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The Effects of Technology-Mediated Instructional Strategies on Motivation, Performance, and Self-Directed Learning

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THE EFFECTS OF TECHNOLOGY-MEDIATED INSTRUCTIONAL STRATEGIES ON MOTIVATION, PERFORMANCE, AND SELF-DIRECTED LEARNING

By

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This work is dedicated to my mother Siné “Sheena” Gabrielle, my father George “Gabe” Gabrielle, my brother David Gabrielle, my nephew Andrew Gabrielle, my Godmother and Aunt Connie Finnicum, and a special dedication goes to my Godfather and Uncle Richard Gabrielle, who died in the terrorist attacks on the World Trade Center on September 11, 2001.

I am blessed to have known and loved you, and to have been loved by you.

For those who matter most to me, especially my “mum” and dad:
The sunshine that was once extinguished is rising again. Thank God.

Your Spirit Lives On

For Richard S. Gabrielle, 12/14/1950- 9/11/2001

The loss, the sadness, the emptiness inside
The pain and grief we cannot hide
Somehow it still seems surreal
But beyond the ashes of devastation,
Together we must heal
Because your spirit lives on.

Your spirit lives in our memories.
You gave so much joy to our lives
50 wonderful years’ worth.
We cannot let one day of terror
Overtake the mirth.

Your spirit lives in our acceptance.
Everything in life happens for a reason,
We may never know the reasons why.
We thank God to have been blessed with you in our lives,
Though it's not fair when people we love die.

Your spirit lives in our hearts.
You overcame and excelled.
A loyal husband, a devoted dad,
Gave your little girl love, support, and encouragement,
All the things you never had.

Your spirit lives in our hopes.
You made the most of everything
Though laughter sometimes hid the pain,
The little boy who lost his mom
Is finally in her arms again.

Your spirit lives in our minds.
You triumphed in the face of adversity
Successful in everything you tried.
Intelligent, compassionate, and kind;
Your passion for learning never died.

Your spirit lives in our faith.
Angel Gabriel is God's great messenger
Telling us we must be strong,
Treating others as we'd like to be treated.
In your name we must carry on.

Your spirit lives in our unity.
You enriched our lives
From the day that you were born
But your power is stronger now than ever
As friends and strangers unite and mourn.

Yes, it's time to say goodbye,
But only to the pain
We must grow from your great spirit
For you did not die in vain.

Your spirit lives on through our love.
Our lives are forever changed since the evil on nine eleven
But peace and freedom will prevail with your loving soul in heaven.
We must celebrate your life to heal,
Live our lives to the fullest to get beyond the pain.
You left this earth a hero
And your spirit will always remain.

Poem written by Donna M. Gabrielle in loving memory of her uncle and Godfather, Richard S. Gabrielle, who was killed by terrorists in the attack on the World Trade Center on September 11, 2001.

This one is for you, Uncle Richie….

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

The purpose of this design experiment was to positively affect motivation, performance, and self-directed learning of undergraduate students enrolled in a tuition-free, public military school. A second purpose was to use new technologies to efficiently deliver these instructional strategies as supplementary course content. This empirical study was conducted during one semester with 784 students, representing approximately 20 percent of the population at the academy.

The within-subjects research design used a mixed method approach involving quantitative and qualitative data. Four surveys were used to measure motivation and self-directed learning: (1) the Course Interest Survey developed by Keller; (2) the Instructional Materials Motivation Survey developed by Keller; (3) the Self-Directed Learning Readiness Scale developed by Guglielmino, and; 4) the Self-Directed Learning survey.

Students in 48 participating sections were randomly divided into control and experimental groups for each of 16 instructors. Within these courses, students in each section had identical syllabi and classroom-based content. The researcher communicated with control and experimental group students via email, and used email to direct experimental group students to the technology-mediated instructional strategies (TMIS). Strategies were designed using Keller's ARCS model of motivation and delivered via Personal Digital Assistant (PDA), web, CD-ROM, and other technologies. For students in the experimental group, web-based post-strategy SDL surveys were administered throughout the semester, tracking participation, perceptions, and self-directed learning. To provide for a richer study, qualitative data were collected via open-ended questions on the SDL survey and via threaded discussions on web forums. Follow-up interviews also helped triangulate the data.

Those students who accessed the TMIS had significantly higher levels of academic performance than control group students. There were also significant differences in motivation and proclivity to be self-directed learners, with higher levels for treatment group students than control group students.

These findings suggest that systematically designed technology-mediated instructional strategies can positively effect motivation, performance, and self-directed learning. Further, new technologies such as the PDA can help improve the efficiency of delivering such strategies. Suggestions for future empirical research are presented.

CHAPTER I

INTRODUCTION

Context of the Problem

In the past century, the concept of distance learning has evolved from correspondence courses to instructional television to computer-based instruction to web-based learning. Today, the effort to put courses online is ubiquitous in education and training. Technology-mediated learning environments provide new opportunities for people to learn at their own convenience and pace. This shift in education from an instructor-centered to a learner-centered focus requires learners to be motivated and self-directed (Lee, 2000). However, empirical data are lacking on how to positively effect self-directed learning and satisfy the motivational needs of learners (Visser & Keller, 1990). Further, there is need for more literature examining motivation in technology-mediated learning environments.

Csikszentmihalyi, for example, spent over thirty years researching controlled experiments and case studies to investigate the importance of motivation and positive psychology (1990). His volumes of empirical evidence conclude that motivational issues are as important to learning as cognitive issues. Motivation has been found to be one of the most critical concerns in how and why people learn (Efklides, Kuhl, & Sorrentino, 2001; Keller, 1979; Wlodkowski, 1999). Keller (1999a) notes that instructional designers are faced with even greater challenges in self-directed learning environments than with traditional instruction, especially with regard to satisfying the motivational needs of learners.

Further, there has been some criticism about the quality of existing literature. Reeves (1995) analyzed decades of research studies in instructional technology (IT). He concluded that most studies in the field have problems including insufficient sample sizes, specification errors, lack of connection to theoretical foundations, meager treatment implementation, various measurement flaws, inaccurate statistical analyses, and futile discussions of results. The same author (Reeves, 2000, p. 4) said, "Given the poor quality of the inputs to research syntheses in the field of instructional technology, it is little wonder that the literature reviews and meta-analyses in IT yield disappointing results that provide practitioners with insufficient or confusing guidance." Similarly, Kulik and Kulik (1991) conducted an extensive literature review to examine the effectiveness of computer-based instruction. They argued that researchers conducting meta-analyses often reject more than 75 percent of published studies to include a small number that are worthy of additional analysis.

Thus, for researchers, the challenges include the need to pay particular attention to research design, development, and analyses. For instructional designers and educators, the challenges include the need to select the most appropriate instructional, technological, and motivational methods to improve learning. This study dealt with some of these challenges.

Problem Statement

Motivation is essential to learning and performance, particularly in technology-mediated environments where students must take an active role in their learning by being self-directed (Lee, 2000). However, empirical data are lacking on how to positively effect self-directed learning (SDL). Further, despite the importance of motivation to learning, J. Visser and Keller (1990) argue that the motivational needs of learners are often overlooked in educational research. To demonstrate this gap in the literature, L. Visser, Plomp, Amirault, and Kuiper (2002) examined the proceedings of the World Conferences of the International Council for Distance Education between 1988 and 1995. They found that less than one percent of the papers (only six of 801) focused on motivational issues. Consequently, more empirical research is necessary to examine motivation in technology-mediated learning environments.

Maslow (1970) defines motivation as a psychological process where a behavior is directed toward a goal based on an individual's needs. Keller (1999a) argues that although motivation is idiosyncratic, learner motivation can also be affected by external aspects. These factors include systematic instructional design of tactics and strategies intended to improve motivation and performance, as well as encouragement and support by instructors, tutors, or peers. Thus, it would seem feasible that after conducting a motivational analysis of learners, appropriate strategies could be developed to improve motivation, performance, and SDL.

There is both experimental and correlational support for the instructional methods presented in this study. Song (1998) used Keller's ARCS model of motivation to develop computer-based instruction for middle school students. One control and two experimental groups received different levels of motivation in the instruction. Song found significantly higher levels of attention, relevance, motivation, and effectiveness in the group that received motivationally adaptive instruction than in the control group. J. Visser (1990) studied the impact of strategies designed using Keller's ARCS model that were delivered to adult learners. His embedded single-case exploratory study concluded that motivational messages could enhance learning by motivating students to undertake SDL tasks outside the classroom. Visser and Keller (1990) further studied the efficacy of motivational messages with adult learners in Mozambique, also with positive results. L. Visser (1998) took the concept of motivational messages a step further to encourage learners to persist in correspondence courses. She found that learners who received the motivational messages had reduced dropout rates and increased satisfaction. L. Visser, Plomp, and Kuiper later (1999) used similar strategies using the ARCS model with distance learners. In all studies, motivational messages were generally found to improve learner motivation, retention, satisfaction, and performance.

Fischer and Scharff (1998) concluded that interactivity and supported self-directed learning are essential in technology-mediated environments. A number of studies have shown that this social context of learning can positively affect motivation, performance and persistence. Beatty (2002) found that choosing appropriate instructional methods helped engage learners and improve motivation in online learning. Boyer (2001) used a similar framework to examine the social context of self-directed learning in an international online environment. The study used strategies including threaded discussions, online chat, and group goal setting in a virtual learning community (Boyer & Maher, 2002). Both studies involved complex case study designs and found that social interaction is essential to technology-mediated learning.

Even in the absence of technology, research has revealed that the social aspect of learner support and encouragement is essential to motivation, persistence, and performance. As noted earlier, L. Visser (1998) found that the use of a motivational messages support system (MMSS) had a positive impact on retention and satisfaction of correspondence students. She concluded that instruction was too expensive and time-consuming to revise; therefore, learner support was more feasible. Will this use of the social context of motivational messages be improved by using technology to deliver the messages? Will the addition of instructional strategies positively effect academic performance? Will the use of new technologies such as the Personal Digital Assistant (PDA) be an effective means of delivering instructional content? Further, will the use of these technology-mediated instructional strategies cause changes in learner behavior to improve motivation and SDL? These questions provided the impetus for the topic of this research study.

Purpose of the Study

The purposes of this research were to: a) determine if there are differences in academic performance of students who use systematically designed interventions of technology-mediated instructional strategies (TMIS); b) determine if there are differences in proclivity to be self-directed learners of students who use TMIS interventions, and; c) determine if there are differences in motivation of students who use TMIS interventions.

Four surveys were used to collect data on motivation and self-directed learning: (1) the Self-Directed Learning Readiness Survey (SDLRS) developed by Guglielmino to measure "readiness for self-directed learning", (2) the Course Interest Survey (CIS) developed by Keller to measure motivation related to a course, (3) the Instructional Materials Motivation Survey (IMMS) developed by Keller to measure motivation related to instructional materials, and (4) the Self-Directed Learning (SDL) survey developed by this author to track participation and perceptions. Extensive information on each student's course academic performance measures was also collected.

To summarize the intent of this study, the purpose was for students to be motivated by accessing supplementary instructional strategies and learning beyond the requirements of a college course, ideally resulting in increased academic performance and increased proclivity to be self-directed beyond the course.

Research Questions

Using a quasi-experimental research design, this study addressed the following research questions:

1. In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on academic performance as measured by course aggregate points (projects, homework, and examination grades throughout the semester)?
2. In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on learner proclivity to be self-directed as measured by the SDLRS instrument?
3. In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on learner motivation as measured by Keller's ARCS instruments (CIS and IMMS)?

