBI is generally combined with practice which "provides for learners' active participation in the learning process" and assessment of learner progress (Smith and Ragan, 1993, p. 78). In contrast, performance feedback is used to describe overall test scores and characterizes the individual's status on a criterion dimension. This information is then used metacognitively by learners to make decisions (Hannafin, Hannafin and Dalton, 1993). Effective tutorial design gives the learner informative feedback information such as correct and incorrect responses and hints. There is a large body of research concerning computer-based instruction and feedback and a large body of research on the effects of goal orientation and feedback. Goal-setting has been described as a dynamic, iterative process (Locke & Latham, 1990). In terms of goal-oriented behavior, feedback generally occurs during or after engaging the goal task and considerably after the learner sets goal choice and commitment levels. However, there appears to be little research on goal orientation prior to learner engagement of an educational goal task in a computer-based instructional setting.

Research on Goal-setting in Computer-based Instruction

To date, few studies been found involving goal-setting and computing behavior. Studies have been conducted on the effects of assigned learning goals versus self-set performance goals on computing skills, efficacy and strategies. Research has found significant differences in efficacy, competency and frequency due to goal setting (Ertmer and Schunk, 1997; Schunk and Ertmer, 1998). Ertmer & Schunk (1997) examined the influence of learning goals on college students' achievement outcomes during computer skill learning. The researchers found that assigned goals reported higher levels of efficacy than the self-set goal condition. However, the results obtained by the researchers may not have genuinely reflected the possible constellation of self-set goal effects on efficacy. "Do-best" goals were utilized in the self-set goal condition, but not the assigned goal condition. As discussed previously, "do-best" goals are vague and research indicates that "do-best" goals are not as effective as specific, self-set goals in terms of performance.

A study by Last, O'Donnell and Kelly (1998) investigated the influence of prior knowledge and goal strength on the difficulties and benefits of hypertext use. However, the sample size for this study was quite small, consisting of only 12 participants. Last, O'Donnell & Kelly's (1998) research can be distinguished from the current study in that it used goals assigned by the researchers rather than specific, self-set goals. Self-set goals reflect a more naturalistic goal-setting condition and goal strength is a related, but separate, construct indicating level of effort regarding goal choice rather than goal commitment.

Given previous research findings on goal-setting and the nature of this study, it is important that participants self-set specific goals to ascertain the effects of software disruption on participants' goal commitment and performance levels in a genuine educational setting to better understand the psychological issues affecting motivation and performance. No studies have investigated the contributing factors of learner goal commitment as applied to the instructional design process, in general, or the interaction between goal commitment and performance in computer-based instruction, in particular. One of the fundamental steps in any instructional design model concerns audience analysis and identification. In terms of the instructional design process, it is important to identify characteristics of the audience in order to design appropriate and effective instruction to meet learning needs and to accomplish the intended state change in the learner. In this context, it seems crucial that designers understand the audience in terms of learner commitment to achieving the educational goal task at the moment of learner engagement. Since goal commitment is interwoven with other motivational variables that may contribute to learner affective responses and subsequent self-efficacy levels, it may prove to be a pivotal link in the improvement of our understanding with regard to learner cognition and motivation in the context of the instructional design process. These issues may also carry over into educational software design and development in terms of explaining how learners initially approach computer-based educational tasks from a motivational standpoint.

Methodology

The independent variable utilized in this study consisted of two levels of software disruption that occurred during the testing segment of a computer-based instructional program. Four dependent variables were utilized in this study to measure the effect of the independent variable: goal commitment, task self-efficacy, computer self-efficacy and test performance.

Research Design

This study utilized a pre-test/post-test counter-balanced design utilizing one-way multivariate analysis of variance (MANOVA) statistical analysis. MANOVA is an extension of ANOVA and applies to situations with one or more multiple dependent variables (Tabachnick and Fidell, 1996).

The materials were also counter balanced in that participants were exposed to two different sets of vocabulary word pairs. One-half of the participants in all treatment conditions were randomly assigned program Version A on the first exposure to the program and the other half of the participants will receive program Version B first. On the second exposure to the program, the participants receiving Version A the first time received Version B the second time, and, correspondingly, those who received Version B first received Version A the second time.

Population and Sample

The target population for this study was undergraduate college students enrolled in two introductory college-level computing applications courses, EDIT 2318 – Introduction to Computers & Technology and EDIT 3318 – Applications of Technology in Elementary Education at a southwestern university in the United States. The sample included a representative cross-section of the general college student population at this university. Subjects were randomly assigned to one of the three treatment conditions (no disruption, moderate disruption in the test, or severe disruption in the test). The study was administered across several sessions of small groups of approximately eight (8) participants each. This was due in part to the constraint on the number of computers available in the Education Computing Center (ECC) lab and to provide some measure of experimental control of the number of participants that experience a disruption at the same time. The combined sessions formed three groups of approximately thirty (30) participants each, with a total sample size of ninety (90) participants. Participants were given extra credit for full participation in the study and were also instructed that an 80% average test score out of two possible test scores on a computer-based antonym test would earn bonus extra credit points.