Limitations of the Study

The most palpable limitation of the study is the homogeneity of the population. Prior studies in this publicly funded military academy reveal that the demographics of these cadets are not representative of traditional institutions of higher education (Hancock, 1991; Preczewski, 1997). For example, only 15% of cadets are female, all are unmarried with no children, and none are physically handicapped. The results are not likely generalizable beyond this context. However, this homogeneity also provides increased scientific control of the internal validity of the research.

Another concern is with performance ceiling effects; however there is variation in grades. The students are often in the top 10% of their graduating high school class and achieve high ACT and SAT scores. It may be difficult to positively affect performance in students who are already high achievers, though there is opportunity for improvement.

Another issue is the potential for contamination among control group and treatment group students, particularly because students live and socialize together in this structured environment. Unfortunately, there is no way to prevent this potential contamination, though this is not an unusual issue in an undergraduate environment. Follow-up interviews with study participants attempted to address this question.

Further, some studies have suggested that interventions may take more time to show results than the one semester that this study is using. A final issue is that due to cadets' intense schedules, interventions needed to be useful, appealing, and "chunked" in manageable (10-15 minute) segments. There were opportunities to access multiple segments of these strategies for those students who chose to self-direct beyond the initial segments of time.

Significance of the Study

A careful review of the existing literature revealed much discussion but little empirical data on motivation in technology-mediated learning environments. Research is also lacking on how to positively effect self-directed learning and motivation of undergraduate students. Motivation is essential to all learning; consequently, this study benefits the fields of adult education and cognitive psychology since it addresses the motivational aspects of self-directed learning.

Perraton (2000) argues that existing research is seldom grounded in theory and is instead typically descriptive, stressing the need for additional empirical development of the literature. Likewise, Visser and Keller (1990) point out that the literature often neglects the motivational needs of learners. Motivation has been the topic of research for decades in pedagogy; however, there is little formal research on the topic as it relates to technology-mediated learning.

Further, in the Information Age, the transformation in education from an instructor-centered approach to a learner-centered focus requires learners to be self-directed and motivated (Fischer & Scharff, 1998). The proliferation of web-based courses and other technologies further necessitates these traits in adult learners. Despite this transformation to a learner-centered focus, the question of how to positively effect these traits has not been adequately examined in the existing literature. This study addressed the gap of how to effect learner behavior changes toward this motivated, self-directed learning, thus advancing knowledge in the literature.

This research study is a likely expansion of J. Visser's (1990) and L. Visser's (1998) use of motivational messages for learner support, adding technology-mediated instructional strategies to the messages. Since the literature suggests that motivation plays a critical role in performance (Song & Keller, 2001), interventions were designed using Keller's ARCS model of motivation and developed from performance objectives. The study was also motivated by Preczewski's (1997; 1998) research findings on self-directed learning of cadets at a military academy which concluded that the undergraduate experience fails to positively affect SDL of students. Finally, this research was one of the first empirical studies to use new technologies such as the Personal Digital Assistant (PDA) for instructional content. Knowledge about the impact of technology-mediated interventions presented in this study could be of benefit to instructional designers of blended learning (a combination of classroom-based and technology-mediated learning) environments.

Operational Definitions

Review of existing research and literature led to the following operational definitions of terms:

Blended Instruction/ Blended Learning

Blended learning is a combination of classroom-based and technology-mediated instruction/ learning.

Instructional Strategy

An instructional strategy is a plan for supporting learners as they study for any given performance objective (Gagné, Briggs, & Wager, 1988). In this study, an instructional strategy is supplementary (outside of the course requirements) content that is systematically designed to assist learners in mastering specific learning objectives.

Motivation

Motivation is an individual's desire to learn course content, measured by the Course Interest Survey (Keller & Subhiyah, 1993), and interest in instructional materials, measured by the Instructional Materials Motivation Survey (Keller, 1993).

Performance

Academic performance is course aggregate points per course, as measured for each learner in the study, by grades including homework, projects, participation, papers, quizzes, and examinations.

Readiness for Self-Directed Learning

Readiness for self-directed learning, indicated by scores on the Self-Directed Learning Readiness Scale (SDLRS) (Guglielmino, 1978), is a learner's proclivity to be self-directed.

Self-Directed Learning

Self-directed learning is an individual's desire to learn beyond the requirements of a course, measured by the Self-Directed Learning survey.

Technology-Mediated Instructional Strategy

A technology-mediated instructional strategy (TMIS) is a systematically designed strategy to assist learners in mastering specific course performance objectives. Each TMIS is developed with Keller's ARCS model, delivered via email, and includes three components: (1) motivational messages at the beginning and end of each TMIS; (2) a link to instructional content provided on technologies including PDAs, Internet, intranet, CD-ROM, and streamed video, and; (3) the SDL survey to track participation and obtain feedback to improve future TMIS.

CHAPTER II

REVIEW OF RELATED LITERATURE

The following analysis of the literature will begin with a review of empirical literature on motivation and self-directed learning. The analysis of the literature will then review: (1) self-directed learning instrumentation, particularly the SDLRS developed by Guglielmino (1978); (2) Keller's ARCS model of motivation; (3) motivation instrumentation, particularly the CIS and IMMS developed by Keller (1993; Keller & Subhiyah, 1993); (4) systematic instructional design, and; (5) a conceptual model for the present study.

Motivation and Self-Directed Learning

Motivation and self-directed learning (SDL) have many commonalities, particularly with regard to technology-mediated instruction. The literature seems to indicate that both motivation and SDL: (1) can be influenced by external factors; (2) are situational in that learners can have different levels for different topics and at different times, and: (3) can affect performance.

Both motivation and self-directed learning are personal and individual. Some people seem to have an innate proclivity to learn, while others do not. However, external factors can also affect motivation (Keller, 1999a) and SDL. For instance, much empirical research exists on the effects of systematic instructional design and learner support. Visser and Keller (1990) studied the validity of the clinical use of motivational messages designed with the ARCS[1] model of motivation. They found that adult learners in Mozambique benefited from the motivational interventions. J. Visser (1990) then used motivational messages and instructional content to encourage adult learners to pursue self-directed learning activities outside the classroom. He found that the systematically

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[1] The ARCS model (Attention, Relevance, Confidence, Satisfaction) was developed by John Keller (1979) for the purpose of systematic motivational design.

designed interventions were an effective way of improving SDL. L. Visser's (1998) later use of the Motivational Messages Support System (MMSS) showed that such systematic support can improve motivation and reduce dropout rates of correspondence students. Visser and her colleagues (1999) subsequently examined the use of the MMSS with distance learners, also with positive effects on motivation and retention. Visser, Plomp, Amirault, and Kuiper's later examination of motivational messages with international distance learners also yielded positive results and revealed more insight about how the messages helped learners (Visser et al., 2002). Likewise, in all studies, students said they appreciated the messages. These findings are consistent with the literature that says that the social context of learning has positive effects on motivation and SDL. It would be useful to examine the effect of such motivational messages in a technology-mediated learning environment.

Further, the literature seems to indicate that people may be more motivated or self-directed in different topics and at different times. Caffarella (1993) first suggested that autonomy may be a trait that can be developed and may be situational in context, indicating that formal education could promote this characteristic. The situational context of learning is receiving more attention recently in the literature. Beatty (2002) examined social interaction in web-based learning. The research used a survey of descriptive case studies, as well as interviews and surveys of authors of the case studies. His "situationalities framework" resulted in prescriptive instructional design issues including learning goals, values, conditions, and outcomes that instructional designers should regard when determining instructional methods of technology-mediated learning environments. Boyer likewise researched andragogical systems implications for social, self-directed learning with international graduate students in a two-phased study (Boyer & Maher, 2002; Boyer, 2001). The mixed method research presented a systems model metaphorically as architecture in a virtual community of learners (see Figure 2-1).

Specific themes that emerged from qualitative analyses included: role difficulties, academic expectations, intimidation concerns, the importance of input relationships and participation, and the value of systems elements of input, process, output, and outcomes (Boyer & Maher, 2002). The results revealed different levels of participation, SDL, and active involvement, which is consistent with the literature on the situational nature of motivation and SDL.

Moreover, the literature seems to indicate that both motivation and self-directed learning can positively affect performance. Hancock (1991) used the Paragraph Completion Method test to categorize learners at a military academy into high and low conceptual levels. She found that learners with high conceptual levels had greater achievement and motivation when they were given an opportunity to have nondirect instruction (by participating in planning course objectives and other self-directed learning activities). Rowley, Bunker, and Cole (2002) found that converting a course from a classroom-based environment to blended instruction and adding a problem-based learning approach increased performance for adult learners at a military training education college. Volumes of literature confirm that motivation is an important factor in dropout rates of distance learners (Berge, 2001; Perraton, 2000). These high dropout rates have been improved through the use of mentors and tutors (Harrison, 2002), blended instruction (Rowley et al., 2002), motivational messages (Visser, Plomp, Amirault, & Kuiper, 2002), and other methods of learner support to improve performance and retention.

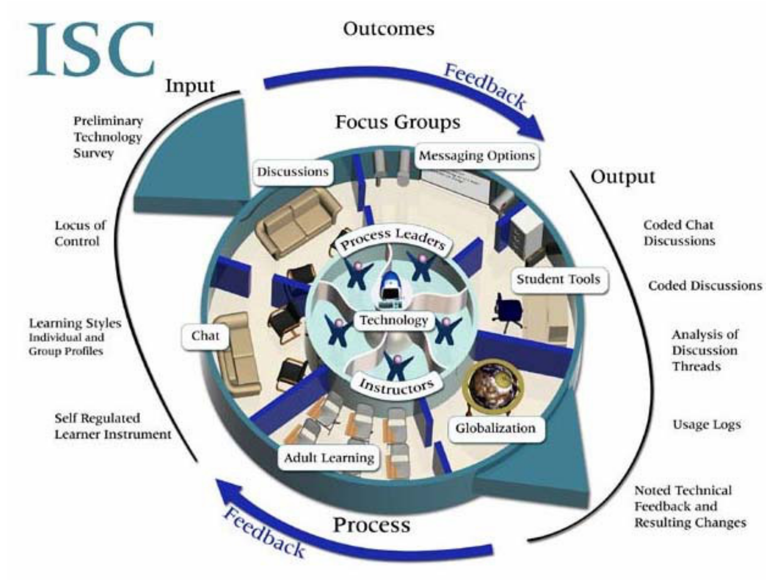

Figure 2-1: ISC Model (Boyer, 2001)

Of the two studies that deal directly with the proposed research questions in this dissertation, Preczewski (1997; 1998) found no significant differences across grade levels in SDL among undergraduate students, arguing that the undergraduate experience failed to positively affect SDL, while L. Visser (1998; Visser, Plomp, Amirault, & Kuiper, 2002; Visser, Plomp, & Kuiper, 1999) asserted that messages based on Keller's ARCS model of motivation positively affected motivation, persistence, and satisfaction of distance students. Of concern in Preczewski's study is the reliability of the Oddi Continuing Learning Inventory instrument[2] as evidenced by the lack of variance in the scores. Although Preczewski's research focused on the psychological conceptualization of SDL, it did not attempt to examine the social context of SDL. Visser's interventions

[2] The Oddi Continuing Learning Inventory, developed by Lorys Oddi (1984), measures self-directedness for continued learning and is widely used in the SDL field.

of motivational messages, while addressing the social context of SDL, did not regard the situational context and were not efficiently delivered. Further, neither study attempted to influence academic performance. The findings of these two studies, and the associated issues, provide the impetus for this research study on the effects of technology-mediated instructional strategies on motivation, performance, and SDL.

Preczewski first examined SDL at the United States Military Academy in 1997. A cross-sectional survey approach was used to investigate self-directedness of cadets (N=723) enrolled in all four years (from freshmen to seniors) at the academy. The study presented two research questions: (1) Are there differences in SDL among undergraduate levels (freshmen through senior) as measured by the *Oddi Continuing Learning Inventory* (OCLI)? and; (2) Is self-directedness for continuing learning associated with any of the following nine variables: age; gender; minority status; academic and engineering discipline; athletic participation; ACT/SAT score; intent to pursue post-baccalaureate educational activities; and parental education level (Preczewski, 1997)?

No significant differences were found in total OCLI, General Factor, or Ability to be Self-regulating scores as measured by the OCLI across grade levels. Preczewski reported that many variables significantly correlated with OCLI scores, but none achieved a Pearson's $\underline{r}$ value greater than .19. However, significant differences were found for the Avidity for Reading subscore, with higher levels for sophomores and seniors. Further, regression analyses revealed gender differences in the Ability to be Self-Regulating as a function of grade level.

Preczewski indicated that his choice to use the OCLI instrument was due to its availability, cost, and the fact that the author allowed external scoring of the instrument. He later stated, "The OCLI does require additional refinement. For this sample, only 23% of the total variance in Total OCLI scores was explained…leaving over three-fourths unexplained" (Preczewski, 1997, p. 92). Preczewski further questioned the reliability of the instrument.

Preczewski's study laid the groundwork for research on SDL in a military academic environment. He expanded his study in 1998 with mid-career and senior officers (N=1002). This research revealed significant differences in self-directedness for learning as a function of gender and seniority among undergraduate, mid-career, and senior professionals in the military (Preczewski, 1998). As the author noted, the study contributed to the field by examining how SDL as a personality construct can change with time and experience. Regarding the initial research with undergraduates, it would be useful to address the question of the reliability of the OCLI instrument by exploring the use of the SDLRS instrument. The question of whether the SDLRS would benefit the study, and Preczewski's (1999, p. 121) conclusion that, "the undergraduate experience fails to increase self-directedness as measured during and at the end of the undergraduate experience," would benefit from additional investigation.

To attempt to address Preczewski's conclusion, another relevant study supplied the design of interventions in this research study. The two-part study was conducted in

1996 and 1997 in England, and it examined development research applied to improve motivation in distance learning. The primary research question asked, "To what extent are motivational messages, based on Keller's ARCS model of motivational analysis, effective in distance education courses?" (Visser et al., 1999, p. 406). A second research question addressed effectiveness and cost-efficiency differences between customized and mass motivational messages.

To consider the problem of motivating students, Visser noted that revising instruction is not always feasible, and learner support via motivational messages is a viable alternative. A developmental design approach was used to prototype and improve motivational messages in the pilot phase, and a multiple case design was chosen for the main study. Students received encouraging messages throughout the semester, usually in the form of greeting cards. Students completed surveys on their perceptions of the effectiveness of the motivational messages, and some were also contacted for follow-up information.

Results from the main study confirmed the pilot study's findings and indicate the Motivational Messages Support System (MMSS) is an effective method of increasing retention in distance courses. Completion rates increased from 32% in 1995 to 53% in 1996 in the pilot study, and the completion rates further increased in the main study to more than 61% (Visser et al., 1999). Students also reported that they appreciated the messages. There was no evidence that personalized messages were more advantageous than mass messages, indicating that costs and time could be reduced with mass messages.

Concerns in the study include a 55% response rate on the surveys, though this is not unusual with distance students. This study provides evidence that the MMSS is an effective method of providing learner support and motivation. However, the study did not investigate the situational context of motivation, which could be addressed with Keller's CIS and IMMS instruments. Further, the efficiency of the delivery of the MMSS could be improved through the use of technology such as email.

To summarize, there is little empirical data addressing motivation, performance, and SDL in technology-mediated learning environments. This research study attempted to address this gap in the literature. Thus, the effective use of technology-mediated motivational interventions, based on Visser's research on MMSS, was a key impetus for this research study.

Self-Directed Learning Instrumentation

There are two primary SDL instruments used in the literature: (1) the Self-Directed Learning Readiness Scale (SDLRS), which measures readiness for self-directed learning; and (2) the Oddi Continuing Learning Inventory (OCLI) instrument, which measures self-directedness for continued learning (Brockett & Hiemstra, 1991; Long, 2001). Brockett and Hiemstra (1991) note that these two instruments have progressed the field by shifting the focus from the process of SDL to the psychological characteristics underlying self-directed learning.

The OCLI was developed by Oddi in 1984. Oddi's (1984) instrument measures self-directedness for continued learning as measured by three dimensions. These elements were the result of interpretation from a factor analysis: (1) a "General Factor" that includes one's ability to work independently, to work with others, and the degree to which one is proactive or reactive in the ability to initiate and persist in learning independent of external reinforcement; (2) the ability to be self-regulating; and (3) an avidity for reading. The instrument has been validated with graduate students in nursing, law, and adult education, as well as with undergraduates in business, secretarial science, and a variety of majors at a military academy. The OCLI is a 24-item survey with a seven-point Likert-type scale.

Empirical literature using the SDLRS, the OCLI, and other instruments lack experimental research methodology. Stockdale, Fogerson, Robinson, and Walker (2002) examined SDL literature from 1990-2000 in International SDL Symposia proceedings and adult education journals. The content analysis revealed that 74.4% of empirical studies used correlational designs, 21.8% used surveys, and only 3.8% had experimental research designs.

Despite the prevalence of correlational research, there are conflicting findings with the association between individual characteristics and SDL. For example, Oddi (1984) and Shulman (1994) found no significant relationship between age, gender, and self-directedness as measured by the OCLI instrument. However, Preczewski (1997; 1998) found significant changes in female Self-Regulating subscores on the OCLI and no significant changes in males during their freshman and sophomore years. Likewise, Tsay (1999) found significant correlations between age and SDL as measured by the SDLRS. Hassan (1981) found no relationship between educational achievement level and the SDLRS, though a later study by Long (1991) found significant correlations.

These conflicting findings have led to some criticism of the instruments, though such criticisms have likewise been refuted (for example, see Delahaye & Sarojni, 2000). It would be beneficial to use the SDLRS in a more controlled environment with an experimental research design. To summarize, although neither the SDLRS nor the OCLI has been without scrutiny, they are widely used in the field as evidenced by their extensive application in a variety of contexts that commonly validate the instruments.

Self-Directed Learning Readiness Survey (SDLRS)

The most frequently implemented instrument, and the one selected for this study, is the Self-Directed Learning Readiness Survey (SDLRS). The instrument was developed by Guglielimino in 1978. Guglielmino's (1978) SDLRS instrument measures an individual's readiness for self-directed learning as calculated from eight cognitive dimensions. These elements resulted from a three-round Delphi technique followed by interpretations of item analysis and factor analysis: (1) openness to learning opportunities; (2) self-concept as an effective learner; (3) independence and initiative in learning; (4) responsibility for one's own learning; (5) love of learning; (6) creativity; (7) future orientation; and (8) ability to use basic study skills and problem solving skills. Long and his colleagues (2000) assert that the SDLRS is considered the instrument of choice in the field. Indeed, Stockdale and her colleagues (2002) report that in ten years of research on SDL, sixty percent use the SDLRS instrument, exceeding the use of the OCLI and four other instruments combined. The SDLRS has been used in over 500 studies and has been translated into 14 different languages (Guglielmino, 2002). The SDLRS has been validated with a variety of populations, primarily with undergraduate students. The instrument is a 58-item survey with a five-point Likert-type scale. Seventeen of the 41 items are reversed. The response scale ranges from 1 (Not True) to 5 (Very True). Therefore, the minimum score on the 58 item survey is 58, and the maximum is 290 with a midpoint of 102. The average score with adult learners is 214.

In summary, the literature seems to indicate that: (1) learners exhibit different levels of ability to be self-directed; (2) external factors can influence motivation and SDL, and; (3) motivation can affect performance. Hence, research is necessary to examine the relationship between SDL, motivation, and academic performance in technology-mediated learning.

Keller's ARCS Model of Motivation

Keller's (1987) attention, relevance, confidence, and satisfaction (ARCS) model of motivational design emphasizes the motivational requirements of learners and provides the theoretical framework for the interventions in this study. The model has been successfully tested for its validity and reliability in a variety of contexts including classroom-based instruction (Naime-Diefenbach, 1991; Small, 1997; J. Visser, 1990; J. Visser & Keller, 1990), distance learning (L. Visser, 1998; L. Visser et al., 2002; L. Visser et al., 1999), web-based learning (Maushak, Lincecum, & Martin, 2000; Vafa, 1999), multimedia (Gibson, Herbert, P., & Mayhew, 1998), and computer-aided instruction (Song, 1998; Suzuki & Keller, 1996). The premise is that after conducting a motivational analysis of the learners, instructional designers use the model to develop effective and appropriate tactics and strategies to enhance and maintain learner motivation. The present research study was the first known research to examine the ARCS model with blended learning. Research applying the model will be discussed in more detail later in this chapter, but first it is necessary to describe the four dimensions of Keller's ARCS model, beginning with learner attention. Details of each dimension are provided for the motivational analysis, which will follow in Chapter 3.

Attention

Attention refers to the ability to capture the interest of learners, to pique their curiosity to learn, and to hold their attention (Keller, 1992). Keller (1992) differentiates three types of attention: (1) Perceptual Arousal; (2) Inquiry Arousal, and; (3) Variability. Systematically designed and developed instructional strategies can be used to enhance all three types of attention.

Through Perceptual Arousal (A1), curiosity is piqued to gain the attention of learners (Keller, 1992). Methods of gaining attention include providing visually appealing graphics or unexpected actions to capture learner interest. Through Inquiry Arousal (A2), this initial perceptual attention can be maintained for greater lengths of time. Methods of sustaining attention include asking challenging or stimulating questions and integrating inductive and problem-solving approaches. With either of these types of attention, Variability (A3) is important to prevent learner boredom (with too little variation) or frustration (with too much variation).

Keller (1999a) notes that rich graphics, color, and animation, when used appropriately, can help improve learner motivation and performance. L. Visser (1998) used greeting cards with graphics and personalized messages to gain and sustain learner attention. As discussed earlier, she found that the use of these motivational messages improved motivation, satisfaction, and completion rates of distance learners.

Relevance

Relevance refers to the connection of the instructional content to things that are meaningful to the learners. Keller (1987) notes that in any environment with adult learners, relevance of the instructional material to the learner is imperative. One aspect of relevance is concerned with ensuring that learners see the connection between what they need to know and what new learning opportunities are presented to them. Keller (1992) identifies three categories of tactics dealing with relevance: (1) Goal Orientation; (2) Motive Matching, and (3) Familiarity.

Through Goal Orientation (R1), the instruction is related to learners' goals (Keller, 1992). With Motive Matching (R2), tactics could include encouraging learners to visualize achieving a goal, or appealing to personal interests and learning styles. The third of Keller's (1992) categories of relevance tactics is Familiarity (R3). The premise of this construct is to connect the instruction to the learner's own experiences.