Instruments

Goal commitment instrument

The goal commitment instrument utilized in this study was a modified version of the seven-item instrument developed by Hollenbeck, et al. (1989b). The instrument was modified by changing the phrase “GPA goal” to “test goal” to reflect a participant’s commitment to a proximal, self-set performance goal. This instrument has been used in traditional goal setting research and other specific research issues such as absenteeism, accident reduction, personality, creativity, multiple goal environments, and group goal-setting. The instrument uses a five-item Likert scale with all but items one and seven scored in reverse to reflect low, moderate or high goal commitment levels. According to Hollenbeck, et al., (1989b) evidence supports the construct validity of the instrument. According to Hollenbeck, et al., (1989b), the measure also reflects attitude components. Item seven is considered a cognitive component, item two is an affective component and item four is a behavioral component. DeShon and Landis (1997) investigated the dimensionality of the Hollenbeck, et al. (1989b) goal commitment measure with 402 undergraduate students. Their research found that psychometric evidence shows the scale to be unidimensional (Hollenbeck, et al., 1989a; 1989b; Wright, O'Leary-Kelly, Cortina, Klein, and Hollenbeck, 1994) with responses stable over time and the scale is related to other motivational constructs such as motivational force and performance. Although the items were listed in a different order than the original research of Hollenbeck, et al. (1989b), the researchers' findings were that items four, five, six, seven and eight of the scale reflect common goal commitment themes. Item five ("I am strongly committed to pursuing this goal") is a direct assessment of goal commitment and can be used as a single measure of the construct (Earley, Connolly and Ekegren, 1989; Kanfer and Ackerman, 1989). Item six ("It wouldn't take much to make me abandon this goal") reflects an unwillingness to lower a goal. Item eight ("I am willing to put in a great deal of effort to achieve this goal ") reflects a willingness to invest effort to achieve a goal. Items four ("Quite frankly, I don't care if I achieve this goal or not") and seven ("I think this goal is a good goal to shoot for") reflect goal importance. Responses to items one through three on the goal commitment measure reflect goal difficulty and performance expectancies, while the remaining items reflect goal commitment.

To quantitatively assess goal commitment levels, it was necessary to first require participants to choose a goal level. The goal choice portion of the instrument used in this study was developed to ascertain participants' specific, self-set goal choice and was constructed in accordance with research recommendations and findings of Locke & Latham (1990) and Wright and Kacmar (1995). In order to provide a degree of motivational interest and value to the choice of goal, participants were informed by the researcher prior to the study that they must achieve a minimum 80% average test score out of the two CBAT tests to receive a bonus EDIT 2318 module test credit or bonus EDIT 3318 extra credit points. Table 1 below reflects all possible combinations of participant self-set goal choice levels to achieve an 80% passing rate. For purposes of illustration, a categorical description has been added to show how a participant's goal choice will be descriptively categorized for purposes of this study.

Table 1. Possible self-set goal choice levels.

Test 1 score	Categorical description	Test 2 score	Categorical description
12	Low self-set goal level	19	High self-set goal level
13		18	
14	Moderately low self-set goal level	17	Moderately high self-set goal level
15		16	
16	Moderately high self-set goal level	15	Moderately low self-set goal level
17		14	
18	High self-set goal level	13	Low self-set goal level
19		12	

There are nine self-set goal choice levels ranging from 12 to 20 correctly answered items out of a total of 20 test items. After participants chose a goal level, they completed the goal commitment questionnaire. Internal consistency reliability analysis was performed to provide a measure of item reliability.

Demographics questionnaire

Demographic data was collected in the form of a multi-part questionnaire for the purposes of describing the sample. Data collected from the questionnaire consisted of items assessing the participants' gender, age, classification, computing experience and personal computing habits.

Self-efficacy instrument

The self-efficacy instrument was a two-part questionnaire consisting of five-item Likert scales. Part I of the measure collected data on the dependent variable of task self-efficacy. The task self-efficacy scale featured an adaptation of Pintrich, Smith, Garcia & McKeachie's (1991) self-efficacy for learning and performance scale, which assesses 2 aspects of expectancy: expectancy of success and self-efficacy. Item 5 of the Pintrich, et al. (1991) measure which read, "I believe I will receive an excellent grade in this class" was modified for this study to read, "I believe I will meet the goal I set for myself on this test." Item 6 of the Pintrich, et al. (1991) measure was modified by changing the word "readings" to "test." Item 12 of the Pintrich, et al. (1991) measure which read, "I'm confident I can understand the basic concepts taught in this course" was modified to read, "I'm confident I can understand the basic concepts necessary to complete the test." Item 15 of the Pintrich, et al. (1991) measure which read, "I'm confident I can understand the most complex material presented by the instructor in this course" was modified to read, "I am certain I can understand the most difficult material presented in the test I'm about to take." Item 20 of the Pintrich, et al. (1991) measure which read, "I'm confident I can do an excellent job on the assignments and test in this course" was modified to read, "I'm confident I can do an excellent job on future tests of this type." Item 21 of the Pintrich, et al. (1991) scale was omitted. Item 29 of the Pintrich, et al. (1991) measure which read, "I'm certain I can master the skills being taught in this class" was modified to read, "I'm certain I can master the vocabulary in this test." Item 31 of the Pintrich, et al. (1991)

which read, “Considering the difficulty of this course, the teacher, and my skills, I think I will do well in this class” was modified to read, “Considering the difficulty of this test, I think I will do well on this test.” Pintrich, et al. (1991) reported a Cronbach alpha of .93 on their scale. The scale is highly correlated with intrinsic goal orientation (*r*=.59), task value (*r*=.51), and control beliefs (*r*=.44).