For example, Song (1998) designed motivationally adaptive computer-aided instruction (CAI) for middle school students using Keller's ARCS model of motivation. He created checkpoints in a genetics program of CAI that asked learners questions about their motivation and attitude. Based on learners' responses, the CAI directed students to an appropriate tactic to improve attention, relevance, or confidence. This treatment group was compared to two other groups of learners, one who received minimal tactics of motivation and another with a maximum number of tactics that were sometimes excessive. The two groups that received appropriate and maximum motivational tactics responded more positively than the group that received minimal tactics. Overall, significantly higher levels of attention, relevance, motivation, and effectiveness were found in the group that received motivationally adaptive instruction than in the control group.

Wager (1982) notes that it is also important to select the appropriate kinds of media and amounts of interactivity. Technology-based learning can provide rich opportunities for task-related simulations, practice, and customized feedback. Harrison (1999) notes that when these capabilities are integrated to their full potential, they can enhance the learning process. These concepts serve inform the present study's media selection process, as well as to ensure that the strategies are relevant to the population.

Confidence

Expectancy Theory of Motivation includes learners' self-efficacy for success, perceptions of whether the effort will lead to desired outcomes, and the value of the expected outcomes (Vroom, 1964). Bandura (1997) notes that people who believe they have control over their capacity to affect change in their lives are more effective and successful. Confidence refers to these positive expectancies for success by learners (Keller, 1979). Keller (1992) presents three methods of instilling confidence in learners: (1) Learning Requirements; (2) Positive Consequences, and (3) Personal Responsibility.

Learners are informed of the expectations through Learning Requirements (C1) (Keller, 1992). An obvious tactic is to provide learners with clear learning objectives and expected outcomes of the instruction. Positive Consequences (C2) occur when learners are challenged an appropriate amount. Visser, Plomp, Amirault, and Kuiper (2002) note that chunking instructional material into manageable segments can improve confidence by giving learners more control. Finally, Personal Responsibility (C3) involves ensuring that learners feel that they succeeded due to their ability rather than because the task was too easy, they were lucky, or other external factors played a role (Keller, 1992).

Attribution theory (Weiner, 1986) likewise emphasizes the learner's perception of the explanation for their success or failure and states four possible reasons: effort, ability, level of task difficulty, and luck. Hoban and Sersland (2000) found that self-efficacy was improved when learners were confident that their achievement was due to internal factors. In a study of 86 graduate students, they found a significant positive relationship between readiness for SDL (as measured by the SDLRS) and self-efficacy for SDL (as measured by the Self-Efficacy for SDL questionnaire). They concluded that appropriate instructional strategies could be developed to improve learner self-efficacy and SDL.

Satisfaction

Satisfaction refers to learners' positive feelings about their learning experiences, and it includes affirmation to learners that the instructional content was relevant and that they had the ability to learn the material. Keller (1992) identifies three kinds of tactics to improve learner satisfaction: (1) Intrinsic Reinforcement; (2) Extrinsic Rewards, and (3) Equity.

Intrinsic Reinforcement (S1), or an internal desire to learn, is most aligned with self-directedness. Through Extrinsic Rewards (S2), learners are recognized for their accomplishments, either verbally or through actual rewards. The research is extensive on intrinsic reinforcement and extrinsic rewards. Rotter (1966) used several experiments to examine the effects of reward or reinforcement, which he concluded depends in part on whether the individual perceives the reward as dependent on or independent of the individual's behavior. Technology-mediated instruction can provide instant feedback and reinforcement to learners to enhance satisfaction with their learning experience. For example, Song (1998) used immediate feedback based on learner motivation levels to direct them to appropriate instruction. Equity (S3) includes learner perceptions of fair and equal treatment, which are essential to motivation regardless of the context.

In summary, components of the ARCS model (see Table 2-1) can be addressed with various instructional strategies. Sound instructional design tactics with clear and attainable objectives through chunking of information help direct learners through technology-mediated instruction. Opportunities for reality-based practice, games, and simulations help learners remain engaged throughout the process. Customized feedback on practice items helps learners improve their confidence and knowledge while giving them opportunities to review areas that need clarification. All of these components enable an instructional designer to conduct a requisite motivational analysis of learners.

Table 2-1: Summary of ARCS Components

Attention	**Relevance**	**Confidence**	**Satisfaction**
A1 Perceptual Arousal	R1 Goal Orientation	C1 Learning Requirements	S1 Intrinsic Reinforcement
A2 Inquiry Arousal	R2 Motive Matching	C2 Positive Consequences	S2 Extrinsic Rewards
A3 Variability	R3 Familiarity	C3 Personal Responsibility	S3 Equity

The utility of Keller's ARCS model of motivation is particularly pertinent to self-directed learning. As stated earlier, the model has been tested extensively in a variety of contexts. Research using the ARCS model has primarily shown improved motivation, satisfaction, and performance. However, since Keller's development of the model, the emphasis was predominantly on the design and development of instruction. L. Visser's (1998) research was groundbreaking because it instead focused on learner support, finding that systematically designed interventions using Keller's ARCS model positively affected motivation, persistence, and satisfaction of distance students. This pioneering effort warrants further investigation.

Motivation Instrumentation

A number of instruments, models, and theories of motivation exist (for example, see Deci and Ryan (1985); Maslow and Frager (1987); and Weiner (1986)). Wlodkowski (1985) developed the Time Continuum Model of Motivation that proposed which motivational strategies should be used at set time intervals. He differentiated six motivational factors that he said influence learning in a fixed sequence: attributes, needs, stimulation, affect, competence, and reinforcement. The components of the model are linked to specific motivational strategies, developed from theory, that the teacher or instructional designer can apply. Hence, this prescriptive model differs from Keller's ARCS model which is more flexible and non-linear in its approach to solving motivational problems (Visser & Keller, 1990).

Keller developed two instruments that measure ARCS components of motivation, the Instructional Materials Motivation Survey (IMMS) and the Course Interest Survey (CIS). The IMMS is a situational measure to identify motivation with specific instructional materials, and the CIS is a situational measure to identify motivation in a specific course. The IMMS has been tested extensively for reliability, primarily on undergraduate and graduate students, while a handful of studies have used the CIS.

Course Interest Survey (CIS)

The Course Interest Survey (CIS) is a 34-item survey with a Likert-type scale (Keller & Subhiyah, 1993). Participants are asked to think about each statement in relation to the course itself, and to indicate how true each statement is. The response scale ranges from 1 (Not True) to 5 (Very True). Therefore, the minimum score on the 34 item survey is 34, and the maximum is 170 with a midpoint of 102. The minimums, maximums, and midpoints for each subscale vary because they do not all have the same number of items. There are 5 subscales: one for each of the ARCS components (Attention, Relevance, Confidence, Satisfaction) and one for the ARCS total score. Nine of the 34 items are reversed.

Instructional Materials Motivation Survey (IMMS)

The Instructional Materials Motivation Survey (IMMS) is a 36-item survey with a Likert-type scale (Keller, 1993). It has been validated in a number of studies, primarily with undergraduate students. Participants are asked to think about each statement in relation to the instructional materials they have just studied, and to indicate how true each statement is. The response scale ranges from 1 (Not True) to 5 (Very True). Thus, the minimum score on the 36 item survey is 36, and the maximum is 180 with a midpoint of 108. The minimums, maximums, and midpoints for each subscale vary because they do not all have the same number of items. There are 5 subscales: one for each of the ARCS components (Attention, Relevance, Confidence, Satisfaction) and one for the ARCS total score. Ten of the 36 items are reversed.

Systematic Instructional Design

Systematic instructional design, according to Gagné, Briggs, and Wager (1988), refers to the planned design and development of instruction to improve learning. Learning has traditionally been defined as an observable change in performance due to interaction with the environment (Driscoll, 2000). However, Jonassen (2000) argues that this established definition is inadequate because in addition to examining learner performance, it is necessary to look at the social and cultural contexts in which learning occurs as well as the tools that learners use to construct meaning. Berge and Collins (1995) note that scholars in the field are beginning to address three related concepts: (1) Learners have different learning styles; (2) students construct their own meaning through learning, and; (3) retention and transfer are enhanced not as much by what is taught, but what students are encouraged to learn themselves. This concept of encouraging learners to change their behavior toward active, self-directed learning is increasingly emphasized in literature and is the foundation for the conceptual framework of this study.

Keller (1999a, p. 3) proposes three assumptions of systematic instructional design: (1) learner motivation can be affected by external factors; (2) motivation is a method of affecting performance, and; (3) systematically designed instruction can "predictably and measurably influence motivation." One method of affecting motivation is through the use of systematically designed instructional strategies, which Gagné, Briggs, and Wager (1988) define as a plan for supporting learners as they study for any given performance objective. This research study uses systematically designed instructional strategies to attempt to positively affect motivation, performance, and self-directed learning.

Despite the importance to improving learning, the SDL field did not adequately address the systematic design and development of instruction until the 1990s when researchers recognized the need to focus on systematic solutions. Consequently, there is unexploited potential in the application of systematic solutions in cognitive science to technology-mediated learning.

Conceptual Model for the Present Study

This design experiment sought to examine the effects of technology-mediated instructional strategies (TMIS) on motivation, performance, and self-directed learning (see Figure 2-2). In addition, it used new technologies to improve the efficiency of the delivery of TMIS.

Figure 2-2: Conceptual Model

The within-subjects design experiment used a mixed method approach involving both quantitative and qualitative data. Four surveys produced specific information on motivation and self-directed learning: (1) the Course Interest Survey (CIS) developed by Keller to measure motivation specific to a course; (2) the Instructional Materials Motivation Survey (IMMS) developed by Keller to measure motivation specific to instructional materials; (3) the Self-Directed Learning Readiness Scale (SDLRS) developed by Guglielmino to measure learner readiness to be self-directed, and; (4) the Self-Directed Learning (SDL) survey developed by this author to track experimental group students' participation, SDL, and perceptions of the strategies.

The conceptual framework of the present study is defined by the proposition that the use of TMIS has a positive effect on motivation, performance, and SDL in a technology-mediated learning environment. This proposition is supported by the problem-solving conceptual framework provided by Keller's ARCS model of motivational design.

Because motivation is essential to learning and performance, this study used prior research on motivational messages (Visser, 1990; Visser & Keller, 1990; Visser, 1998; Visser et al., 2002; Visser et al., 1999) as groundwork for TMIS design. Particularly, the TMIS design was inspired by L. Visser's motivational messages support system (MMSS) and her findings that motivational messages improved learner satisfaction, persistence, and motivation. Each motivational message incorporated components of the ARCS model and directed students to access content-specific strategies intended to help them improve learning (see Figure 2-3). The key difference between the MMSS and the TMIS, aside from the use of technology, is the addition of instructional content intended to help students master performance objectives. Also, the SDL survey was added to monitor student access and perceptions of the TMIS.

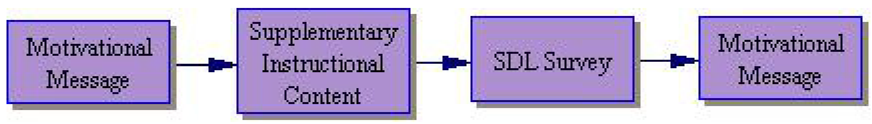

Figure 2-3: Systematic Design of Technology-Mediated Instructional Strategies

Research Questions and Hypotheses

The purpose of this design experiment was to attempt to positively effect motivation, performance, and self-directed learning of undergraduate students enrolled in a tuition-free, public military school. A second purpose was to use new technologies (such as the PDA) to efficiently deliver instructional strategies as supplementary course content via blended instruction. Three questions were examined to achieve these purposes. The research questions are:

1. In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on academic performance as measured by course aggregate points (projects, homework, and examination grades throughout the semester)?
2. In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on proclivity to be self-directed as measured by the SDLRS instrument?
3. In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on learner motivation as measured by Keller's ARCS instruments (CIS and IMMS)?