Part II of the measure was a computer self-efficacy scale which collected data on the dependent variable of computer self-efficacy. The scale consisted of a modified version of Murphy, Coover & Owen's (1989) computer self-efficacy (CSE) scale. The mainframe CSE items were not used in this study since the EDIT 2318 and EDIT 3318 courses involved only microcomputer usage. Research on CSE by Moroz and Nash (1997) suggests that it differentiates between users in terms of computer experience, in addition to self-efficacy. Murphy, et al.’s (1989) research revealed that CSE represents beginning computer skills, moderate computer skills, and advanced computer skills. Internal-consistency reliability coefficients of .97, .96 and .92 were reported. Factor analysis by Harrison and Rainer (1992) supported findings by Murphy, et al. yielding a 3-factor solution, which explained 66.7% of the systematic covariance among the 32 CSE items. The first factor of the CSE scale accounted for 52.3% of the covariance and contains 16 items with loadings ranging from .69 to .89. These items indicate a beginning level of computing skills. The second factor of the scale accounted for 11.1% of the covariance and contains 12 items with loadings from .61 to .89. These items indicate conceptual computing terminology. The third factor accounted for 5.3% of the covariance and includes three items relating to mainframe computers. Internal consistency reliability analysis was performed to provide a measure of item reliability.

User Satisfaction Questionnaire

The User Satisfaction Questionnaire contained three sub-scale consisting of items assessing participants’ satisfaction regarding the CBAT program, frustration levels, and anxiety levels. Items 1,3, 7, 8, 11, and 13 reflected user satisfaction. These items were constructed in accordance with research findings (Hsee & Abelson, 1991; Eason & Damodaran; 1981; Shneiderman, 1979) and adapted from Chin, Diehl & Norman’s (1988) User Satisfaction Questionnaire. Generally, items adapted related to overall reactions to the software and system information. The response range was changed from 10-points to 5-points and the response range extended to reflect extremes on each end of the scale of dissatisfaction or satisfaction.

Items 4, 6a, 6b, 10, 17 and 19 reflected participant frustration levels. These items which were constructed in accordance with research findings on stress, anger and frustration (Brown, Tomarken, Orth, Loosen, Kalin, & Davidson, 1996; Eckhardt & Deffenbacher, 1995; Kassinove & Sukhodolsky, 1995; Spielberger, Reheiser, & Sydeman, 1995; Thomas, 1993; Martin, Achee, Ward & Harlow, 1993; Berkowitz, 1993; Digman, 1990; Dryden, 1990; Berkowitz, 1990; Berkowitz, 1989; Eichler, Silverman, & Pratt, 1986; Moos, 1986; Breznitz, 1986; Averill, 1983; Averill, 1982; Ellis, 1977).

Items 2, 5, 12, 14, 16, and 18 reflected participant anxiety levels. These items were developed based on research findings on stress and anxiety (Eysenck, 1997; Newton, & Contrada, 1992; Lazarus, 1986; Carver & Scheier, 1990; Ortony, Clore, & Collins, 1988; Folkman & Lazarus, 1986; Lazarus, 1986; Folkman & Lazarus, 1985; Knight & Glass, 1985; McCord, 1984; Spielberger, Jacobs, Russell, & Crane, 1983; Galassi, Frierson, & Sharer, 1981; Raub, 1981; Gudjonsson, 1981; Richardson, & Woolfolk, 1980; Weinberger, Schwartz, & Davidson, 1979; Sarason, 1978; McCroskey, 1970; Schacter, & Singer, 1962; Miller, 1960; Taylor, 1953) and Heinssen, Glass & Knight's (1987) scale. The item, "I hesitate to use computers for fear of making mistakes that I cannot correct" was utilized from the Heinssen, et al. (1987) scale.

Finally, two additional items pertained to participant expectations of the software and three open-ended questions provided qualitative data regarding the effects of the treatment conditions and participant satisfaction with the software. Statistical analysis of the satisfaction, frustration and anxiety sub-scales were performed using one-way Analysis of Variance (ANOVA) to determine if there were statistically significant differences between the groups. In addition, internal consistency reliability analysis was performed to provide a measure of item reliability.

Materials

Computer hardware

The computer hardware utilized in this study consisted of 25 Pentium-III IBM-PC compatible desktop computers located in the ECC lab in the College of Education using Microsoft Windows 98 as the computer operating system. The ECC lab also featured existing videotape monitoring devices.