Question 1: In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on academic performance as measured by course aggregate points (projects, homework, and examination grades throughout the semester)?

Research Question One examined the effect of TMIS on academic performance. Song and Keller (1999) argue that motivation plays a critical role in performance. Since motivation is essential to learning and performance, this study used prior research on motivational messages (Visser, 1990; Visser & Keller, 1990; Visser, 1998; Visser, Plomp, Amirault, & Kuiper, 2002; Visser, Plomp, & Kuiper, 1999) as a foundation, and it added instructional strategies designed from course objectives to help students master performance objectives. Academic performance was measured by course aggregate points including projects, homework, and examination grades throughout the semester. This question first tested for the interaction effect of instructor and course on the treatment variable. Differences in academic performance were measured for those who received traditional instruction (control) versus those who received traditional instruction *and* supplementary TMIS (treatment).

H_{01}: There are no statistically significant differences between academic performance (measured by course aggregate points including homework, projects, papers, and examinations) of treatment group students who used TMIS and control group students who receive traditional instruction.

H_{A1}: Treatment group students with access to TMIS have significantly higher levels of academic performance (measured by course aggregate points including homework, projects, papers, and examinations) than control group students taught with traditional methods.

<u>Question 2: In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on proclivity to be self-directed as measured by the SDLRS instrument?</u>

Research Question Two examined the effect of TMIS on proclivity to be self-directed, as measured by the SDLRS instrument. The literature shows that external factors can positively affect SDL. However, prior research (Preczewski, 1999) found that the undergraduate experience fails to positively affect SDL at a military academy. Further research verified that cadets do not spend their free time pursuing outside learning activities (<u>Cadet Time Survey Results,</u> 1998). The present research study used the SDLRS in a more controlled environment than has characteristically been used. The SDLRS measures psychological constructs of SDL and is said to measure "readiness" for self-directed learning. Differences in proclivity to be self-directed (readiness for self-directed learning) were measured for those cadets who received traditional instruction (control) versus those who received traditional instruction *and* supplementary TMIS (treatment). With the intention of having approximately 100 control group and 100 treatment group students complete the SDLRS (to ensure sufficient sample size), 106 were randomly selected in each category and asked to complete the SDLRS. Some cadets were resigned from the academy before the end of the semester or did not complete the posttest, yielding 91 control and 104 treatment group students. The SDLRS was administered near the beginning and, again, at the end of the semester, providing a pretest/ posttest measure. Change in the mean pretest and posttest SDLRS scores were measured for those who received traditional instruction (control) versus those who received traditional instruction *and* supplementary TMIS (treatment).

H_{02}: There are no statistically significant differences between the change in mean pretest and posttest SDLRS score of treatment students with access to TMIS versus the change in mean pretest and posttest SDLRS score of control group students taught by traditional methods.

H_{A2}: The change in the mean pretest and posttest SDLRS score of treatment students with access to TMIS is significantly higher than the change in the mean pretest and posttest score of control group students taught by traditional methods.

<u>Question 3: In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on learner motivation as measured by Keller's ARCS instruments (CIS and IMMS)?</u>

Research Question Three examined the effect of TMIS on learner motivation (measured by the CIS and IMMS and their attention, relevance, confidence, and satisfaction subscores). TMIS were developed from performance objectives and delivered via email with links to instructional content on various technologies including PDA, web, CD-ROM, and streamed video. In order to gain a deeper understanding of the effectiveness of TMIS, the IMMS was administered to all participants. Control group participants gave their perceptions of instructional materials related to specific lesson objectives. Treatment group participants gave their perceptions of instructional materials *and* associated supplementary strategies related to specific lesson objectives. All students were asked to complete the CIS to assess their motivation as it related to their course. There were separate analyses of mean vector scores for the IMMS (including its ARCS subscores) and the CIS (including its ARCS subscores). Differences in motivation were measured for those who received traditional instruction (control) versus those who received traditional instruction *and* supplementary TMIS (experimental).

H_{03}: There are no statistically significant differences in mean vector scores of CIS and IMMS for students who use TMIS (treatment) versus students who do not use TMIS (control).

H_{A3}: Treatment group students with access to TMIS have significantly higher mean vector scores for CIS and IMMS than control group students taught by traditional methods.

Assumptions

1. The SDLRS is a reliable and valid instrument for measuring self-directed learning readiness among adult learners (see Guglielmino, 1978, 2002; Guglielmino & Guglielmino, 2001).
2. The IMMS is a reliable and valid instrument for measuring the situational context of motivation related to instructional materials (see Keller, 1993).
3. The CIS is a reliable and valid instrument for measuring the situational context of students' motivation to learn specific to a course (see Keller & Subhiyah, 1993).
4. All of the instruments in this study require students to self-report, and it is assumed that they did so honestly and accurately with regard to their motivation, participation, and self-directed learning, especially because this population of students abides by an honor code.

Chapter Summary

In summary, a review of the existing literature revealed much discussion of the importance of motivation, but little empirical research that examines motivation in technology-mediated learning environments. Specifically, there are three gaps in the literature that are addressed in this study: (1) the situational context of learning; (2) the social context of learning including the motivational needs of learners, and; (3) the systematic design and development of interventions to attempt to improve motivation, performance, and SDL.

Further, the field has historically presented many correlational, descriptive, and opinion papers, but there is little empirical data on both motivation and technology-mediated learning, and there is an absence of experimental research. The use of interventions, as investigated in this research study, presents an attempt to advance the body of literature in the fields of adult learning and instructional systems.

CHAPTER III

METHOD

Subjects

The subjects in this study were undergraduate students enrolled in a tuition-free, federally funded military school in the northeast United States. A random selection of 784 students, representing approximately 20% of the population at the academy, participated in the study. The selected courses enrolled primarily freshmen and juniors. The courses were undergraduate level classes taught during one semester in spring 2002 that were diverse in content (i.e. hard sciences vs. humanities). The diverse range of subject matter was deliberate and served to address the situational aspects of motivation.

Twelve courses were selected for treatment and control, in a balanced design where each instructor had randomly assigned treatment and control sections. Instructors were not informed of which sections were treatment and which were control. Further, the analysis controlled for instructor and course to minimize the potential confounding effects of such variables. The design is represented in Table 3-1.

Research Design

This design experiment employed a mixed method approach involving quantitative and qualitative components. Four surveys were used to measure motivation and self-directed learning: (1) the Course Interest Survey (CIS) developed by Keller; (2) the Instructional Materials Motivation Survey (IMMS) developed by Keller; (3) the Self-Directed Learning Readiness Scale (SDLRS) developed by Guglielmino, and; (4) the Self-Directed Learning (SDL) survey developed for this study to track experimental group students' participation and perceptions of the strategies.

Table 3-1: Summary of Research Design

Course	Instructor	Section	# of Students	Treatment
PL100	Instructor 1	Sec. 1	17	TE
		Sec. 2	17	Control
		Sec. 3	18	TE
		Sec. 4	16	Control
PL300	Instructor 2	Sec. 1	14	TE
		Sec. 2	17	Control
		Sec. 3	17	Control
		Sec. 4	17	TE
CH101A	Instructor 3	Sec. 1	9	TE
		Sec. 2	8	Control
CH102	Instructor 4	Sec. 1	16	TE
		Sec. 2	16	Control
		Sec. 3	17	Control
	Instructor 5	Sec. 4	16	TE
		Sec. 5	16	Control
	Instructor 6	Sec. 6	16	Control
		Sec. 7	16	TE
CH384	Instructor 7	Sec. 1	8	Control
		Sec. 2	10	TE
	Instructor 8	Sec. 3	11	TE
		Sec. 4	10	Control
CS105	Instructor 9	Sec. 1	18	Control
		Sec. 2	17	Control
		Sec. 3	18	TE

Table 3-1 continued

PE210	Instructor 10	Sec. 1	16	Control
		Sec. 2	16	Control
		Sec. 3	18	TE
		Sec. 4	16	TE
HI302	Instructor 11	Sec. 1	16	TE
		Sec. 2	16	Control
		Sec. 3	16	Control
		Sec. 4	14	TE
MA104	Instructor 12	Sec. 1	17	Control
		Sec. 2	14	TE
		Sec. 3	17	TE
EN 102	Instructor 13	Sec. 1	16	Control
		Sec. 2	15	Control
		Sec. 3	17	TE
		Sec. 4	14	TE
	Instructor 14	Sec. 5	16	TE
		Sec. 6	15	TE
		Sec. 7	16	Control
		Sec. 8	15	Control
EN 302	Instructor 15	Sec. 1	14	TE
		Sec. 2	13	Control
		Sec. 3	15	Control
		Sec. 4	12	TE
	Instructor 16	Sec. 5	12	TE
		Sec. 6	15	TE
		Sec. 7	13	Control

The CIS, IMMS, and SDLRS were converted to web-based format and made available along with the SDL survey on the campus intranet. For all students in the study, academic performance (measured by course aggregate points including homework, projects, papers, and examinations) was tracked throughout the semester. The design in standard notation is depicted in Table 3-2.

Table 3-2: Research Design in Standard Notation

Control	R	O_{1A}	I	O_{2A} O_{2B} O_{2C}
Treatment	R	O_{1A}	I + X	O_{2A} O_{2B} O_{2C}

In a double blind design, students were not informed of whether they would be in the control or treatment group, nor were instructors informed of whether their sections were control or treatment. Both groups received email messages from the researcher. Control group students received traditional classroom-based instruction. Treatment group students received traditional classroom-based instruction *and* supplementary TMIS. Both groups completed the SDLRS, IMMS, and CIS in order to provide measures for comparison.

Materials

This study examined the effects of TMIS on motivation, performance, and self-directed learning. The design experiment approach of this study is that suggested by Brown (1992) and Collins (1992) to blend the rigor of experimental research design with the practicality of classroom-based research and formative evaluation of learning technologies (McCandliss, Kalchman, & Bryant, 2003). The developmental component is suggested by Richey and Nelson (1996). Four surveys were used to measure motivation and self-directed learning: (1) the Course Interest Survey (CIS) developed by Keller; (2) the Instructional Materials Motivation Survey (IMMS) developed by Keller; (3) the Self-Directed Learning Readiness Scale (SDLRS) developed by Guglielmino, and; (4) the Self-Directed Learning (SDL) survey. See Table 3-3 for a summary of materials.

Table 3-3: Summary of Materials

	Motivation for Instructional Materials	Motivation for Course	Readiness for Self-Directed Learning	Usage of TMIS, Self-Directed Learning
Instrument	IMMS	CIS	SDLRS	SDL
Type of Data Gathered	Quantitative (36 Likert Scale Responses)	Quantitative (34 Likert Scale Responses)	Quantitative (58 Likert Scale Responses)	Quantitative and Qualitative
Type of Scores Produced	Total Score plus 4 subscores for A,R,C,S factors	Total Score plus 4 subscores for A,R,C,S factors	Total Score including 8 SDL factors	Single item indicators

The Self-Directed Learning Readiness Scale

The present study used the Self-Directed Learning Readiness Scale (SDLRS) developed by Guglielmino. The development of the instrument is detailed in Guglielmino (1978). Long and his colleagues (2000) assert that the SDLRS is considered the instrument of choice in the field. Indeed, in ten years of research on SDL, sixty percent used the SDLRS (Stockdale et al., 2002). The SDLRS has been used in over 500 studies and it has been translated into 14 different languages (Guglielmino, 2002). The instrument has been validated with a variety of populations, predominantly with undergraduate students. Delahaye and Sarojni, in *The Handbook of Psychological Tests* (2000), examined volumes of literature that used the SDLRS, including some papers that criticized the instrument. They concluded that the SDLRS has sufficient reliability and validity to ensure that researchers can have confidence in its accuracy.