Ready-made partitions

Ready-made partitions using presentation poster boards were placed between participants in order to minimize viewing of the content on other participants' monitors and to minimize the possible effects of disruptive discussions about the program or the disruptions during the course of administration of the treatments. Participants were told that the purpose of the partitions was to simulate a private, computer-based testing environment.

Computer-Based Antonym Testing Program (CBAT)

Prior to this study, a computer-based antonym testing program called CBAT was developed to attempt to simulate the effects of software disruption on learners. CBAT was developed using *Macromedia Director 7 for Windows* to measure non-domain specific, declarative knowledge with regard to recognition of twenty novel target word and antonym pairs. Program content and test item construction were adapted from test review materials for the antonym portion of the Graduate Record Examination (GRE) Verbal Test. GRE items are part of a standardized, norm-referenced test. Since CBAT test questions are closely modeled after the antonym portion of the GRE Verbal Test, the test is assumed to meet construct, predictive and content validity requirements for purposes of internal test validity. CBAT contains four main program segments: introduction, tutorial, practice and test. Navigation through the program proceeds in a strictly linear manner in order to control the amount of practice each participant received.

To prevent participants from accidentally skipping screens the program features a trap for mouse double-clicks to enable only single mouse click conditions to advance to subsequent screens. In addition, the "Ctrl/Q", "Esc" and "Ctrl/W." keys were locked out to prevent participants from actually restarting their computers. Due to limitations of *Macromedia Director*, the researcher was unable to trap for the "Ctrl/Alt/Delete" key combination to prevent a warm boot of the system. Therefore, the researcher instituted procedural controls such as verbally warning the users not to attempt to press this key combination because they might possibly risk losing their test scores in the event of unexpected system response following a warm boot. The power button on each computer was also taped over to prevent a cold boot of the system. The key feature of the program related to treatment conditions two and three of this study was a software disruption featuring an initially confusing screen featuring animated graphic material followed by a Microsoft Windows-type alert box consisting of two buttons ("Continue" and "Restart"). Choosing the "Continue" button initiated a simulated system restart. If a participant chose the "Restart" button, the program did not respond. If a participant chose the close box, the program paused for approximately five seconds and the original alert box reappeared. The program also featured unhelpful help options throughout the disruption segments. Following the software disruption, the CBAT program resumed and the participant continued through the program to completion of the CBAT test.

Data Collected by CBAT

CBAT was designed to primarily collect and store test performance data resulting from the CBAT test in a delimited text file. Ancillary navigation data collected for purposes of this study included the amount of time a participant spends on each screen in the program. Additionally, mouse clicks was collected on the disruption segments to determine participant choices in both of the disruption conditions.

Procedure

Participant orientation and administration of pre-test instruments

Participants attended an orientation session in the ECC lab. They were asked to participate in a software usability study where they beta tested software designed to teach college-level vocabulary. The participants were informed that minimum commitment for participation in the project was approximately one hour and fifteen minutes. Upon entering the ECC lab, participants signed-in and received a four-digit identifying number that matched the number on the monitor coversheet of an ECC computer. Participants were also informed that they were required to fully complete the program evaluation sessions in order to receive the extra credit opportunity for participation in this study. As stated previously, to provide a measure of value and motivational interest regarding goal choice, participants were told that an average passing test score of 80% was required to earn bonus test or extra credit points in addition to the extra credit received solely for participation. This facet of the study was deceptive in that all participants actually received the bonus points regardless of their test scores at the end of the study. The participants were reminded not to discuss the particulars of the study with other students or persons outside of the study to purportedly protect the developers' intellectual property rights. Participants opened the first of three packets labeled with the participant's previously assigned unique identification number to complete the consent form and demographics questionnaire. Next, participants were instructed to open the second packet and study a list of ten target word/antonym pairs for thirty seconds. The participants were then instructed to return the list to the packet and complete the goal commitment and self-efficacy questionnaires.

Administration of treatments

Following orientation and administration of the pre-test measures, the three treatment conditions were administered in the ECC lab. Sessions were videotaped using the existing security monitors in the ECC lab. Prior to commencement of the study, one or more graduate students were provided with a script and trained to observe and respond to participants while they complete the CBAT program. Each participant was seated at a pre-assigned computer in the ECC lab. Prior to commencement of the treatments, participants were verbally instructed not to attempt to restart their computers in any manner. The computer's power buttons were be taped over to prevent users from actually initiating a system restart. Participants were then instructed to remove the monitor coversheet and proceed through the program at their own pace.

General program orientation

The first segment of the program consisted of the initial splash screen followed by a participant login screen. Participants were randomly assigned to one of the three treatment conditions according to their pre-assigned number by a subroutine built into CBAT. The second segment consisted of introduction to the program, including the purpose of the program, orientation to the content of the program, and suggestions for strategies to answer test questions. The third segment consisted of a tutorial introducing twenty target word/antonym pairs. The tutorial introduced three pertinent pieces of information: the target word, meaning of the target word, and the matching antonym. The fourth segment consisted of review and practice, including a ten-item guided practice test featuring a combination of elaborative feedback and try-again feedback. The final program segment consisted of a test on the twenty target word/antonym pairs presented in the tutorial segment of the program. Test answer order for items that were on the practice test was scrambled to lessen any effects of recall of answer location.

Treatment Condition One - Control Group

Participants in treatment condition one completed the test with no software disruptions. After answering the last test question, the participants proceeded to the test results screen.

Treatment Condition Two – Moderate Disruption

Participants in treatment condition two completed half of the test and then received a moderately disruptive event requiring participant response via the Windows dialog box. The sequence lasted approximately one minute. After the participant completed the disruption sequence, the test resumed with the next test item in sequence. Upon answering the last test question, the participant proceeded to the test results screen.

Treatment Condition Three – Severe Disruption

Participants in treatment condition three completed half of the test items and then received a disruptive event requiring participant response via the Windows dialog box. The sequence lasted approximately three minutes and was more complex than treatment two in that it featured several response options and required users to make multiple decisions as they worked through the disruption sequence. After the participant completed the disruption sequence, the test resumed with the next test item in sequence. Upon answering the last test question, the participant proceeded to the test results screen.

Data compilation

The CBAT program collected the test results and navigation data to an output file for further compilation and analysis. Following completion of the CBAT program, participants were instructed to open the third packet and to complete the User Satisfaction Questionnaire, adapted from Chin, et al. (1988), to ascertain satisfaction ratings, frustration levels and anxiety levels. The participants were then instructed to take a short break outside of the ECC lab while the CBAT program module was reloaded.

Post-test measures and second testing opportunity

After the break, the participants returned to the ECC lab and again completed the CBAT program. The first part of the study was duplicated, with the exception of administration of the demographics questionnaire. Each participant received and completed a fourth packet containing the computer self-efficacy, task self-efficacy, and goal commitment questionnaires. The participants then completed the second trial of the CBAT program. Participants received the same treatment condition received in the first exposure to the CBAT program. CBAT again collected test results and navigation data to an output file for further compilation and analysis. Following completion of the CBAT program, participants completed a second User Satisfaction Questionnaire. After all participants completed testing, they were instructed not to discuss the particulars of the project with other students or persons outside of the study.

Debriefing

Two days after all sessions were conducted, the researcher gave notice of a meeting of the participants to debrief them on the purpose of the study and to address any concerns the participants might have had.

Results

Internal Consistency Reliability of the Measures

Because adaptations were made to the instruments, internal consistency reliability analysis was performed on the dependent measures and the three sub-scales of the user satisfaction questionnaire to investigate the psychometric properties of the scales and to provide a measure of item reliability. The results of Cronbach's alpha internal consistency analysis yielded α=.88 on the six-item task self-efficacy scale, α=.96 on the 29-item computer self-efficacy scale, α=.69 on the seven-item goal commitment scale.

The results of Cronbach's alpha internal consistency analysis on the user satisfaction questionnaire yielded α=.83 on the quesionnaire's six-item satisfaction sub-scale, α=.81 on the questionnaire's six-item frustration sub-scale, and α=.74 on the questionnaire's six-item anxiety sub-scale.

Findings for the research hypothesis

The research hypothesis stated that there were no significant main effects on goal commitment, task self-efficacy, computer self-efficacy and performance as a result of software disruption. The four dependent variables of post-test goal commitment, post-test task self-efficacy, post-test computer self-efficacy and test 1 performance scores were used to determine differences between the three treatment groups in terms of software disruptions. One-way MANOVA analysis of the computed differences between pre- and post-test scores on each of the measures was conducted to determine if there was a change in goal commitment, task self-efficacy, computer self-efficacy or test performance and to determine if the dependent variables interacted with the treatment conditions. Results of this analysis are reported in Table 2 below.

There was no significant difference found between the three treatment conditions of no disruption, short disruption and long disruption when measured by the computed differences in pre- and post-test computer self-efficacy (p=.415 at .05 alpha), pre- and post-test task self-efficacy (p=.802 at .05 alpha), pre- and post-test goal commitment (p=.621 at .05 alpha), or pre- and post-test performance (p=.651 at .05 alpha).

Table 2. One-way MANOVA analysis of the computed differences between pre- and post-test scores on each of the dependent measures.

Source	**Df**	**MS**	**F**	**Sig.**
Model	2	59.30		
Group:	2			
Computer-self efficacy		44.34	.887	.415
Task self-efficacy		5.14	.221	.802
Goal Commitment		6.08	.480	.621
Test 1 scores		3.73	.432	.651
Error	87	94.57		

One-Way ANOVAs on Sub-Scales of User Satisfaction Questionnaire

An additional analysis was conducted on the post-test scores of the sub-scales of satisfaction, frustration, and anxiety contained in the USQ. One-way analyses of variance (ANOVAs) were conducted on the computed differences between pre-test and post-test scores on anxiety, frustration and satisfaction to determine if there was a change in anxiety, frustration or user satisfaction levels. Results of this analysis are discussed below.