Reliability and Validity

The SDLRS was called the Learning Preference Assessment (LPA) to help prevent subject bias. Guglielmino (2002) states that prior studies have used the name LPA for this reason. Reliability testing on the SDLRS was conducted with a representative sample of the population (N=223), resulting in a total score reliability for the SDLRS of .86.

SDLRS Translation to Web-based Format

The SDLRS was converted to web-based format at least once prior to the conversion for this research study. Rodriguez (2002) researched issues with web-based instrumentation before designing his online version of the SDLRS. He found no significant differences in scores between undergraduates who were administered the traditional version of the SDLRS instrument and those who were given the online version.

The Course Interest Survey (CIS)

The present study used the Course Interest Survey (CIS), developed by Keller, to measure situational components of the ARCS model for learner interest in a particular course. The development of the CIS is detailed in Keller & Subhiyah (1993).

Reliability and Validity

Prior reliability testing of the CIS instrument using Cronbach's alpha measure resulted in all 5 components (Attention, Relevance, Confidence, and Satisfaction subscores and ARCS total score) greater than .80.

CIS Translation to Web-based Format

The CIS was translated to web-based format and made available on the campus intranet. After converting the CIS to web-based format, a representative sample of the population (N=264) completed the survey. The ARCS total score reliability was .81.

The Instructional Materials Motivation Survey (IMMS)

The present study used the Instructional Materials Motivation Survey (IMMS), developed by Keller to measure the situational components of learner motivation with regard to specific instructional materials. The development of the IMMS is detailed in Keller (1993).

Reliability and Validity

Prior reliability testing of the IMMS instrument using Cronbach's alpha measure resulted in all 5 components (Attention, Relevance, Confidence, and Satisfaction subscores and ARCS total score) greater than .81.

IMMS Translation to Web-based Format

The IMMS was translated to web-based format and made available on the campus intranet. After converting the IMMS to web-based format, an inter-item reliability was conducted with a representative sample (N=301) of the population. The total score reliability was .84.

The Self-Directed Learning Survey

The present study tracked participation and student perceptions of TMIS with the Self-Directed Learning survey. To help prevent subject bias, the SDL survey was called the post-strategy questionnaire. The survey consisted of five questions to track usage of TMIS, time on task, and perceptions of how beneficial and motivating the TMIS were. It included one open-ended question to obtain more in-depth feedback on student perceptions of the TMIS.

Variables

Independent Variables

The independent variables for this study are:

1. Course;
2. Instructor (a nested variable within course), and;
3. Treatment- Access to Technology-Mediated Instructional Strategies (measured by the SDL survey).

The rationale of controlling for instructor and course was to minimize the potential confounding effects of such variables. Each instructor taught between two and four sections of the same course, and the sections were randomly divided into control and treatment. There were 12 courses and 16 instructors.

Participation in the study was voluntary. Treatment group students self-reported on the SDL survey as to whether they accessed the interventions. Thus, there are two separate levels of the independent variable of usage of TMIS: (1) no access to TMIS (control), and; (2) access to TMIS (treatment).

Dependent Variables

The dependent variables are:

1. Academic Performance (measured by course aggregate points including projects, homework, quizzes, participation, and examinations);

2. Proclivity for Self-Directed Learning (measured by the SDLRS), and;
3. Motivation (measured by the CIS and IMMS instruments).

Procedure

The researcher met with academy department heads and course directors for input about the most appropriate courses to include. Course directors and department administrators selected instructors who reflected the diversity of all faculty including civilians and military officers. The researcher emailed all selected instructors to share information on their role in the study and request all course instructional materials so TMIS could be developed. A project website was developed to keep instructors informed. See Table 3-4 for a summary of the subsequent procedures and timeline.

Table 3-4: Summary of Procedures and Timeline

	Control	Treatment
1. Visit classrooms in beginning of semester.	All	All
2. Email participants to thank them for participation.	All	All
3. Administer SDLRS pretest 2 weeks into study.	106 randomly selected	106 randomly selected
4. Administer CIS 4 weeks into semester.	All	All
5. Distribute TMIS a maximum of 6 times during semester.		All
6. Administer IMMS 2-4 times throughout semester.	All	All
7. Administer SDLRS posttest 2 weeks from end of semester to same students who took the pretest.	106 randomly selected	106 randomly selected
8. Collect performance data throughout semester.	All	All

After communicating with instructors, the researcher visited all 48 classrooms to discuss the study and obtain signed informed consent forms. To prevent subject bias, the word “self-directed learning” was not used. A mock script was provided to instructors to ensure that students received the same information (see Appendix B). Instructors encouraged participation by assuring students that the strategies would be brief, pre-approved by instructors, and designed to help them master course objectives. Students were assured that their participation was voluntary and confidential. All participating students signed informed consent forms (see Appendix C) before the study began. Sixty-one students, or 7 percent of those asked, chose not to participate in the study and were therefore excluded from analyses.

An email message was sent to all participants thanking them for their participation. The SDLRS instrument was converted to web-based format and made available on the campus intranet. The SDLRS was called the Learning Preference Assessment to prevent subject bias. In the beginning of the semester, a random sample of 106 treatment group and 106 control group subjects received an email message directing them to complete the SDLRS. The rationale for limiting the number of students was the cost of the instrument. In the last two weeks of the semester, the same selected participants were asked to complete the SDLRS, providing a pretest/ posttest measure. It was assumed that four months between the tests was a sufficient interval to prevent test-retest issues. Some cadets were resigned from the academy before the end of the semester or did not complete the posttest, yielding 91 control and 104 treatment group students.

Treatment group students received TMIS via email (for examples, see Appendix E). Each TMIS included motivational messages, a link to supplementary instructional content, and a link to the SDL survey. The SDL survey tracked participation and time on task, as well as open-ended questions for feedback about the TMIS. Control group participants did not complete the SDL survey since they did not receive the strategies.

Control and treatment group participants completed the online IMMS and CIS to quantify situational measures of motivation. The CIS was administered to all participants in the first two weeks of the study to measure their interest in each course. Email messages were sent to control group participants asking them to consider instructional materials related to specific course objectives to complete the IMMS. Email messages were sent to treatment group participants asking them to complete the IMMS to give their perceptions of the same instructional materials *and* associated TMIS.

Academic performance was measured for all participants by course aggregate points (examination, homework, projects, and other grades), except for EN302 students who were graded with pass/fail.

Design of Technology-Mediated Instructional Strategies

In the beginning of the semester, Keller's ARCS model was used to conduct a motivational analysis of the population. See Table 3-5 for a summary of the analysis. Based on the analysis, technology-mediated instructional strategies were developed.

Each TMIS consisted of three basic components (see Figure 3-1): (1) motivational messages at the beginning and end of each strategy; (2) supplementary instructional content, and; (3) the SDL survey to track participation and perceptions.

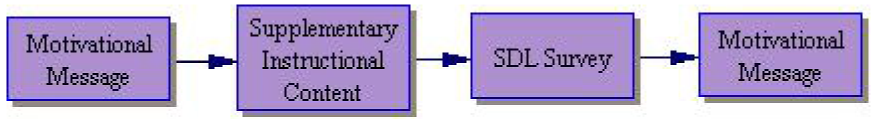

Figure 3-1: Systematic Design of Technology-Mediated Instructional Strategies

Motivational Messages

The Motivational Messages Support System (MMSS), developed by L. Visser (1998) and discussed earlier, served as a foundation for all TMIS. The key difference between the MMSS and the TMIS, aside from the use of technology, was the addition of instructional content. Also, the SDL survey was added to help monitor student access and perceptions of the TMIS. Each motivational message was delivered via email, incorporating components of the ARCS model and directing students to access content-specific strategies intended to help them improve learning. See Figure 3-3 for an example of a motivational message that is annotated with ARCS components.

Supplementary Instructional Content

J. Visser (Visser & Keller, 1990) used strategies designed with Keller's ARCS model to motivate students to undertake self-directed learning activities outside the classroom. Visser stated (1990, p. 18), "The *clinical use of motivational messages* is a strategy which consists of the use of messages, designed by well defined means, such that their content has a desirable effect on the learner's disposition to engage in learning tasks." This approach was emulated in the design of TMIS, encouraging students to access supplementary instructional content outside the classroom.

Each TMIS provided a link to course-specific supplementary instructional content, including opportunities for self-assessment, threaded discussions, and skill briefs (see Table 3-5). Skill briefs are PDA-based content that enable learners to conveniently access instructional materials. ARCS components were integrated into the design of each chunk of instructional content, ensuring that the materials gained and sustained the attention of learners, that they were relevant, and that they offered opportunities for self-assessment and feedback to ensure learner confidence and satisfaction.

Most of the strategies were interactive instructional content provided for PDAs, on the Internet or academy intranet, or on CD-ROM. The TMIS included chunks of instruction, streamed video, threaded discussions, and self-assessment opportunities with immediate feedback. All technology-based content was provided in at least two formats (i.e. PDA and web) to ensure accessibility.

Table 3-5: Examples of ARCS Components Related to Instructional Content

Instructional Content	Technology	ARCS Components
Instructional Resources	Web, streamed video, PDA	A, R, C, S
Self-Assessment	Intranet	C
Skill Briefs	PDA	A, R
Social Interaction	Threaded Discussion, IRC, Email	R, C, S
Mentor Support	Email	C

In order to respect student time constraints, the TMIS were delivered no more than six times per course (see Table 3-6). The delivery of TMIS was planned:

1. In conjunction with times in the semester known to be motivational "low points," such as after major examinations or stressful events (see Figure 3-4);
2. Following the in-class discussion of complex concepts where students seemed confused or frustrated (see Figure 3-5);
3. In times known to the instructor when students tend to struggle with concepts required to master performance objectives (see Appendix E);
4. In times when the topics discussed in class provided thoughtful consideration of and reflection on their connection to the "real world" (see Appendix E);
5. To avoid times when student schedules were already saturated, such as before midterm examinations, and;
6. In response to feedback on the SDL survey or interactions with cadets.

Table 3-6: Examples of Technology, Instructional Design, Delivery and Timing of TMIS

Technology	Design	Delivery	Prompt
PDA	New Content	Email	- Planned with motivational "low points"
Web	New Content		- Instructor or Cadet Concern
CD-ROM	Existing Content		- Planned with Course Objectives - Cadet Responses on TMIS

Figure 3-2 presents an example of a portion of a TMIS provided for PE210, Introduction to Wellness. ARCS components are seen throughout the design. The end of the content (not shown) supplies additional information intended to help students master course objectives and relates to cadets in their everyday lives. The example shows supplementary instructional content that was developed specifically for this study. However, whenever appropriate, existing instructional content was used. For example, a chemistry CD-ROM contained an interactive module on nomenclature that was ideal for CH101A. In this case, the motivational messages were still customized, and the messages related the instructional content to their course (see Appendix E). Of the 58 TMIS designed for this study, 46 included original instructional content, primarily for the PDA.

Figure 3-2: Example of Instructional Content Portion of TMIS

Student feedback allowed the instructional designer to use formative evaluation to improve the TMIS and document the changes throughout the process (see Figure 3-3). Customary of design experiments, the interventions are replicable beyond this study. The instructional content is specific to a course, though the TMIS can be re-used and modified as needed in subsequent semesters. The modifications are facilitated with the use of technology.

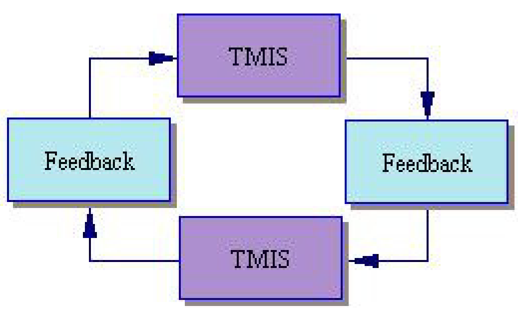

Figure 3-3: Formative Evaluation in TMIS Design Experiment

Hello again EN 102 Cadets,

Congratulations to all of you who participated in or supported the rigorous Sandhurst competition over the weekend! I also hope you did great on your last WPR. Thanks to all of you who have responded to the strategies so far (again, if you haven't, it's never too late). Most of you said you found the last strategy helpful, but as expected, some of you said you had too many other obligations to spend much time with the strategy. Based on your input, we are working to improve the strategies to try to make them as beneficial to learning the course material as possible.

You have been working on the challenging assignment of using your West Point experiences to produce a video that draws from *the Odyssey*. While not directly related to your video production, Strategy 6 should help you with your upcoming writing assignments, including HWE5. The strategy is provided in both web-based and PDA-based formats. Please give us your honest opinion on this supplementary material no later than COB 8 May. *Remember that even if you choose not to access the strategy, you should complete the brief questionnaire.* We would also strongly encourage you to provide your comments in the additional space provided on the web-based questionnaire.

1. Access **Strategy 6**: <> which is a study guide for the writing process. If you would like to add the web site to your PDA, click here to automatically add it to your existing AvantGo channels <>. Hint: when using your PDA on pages with lots of text, use the search function to quickly find what you need. Next, visit <> which is a study guide about writing correctly. To add the site to your PDA, click here to add it to your existing AvantGo account: <>.

2. Complete the brief online questionnaire: <> and please provide comments to give us the most beneficial feedback.

Thanks...and don't hesitate to contact me or CPT Corbett if you have any questions or if you need any assistance. Good luck on your HWE5!

Take care,

Donna Gabrielle

Attention- Provide innovation in the supplementary instruction and offer mentor assistance.

Relevance - Address messages to students in their own language.

Relevance - Connect feedback to learner's daily circumstances, and to their future lives as soldiers.

Satisfaction- Reassure learners by showing personal interest, thanking them for their opinions, and assuring them that their feedback matters.

Relevance- Connect what learners have been working on to what they need to know for their next assignments.

Confidence- Provide alternate forms of instructional content- both PDA and web- to ensure accessibility

Satisfaction- Provide prompt and meaningful feedback. Ensure that motivational mentor is accessible.

Relevance- Use the name of their instructor and reiterate that you are working together to help them master the objectives.

Relevance- Use acronyms and military terms they are used to hearing. HWE5 means homework assignment number 5.

Figure 3-4: Example of Motivational Message Portion of TMIS

Hello again CH101A Cadets,

I hope you are doing great! Thanks for your feedback on the last strategy (and for those of you who haven't accessed it yet, it's not too late). All of you who completed the questionnaire said you thought Strategy 3 was extremely helpful to learning the course material. I appreciate your feedback and again, you can always revisit the strategies at your convenience. Please give your input whenever you are able. Now it is time to focus on the next strategy. After you have accessed the material, you'll complete a quick online survey about the strategy. The entire process should take you no more than 10-15 minutes per week (though you are welcome to spend more time on it if you would like), and hopefully you will find the strategies helpful to learning the course material.

You have been working in a block focused on states of matter, and your current lesson is focused on the liquid state and intermolecular forces of attraction. In order to assess the IMF, you will need to recall how to do Lewis Dot Structures and how to determine Electron Pair Geometry, Molecular Shape, and Polarity. These are all skills that you learned earlier in the semester that will be critical for you to review. You covered this in class today, but many of you may feel confused or overwhelmed with the amount of information you'll need to know, especially for your upcoming quiz, but also for the TEE.

This next strategy is intended to help you recall what you've been learning as well as give you a foundation for your upcoming quiz and future lessons. It is highly interactive and has 3-dimensional aspects, so you'll need to download a plug-in to run the programs. Please give us your honest opinion on this supplementary material no later than COB 29 April. *Remember that even if you choose not to access the strategy, you should complete the brief questionnaire.* We also strongly encourage you to provide your comments in the additional space provided on the web-based questionnaire.

1. Download Authorware Player for Internet Explorer (then be sure to use Internet Explorer to run the tutorials): <>

2. Access **Strategy 4**: <> which is on Lewis Dot structures and molecule shapes The strategy will give you immediate feedback to help you learn.

3. Complete the brief online questionnaire: <> and please be sure to provide comments for the best possible feedback.

Thanks...and don't hesitate to contact me or MAJ Bozic if you have any questions. ***Good luck with your continued preparation for your TEEs, and with your upcoming quiz!***

Take care,

Donna Gabrielle

Attention- Provide innovation in the supplementary instruction and offer mentor assistance.

Relevance - Address messages to students in their own language.

Confidence - Reassure learners by showing personal interest and thanking them for their opinions.

Satisfaction- Refer to positive feelings learner will have when TMIS help them master objectives.

Confidence- Address confusion in the classroom and seek to offer opportunities to help them master complex concepts through TMIS.

Relevance- Connect what learners have been working on to what they need to know to master course objectives.

Satisfaction- Design TMIS with opportunities for immediate feedback.

Relevance- Use the name of their instructor and reiterate that you are working together to help them master the objectives.

Relevance- Use acronyms and military terms they are used to hearing. TEE means term end examination.

Figure 3-5: Example 2 of Motivational Message Portion of TMIS

Steps in TMIS Design

Keller's ARCS model of motivational design includes a ten-step procedure for instructional designers to develop motivational systems. The procedure (see Figure 3-6) was used for the design and development of TMIS in the present study and includes the following steps:

1. Obtain course information
2. Obtain audience information
3. Analyze audience
4. Analyze existing materials
5. List objectives and assessments
6. List potential tactics
7. Select and design tactics
8. Integrate with instruction
9. Select and develop materials
10. Evaluate and revise.

L. Visser's development of MMSS was adapted for this study (see Table 3-7). The steps in TMIS design, intended to improve motivation, performance, and SDL, are:

1. Obtain course information. The instructional designer works closely with the instructor throughout the process and examines all instructional materials including textbooks, lesson plans, projects, homework assignments, and examinations.
2. Obtain audience information. This includes identifying learner attitudes toward technology-mediated learning and attitudes toward courses.
3. Analyze audience. This includes asking instructors to identify performance objectives that students tend to have difficulty mastering, as well as any motivational concerns.
4. Analyze existing materials. Identify positive aspects and deficiencies of existing instructional materials. This requires the assistance of content experts and instructors, as well as feedback from learners when possible.
5. List objectives and assessments. This includes developing motivational design goals and identifying learner characteristics.
6. List potential tactics. Brainstorm ideas for TMIS to be delivered at various points in the semester related to course objectives and lesson plans.

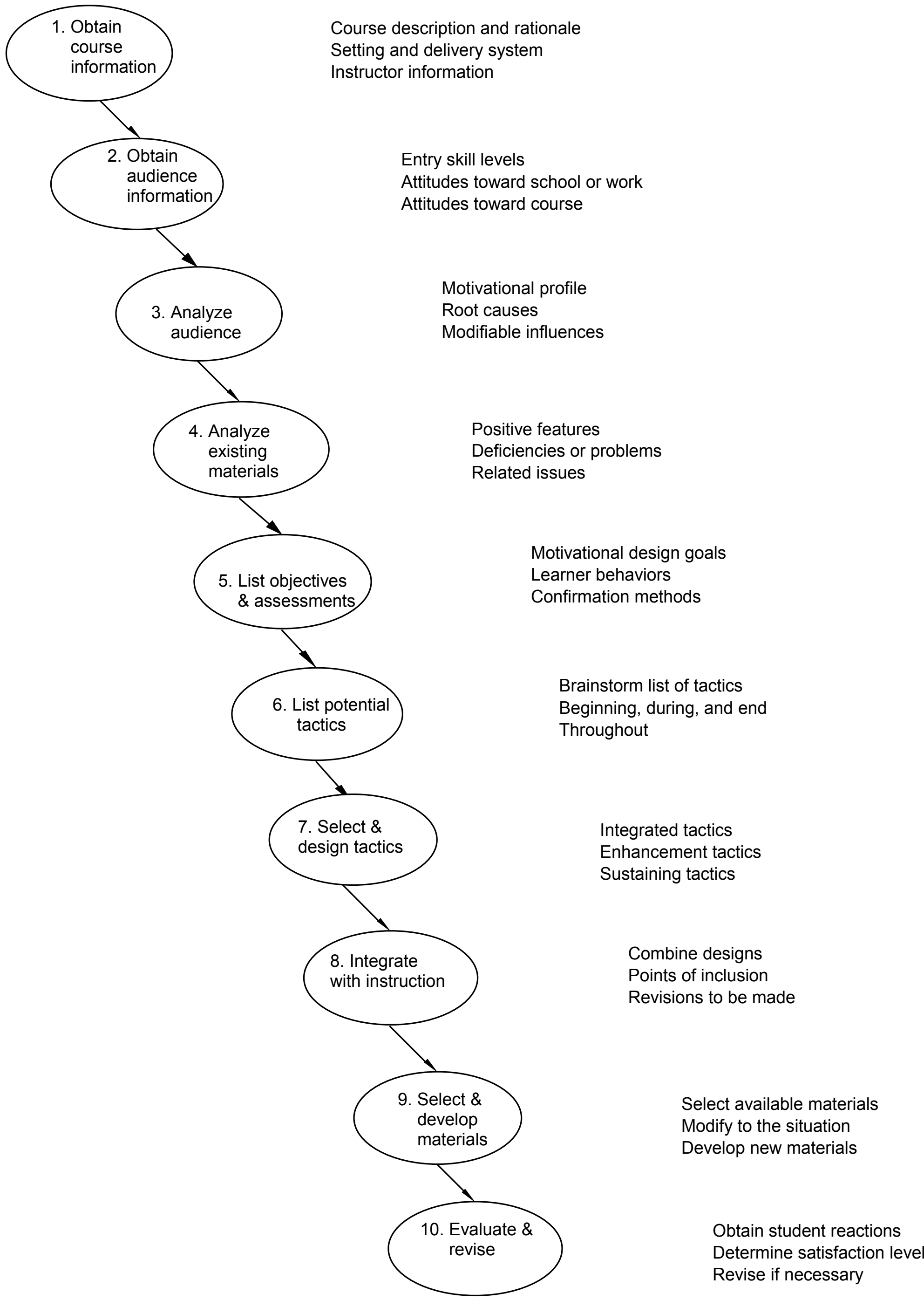

Figure 3-6: Steps in Motivational Design (Keller, 1999a)

7. Select and design tactics. Tactics and strategies are designed using Keller's ARCS model of motivation. Each strategy is chunked in 10-15 minute segments of course content; allowing students to self-direct at their own pace and help them master specific performance objectives. It is also important to respect the time constraints of this highly structured environment; therefore, no more than one strategy every two to three weeks is recommended. This is consistent with L. Visser's study which delivered approximately one strategy per month.
8. Integrate with instruction. This step is essential with TMIS to ensure that all tactics and strategies are directly related to classroom-based instruction.
9. Select and develop materials. Gagné, Briggs, and Wager (1988) note that instructional designers should select media based on its ability to support the learning process. Reiser and Gagné (1983) present a model for media selection (see Figure 3-7) that was modified to assist in the selection of appropriate technologies for this study. These technologies include PDAs, streamed video, CD-ROM, and the Web. Each strategy that uses new technologies should provide a redundant method of delivering content to ensure accessibility. Particular attention should be paid to feedback on the SDL survey and email regarding any technical difficulties encountered. It is also necessary to respond promptly and assist students to overcome any technical issues.
10. Evaluate and revise. TMIS are developed and improved through formative evaluation, using student feedback from each strategy to improve each subsequent strategy (see Figure 3-3). The process is ongoing to ensure continuous improvement. All changes should be well documented.