No statistically significant differences was found (p=.413 at .05 alpha) between the three treatment conditions of no disruption, short disruption and long disruption when measured by the differences between pre-test and post-test anxiety (see Table 3).

Table 3. One-way ANOVA test of the between-subjects effects of the computed differences in pre-test and post-test anxiety.

Source	**Df**	**MS**	**F**	**Sig.**
Model	2	9.64	.893	.413
Group	2	9.64	.893	.413
Error	87	10.80		

No statistically significant differences was found (p=.424 at .05 alpha) between the three treatment conditions of no disruption, short disruption and long disruption when measured by the differences between pre-test and post-test frustration (see Table 4).

Table 4. One-way ANOVA test of the between-subjects effects of the computed differences in pre-test and post-test frustration.

Source	**Df**	**MS**	**F**	**Sig.**
Model	2	7.90	.865	.424
Group	2	7.90	.865	.424
Error	87	9.13		

Finally, no statistically significant differences was found (p=.229 at .05 alpha) between the three treatment conditions of no disruption, short disruption and long disruption when measured by the differences between pre-test and post-test satisfaction (see Table 5).

Table 5. One-way ANOVA test of the between-subjects effects of the computed differences in pre-test and post-test satisfaction.

Source	**Df**	**MS**	**F**	**Sig.**
Model	2	8.23	1.50	.230
Group	2	8.23	1.50	.230
Error	87	5.48		

Summary

The results of the study failed to find statistically significant differences in task self-efficacy between the no disruption, short disruption and long disruption treatment conditions. However, there appeared to be a tendency for overall mean scores on task self-efficacy to increase following the first exposure to the program. The results of the study also failed to find statistically significant differences in computer self-efficacy, goal commitment, or test performance between the control, short disruption and long disruption treatment conditions.

Discussion

The purpose of this study was to investigate the effects of software disruption on learner goal commitment, task self-efficacy, computer self-efficacy and performance during a computer-based learning task. Three treatment groups were established to investigate the effects of no disruption, short disruption, or long disruption on the dependent variables.

The study was conducted at a southwestern university in the United States. Participants were enrolled in two introductory college-level computing applications courses, EDIT 2318 – Introduction to Computers & Technology and EDIT 3318 – Applications of Technology in Elementary Education. Although EDIT 2318 is a sophomore level course and EDIT 3318 is as junior level course, the majority of participants were classified as freshmen. Subjects were randomly assigned to one of the three treatment conditions (no disruption, moderate disruption in the test, or severe disruption in the test). The study was administered across several sessions of small groups of approximately eight (8) participants each.

A one-way MANOVA was performed to determine if differences existed between the groups with regard to participants' pre-test versus post-test goal commitment, task self-efficacy, computer self-efficacy and test performance scores. The results of this analysis failed to find statistically significant differences between the groups regarding pre-test versus post-test scores on the dependent variables as a result of the three treatment conditions of no disruption, short software disruption or long software disruption.

Results of Reliability Analysis

Internal consistency reliability analysis was performed on the task self-efficacy scale, computer self-efficacy scale, goal commitment scale, and the three sub-scales of the USQ to provide a measure of item reliability. The computer self-efficacy scale reported very high reliability (α=.96). The task self-efficacy, satisfaction sub-scale and frustration sub-scales reported moderately high reliability. The anxiety and goal commitment scales reflect moderate reliability ratings, possibly indicating a need for modification and refinement of these scales.

Conclusions

Effect of Disruptions on Dependent Variables

Participants in this study did not appear to be negatively affected by the software disruptions in terms of the effects on the dependent variables of goal commitment, task self-efficacy, computer self-efficacy and test performance. As discussed previously, the relationships between all variables of interest in this study strengthened following trial 1 of the software program. In particular, the relationship between post-test task self-efficacy and performance dramatically increased across all treatment conditions. Generally, these results seem to support Bandura's (1986) contention that people set a more challenging goal of bettering their past attainments and that moderate discrepancies in performance stimulate increased effort to achieve valued standards. In an attempt to assure that the task was genuinely valued, participants in this study were told that to receive an additional full test credit, they would have to average 80% on their CBAT test scores. After the study was completed, of course, all participants received the test credit. Given the increase in relationship between task self-efficacy and performance from trial 1 to trial 2, the results seem to indicate that the task had inherent motivational value. According to Bandura (1986), "notable attainments bring temporary enjoyment, but people enlist new challenges as self-motivators for further accomplishment" (p. 470). Research by Bandura and Cervone (1983) indicates that having accomplished a given level of performance, people generally motivate themselves by setting greater challenges that create new discrepancies to be mastered.

Further, the combination of goal-setting with feedback via features designed into the CBAT program, such as review, practice and test results, may also have had an impact on performance. According to Bandura and Cervone (1983), both knowledge of performance and a standard of comparison are needed to produce motivational effects. In terms of self-set goals, in particular, Bandura (1986) comments, "self-set goals are not in themselves motivating without knowledge of one's performance" (p. 469). Knowledge of performance in relation to attainable, challenging goals contributes to motivation.

Test performance was not significantly affected by the software disruptions. However a comparison of group differences in test 1 performance versus test 2 performance scores indicates that treatment group 1 (no disruption) made greater gains in test 2 performance than did groups 2 and 3, which received varying levels of disruptions (see Figure 1 below).

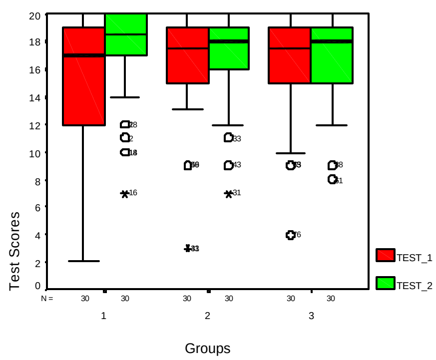

Figure 1. Test 1 and Test 2 scores by treatment group.

Further, the disruptions did not significantly affect goal commitment. Goal commitment scores generally increased following test 1. However, as illustrated in Figure 2 below, the post-test goal commitment mean for treatment group three fell after trial 2.

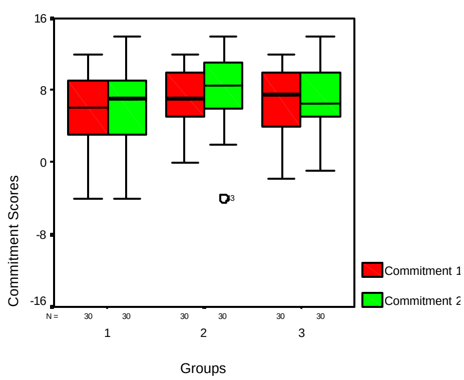

Figure 2. Pre-test and post-test goal commitment scores by treatment group.

It is possible that the disruptions affected groups 2 and 3 (short and long disruptions) in a way not anticipated by the researcher. Given the previous discussion on goal choice and test performance scores, the relatively small mean gains in test 1 performance for group 1 may indicate that the disruptions may have had a positive, rather than negative, cognitive effect on treatment groups 2 and 3. Perhaps the attentional processes demanded by the disruptions heightened awareness and increased attention to the task, thereby increasing performance levels.

Further, a comparison of mean pretest and post-test goal choice with test performance by group, yielded interesting patterns. Recall that the research design employed was counter-balanced in that each participant was exposed to two different sets of vocabulary word pairs. One-half of the participants in all treatment conditions were randomly assigned program Version A on trial 1 of the CBAT program and the other half of the participants will receive program Version B first. On trial 2 of the CBAT program, the participants receiving Version A the first time received Version B the second time, and, correspondingly, those who received Version B first received Version A the second time. Table 6 below reflects mean pre-test and post-test goals chosen compared to mean test performance scores following software trials 1 and 2, respectively.

In comparing pre-test goal choice with actual post-treatment test 1 scores for the 3 treatment groups, mean performance scores for group1 (no disruption) changed the least (.30 points higher) from the mean pre-test goal chosen. Group 2's test 1 performance mean was .93 points higher than the mean pre-test goal chosen and Group 3's test 1 performance mean was 1.14 points higher than the mean pre-test goal chosen. Therefore, it appears that in trial 1 of the CBAT program, the group with the longest disruption (Group 3) had the highest level of performance relative to the mean pre-test goal chosen for that group.

In comparing post-test goals chosen with test 2 performance scores following trial 2 of CBAT, it appears that group 1, which had the least change in mean test 1 performance scores compared with mean pre-test goals chosen, increased post-test goal choice more than groups 2 or 3 (.74 points increased for group 1 compared to .57 and .16 points increase for groups 2 and 3, respectively). Note also that group 3 (long disruption), which made the greatest test performance gains relative to pre-test goal choice, raised mean post-test goals chosen only .16 points -- the smallest post-test margin of the 3 treatment groups. Generally, it appears that the group that exceeded their expectations the most in terms of test performance at trial 1, changed subsequent goals to the least degree in anticipation of trial 2 of the CBAT program.

Further, while all groups had higher mean test 2 performance scores relative to post-test goals chosen, group 1 (no disruption) and group 3 (long disruption) had the greatest change in mean test 2 performance scores compared to mean post-test goals chosen. Group 1 scored .76 points higher on test 2 than mean post-test goals chosen and group 3 scored .67 points higher on test 2 than mean post-test goals chosen.

Table 6. Comparison of mean pre-test and post-test goal choice with mean test 1 and 2 performance by group.

Treatment Group	Mean pre-test goal choice	Mean Test 1 scores	Mean post-test goal choice	Mean Test 2 scores
Group 1 (Control – no disruption)	15.23	15.53	16.27	17.03
Group 2 (short disruption)	15.10	16.03	16.60	17.00
Group 3 (long disruption)	14.93	16.07	16.23	16.90
Total	15.09	15.88	16.37	16.98

As reflected Table 6 above, successful performance on trial 1 may have increased participants' motivation levels to better subsequent test performance . Additionally, participants' may have underestimated their test performance abilities. Test 1 performance scores were generally higher across all participants than participants' pre-test goal choice.

In general, the results of the study seem to suggest that one disruption alone, whether it is short or long in duration, was not enough to greatly impact test performance. Any effect of the disruptions on participants probably occurred at trial 1 since participants may have expected to encounter problems on the trial 2. Computing experience may also have been a factor that affected participants' reactions to the software disruptions. The majority of participants (55.5%) had more than 3 years of computing experience. Satisfaction ratings, which were moderately high following trial 1 of the software across all 3 treatment groups (M = 6.77), increased across all 3 treatment groups following trial 2 (M = 7.50). These results may reflect that participants may have been accustomed to problems with computer software and the disruptions may not have been sufficiently powerful to affect the dependent variables to a significant degree.

Further, in light of the comparison between goal choice and test performance, the disruptions may have resulted in a positive, rather than negative, cognitive effect with regard to the participants in groups 2 and 3. As discussed previously, the combination of goals and feedback in the form of knowledge of performance generally increases motivation. "Self-motivation through internal standards and perceived self-efficacy operate as interrelated rather than as separate mechanisms of personal agency. Goal attainments build self-efficacy.... Whether negative goal discrepancies are motivating or disheartening will be partly influenced by perceptions of personal efficacy for goal attainment" (Bandura, 1986, p. 470). Therefore, it is also possible that the combination of self-set goals, self-efficacy and feedback in this study may have nullified any negative effects of the software disruptions.

Effect of Disruptions on Satisfaction, Frustration and Anxiety

In consideration of the low levels of self-reported anxiety and frustration in treatment groups two and three, a possible explanation for low self-reported scores might be that participants' did not lose any ground when resuming the test following the disruption. The disruptions occurred mid-way through the test and, following the disruption, participants resumed the test at the next test question in sequence. Participants' initial verbal reactions to the disruption commonly consisted of concern about having to start the test over from the beginning, rather than the nature of the disruption itself. Based on participant comments, self-reported low anxiety and frustration levels might have been higher in the treatment groups receiving the disruptions if participants had resumed the test from test question 1.

Another possible explanation contributing reports of moderately low levels of anxiety or frustration might be due to the limited number of participants allowed per session and the partitions. It was observed in the pilot study of the software (*N*=120) that a large group of participants (approximately 20 per session) often resulted in agitated group discussion and participants' helping each other through the disruption sequences. Following the pilot study, the researcher minimized the opportunity for interaction between participants by reducing the size of the sessions and incorporating the partitions, since users are usually not in a group setting when they experience actual computer problems in a naturalistic setting. In the pilot study, it appeared as though the participants actually "fed" off of each other's overt behavioral reactions to the software disruptions, thereby increasing overt behavioral responses indicating possible frustration or anxiety. This observation was supported in the current study, as it appeared that full sessions resulted in more overt participant activity than sparsely attended sessions.

Finally, it is possible that the experimental manipulations via the software disruptions failed. The disruptions may not have been sufficiently disruptive to affect participant responses on the dependent variables or the disruptions may have lacked enough sophistication to be believable by the participants.

Limitations of the Study

One of the limitations of the study is the generalizablity of results to the population from which the sample was selected due to the fact that most of the participants were classified as freshmen. This predominance of classification is not representative of the general college student population. A second limitation of the study is the generalizability of results to the population in terms of gender due to the fact that the percentage of female participants was not representative of the general college student population in terms of gender. Finally, there was no time limit imposed on testing. This factor could have impacted the significance of software disruptions, since there was no "cost" associated with loss of time spent dealing with the disruptions in terms of completing the test.

Suggestions for Further Research

Based on the results of this study, further research is needed to determine whether adding a time-limit factor combined with software disruptions would significantly affect task self-efficacy, computer self-efficacy, and goal commitment or test performance. Interactions between time limit and disruptions could also be investigated. Research also needs to investigate the effects of multiple disruptions in a single trial of a computer-based instructional task rather than one per trial. Further research should be undertaken to investigate the negative or positive effects of software disruptions on learners' cognitive and attentional processes. Finally research utilizing qualitative videotape and audiotape analysis should be undertaken to compare individual differences in self-reported computer anxiety or frustration with actual behavioral and physiological participant reactions.

Summary

This study followed several years of observation of user response to negative events in computing environments. While the main research question failed to find significant differences between the groups with regard to goal commitment, test performance, task self-efficacy and computer self-efficacy, there appeared to be unexplained or hidden phenomena affecting the participants' interface with the software program during the course of the disruptions. Inarguably, human beings are psychologically complex. There remain many intriguing and yet unanswered questions pertaining to the effect of negative events on users in computing environments. It is hoped that this study has elucidated some of the potential factors that may help identify users who experience frustration or anxiety who might otherwise be overlooked. The future of the human-computer interface depends on further understanding of the psychological processes that affect users both from a cognitive and a motivational standpoint.

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