Data Analysis

After consideration of a preset level of alpha (.01), power (.90), effect size of .25σ (Cohen moderate), a minimally adequate sample size was determined to be 100 per group.

1284 entries on the SDL survey were analyzed to determine the effects of TMIS on motivation, performance, and self-directed learning. Table 3-9 summarizes the hypotheses, instruments, variables, and statistical tests for this study. Data were analyzed with SPSS and SAS software.

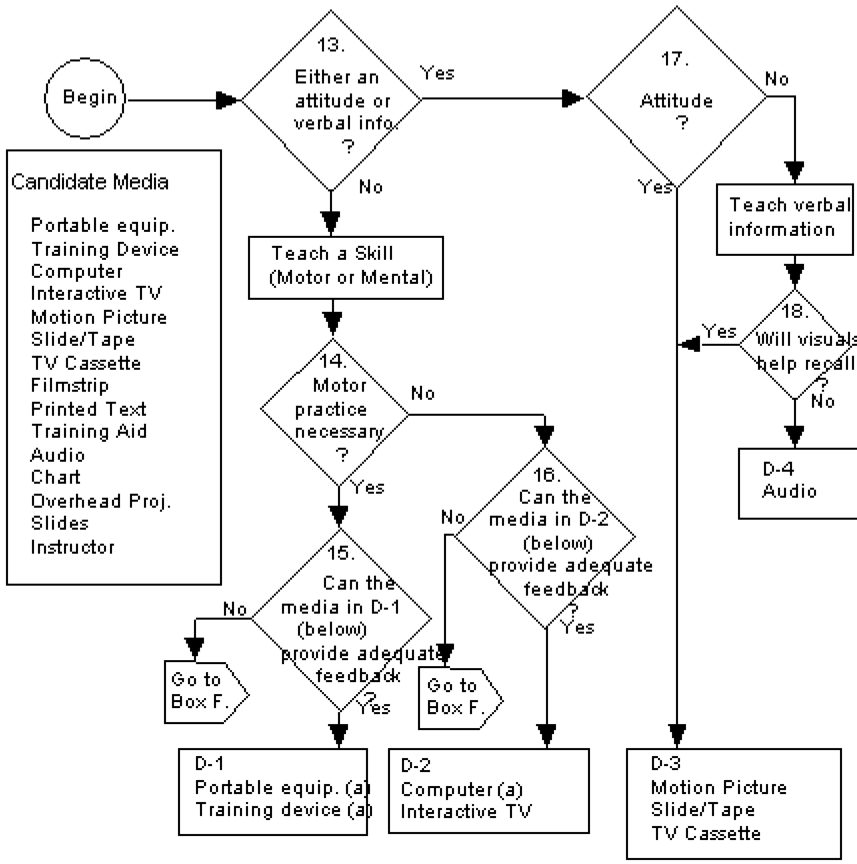

Figure 3-7: Portion of Flowchart for Media Selection (Reiser & Gagné, 1983)

As stated earlier, there are two levels of the independent variable of access to TMIS: (1) no access to TMIS (control), and; (2) access to TMIS (treatment). Table 3-8 summarizes which data were collected from the control and treatment categories of learners.

Data were presented in cells, which are a combination of instructor and course. Due to instructor differences, an interactive model was used that includes the treatment variable and the interaction effect of the instructor as a second variable. An interactive one-way ANOVA model was used to test for the interactive effect between instructor and treatment. Given a significant test for this interaction effect, the interactive model was retained for the test of the treatment.

Table 3-7: Adaptation of L. Visser's Design for the Development of TMIS (Keller, 1999a)

DESIGN FACTORS	Attention	Relevance	Confidence	Satisfaction
Pre-course attitudes of students toward technology-mediated learning	Most students are strong at first (new materials/ new topic). Higher levels of attention for repeaters due to the prospect of being resigned from the academy.	Relevance is critical with this population. May improve as learners apply what they have learned, or decrease if not what was expected.	A concern as the mode of instruction is not familiar. Generally satisfactory for students experienced with new technologies. There is little existing support.	Successful completion of the course is a required step in the completion of a degree.
Midterm attitudes toward technology-mediated learning	Initially high attention and curiosity wear off as time conflicts divert attention.	Lack of relevance causes frustration. Any outside learning opportunities must be linked to classroom-based learning.	Little motivational support included in course. Low level of confidence for newcomers to the academy (freshmen).	Good, but most students are overwhelmed with time constraints and structure.
Student reactions to this course content	Initially high, but decreases due to lack of novelty and variation in content and learning strategies.	Course content is relevant, but too little interactivity to help students learn how to apply it.	Confidence to achieve fades due to volume of work, structure, and lack of opportunity to see application.	Remains fairly positive for most cadets.
Characteristics of student support during the course	Very strong support from instructors, but little peer interaction or feedback regarding assignments. Little innovation in learning opportunities.	Feedback is usually limited strictly to course content. No creative feedback to show connections to students.	Feedback is mostly worded in a positive way, but often too general due to time constraints of instructors.	Positive because of meaningful contact with instructors, small class sizes, and opportunities for individual attention.
Summary	Initial attention soon declines, especially due to conflicting obligations for cadet time. This area needs extensive motivational treatment.	Relevance is critical throughout the course and becomes more important as cadets prepare to leave the academy (seniors).	Confidence depends in the most part on grades, but it is generally good. Low points are that students often feel that their opinions don't matter.	Satisfaction is not a major issue, and will remain so if the other issues are addressed.
Examples of motivational tactics to be used in TMIS	Provide innovation in the supplementary instruction and offer mentor assistance. Use cadet's name and include personal comments in feedback messages. Provide unexpected communication to students from time to time.	Provide manageable chunks of content such as PDA-based study aides. Use acronyms and military terms they are used to hearing. Connect feedback to learner's daily circumstances, and to their future lives as soldiers.	Reassure learners by showing personal interest and thanking them for their opinions. Make them feel part of a group who are all struggling to get it done. Show empathy. Provide encouragement and personal challenges at times that are known to be "low points" such as during WPRs (exams).	Provide prompt and meaningful feedback. Ensure that mentor is accessible. Refer to positive feelings learner will have when TMIS help them master objectives. Help them see application of the learning beyond their course.

Table 3-8: Summary of Data Collection of Study Participants

	TMIS	CIS	IMMS	SDLRS 1	SDLRS 2	Grades
Group 1 (control)		X	X	106 randomly selected	106 randomly selected	X
Group 2 (treatment)	X	X	X	106 randomly selected	106 randomly selected	X

A separate resampling test was used to analyze student data in the one pass/fail course. This course was EN302, where students had up to three opportunities to pass the West Point Professional Writing Examination (WPPWE). To analyze the WPPWE data, a resampling method using the parametric bootstrap was employed. The process of generated bootstrap samples, and calculating their associated test statistic, was repeated a large number of times (i.e., N=10,000), thus yielding an approximate distribution for the test statistic and an approximate p-value for the original data's test statistic value.

To address the hypothesis of the effect of TMIS interventions on proclivity to be self-directed, the SDLRS data were collected in a pretest/ posttest measure from a random sample of 91 control and 104 experimental group participants (the original number was 106 for control and treatment, but due to dropout and not completing the posttest, the numbers declined). Change in the mean pretest and posttest SDLRS score was measured for control and treatment group students. To test the hypothesis for Research Question Two, a Two Independent Samples t-test was employed. This is a parametric test that looked at the change in pre/post difference in SDLRS scores between treatment and control groups. For comparison purposes, the nonparametric analog for this test, the Wilcoxon Rank Sum Test, was chosen.

To test the hypothesis of TMIS and motivation, data from the CIS and IMMS (and their attention, relevance, confidence, satisfaction subscores) provided situational measures of motivation. In order to gain a deeper understanding of the effectiveness of TMIS, the IMMS was administered to all participants. Control group participants gave their perceptions of instructional materials related to specific lesson objectives. Treatment group participants gave their perceptions of instructional materials *and* associated supplementary strategies related to specific lesson objectives. All students were asked to complete the CIS to assess their motivation as it related to their course. Mean vectors of CIS and IMMS scores, and their corresponding ARCS subscales, were compared. Hotelling's t-Squared Test (the multivariate counterpart of the Student's-t statistic) was conducted to examine the effect of TMIS on motivation. Separate analyses occurred for the CIS and the IMMS.

Table 3-9 summarizes the hypotheses, instruments, variables, and statistical tests used in this study.

Hypotheses, Instruments, and Statistical Analyses

Table 3-9: Summary of Hypotheses, Instruments, and Statistical Analyses in this Study

Hypotheses	SDL	SDLRS	IMMS	CIS	Variables	Stat Test
H_{A1}: Treatment group students who used TMIS have significantly higher levels of academic performance (measured by course aggregate points including homework, projects, papers, and examinations) than control group students taught by traditional methods.	Usage				IND= TMIS, instructor DEP= Academic Performance	ANOVA, Resampling for WPPWE examination (P/F)
H_{A2}: The change in the mean pretest and posttest SDLRS score of treatment students with access to TMIS is significantly higher than the change in the mean pretest and posttest score of control group students taught by traditional methods.	Usage	Total Score (pretest/ posttest)			IND= TMIS DEP= Δ SDLRS score	Two Independent Samples t-test, Wilcoxon Rank Sum test
H_{A3}: Treatment group students with access to TMIS have significantly higher mean vector scores for CIS and IMMS than control group students taught by traditional methods.	Usage		A,R,C,S, Total Score	A,R,C,S, Total Score	IND= TMIS DEP= CIS score, IMMS score	Hotelling's t-squared test, MANOVA

SDL = Post-Strategy Self Directed Learning; SDLRS = Self-Directed Learning Readiness Scale;
IMMS = Instructional Materials Motivation Survey; CIS = Course Interest Survey

CHAPTER IV

RESULTS

Introduction

The purpose of this design experiment was to positively affect motivation, performance, and self-directed learning of undergraduate students enrolled in a tuition-free, public military school. A second purpose was to use new technologies to efficiently deliver these instructional strategies as supplementary course content.

Three questions were examined to achieve these purposes:

1. In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on academic performance as measured by course aggregate points (projects, homework, and examination grades throughout the semester)?
2. In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on proclivity to be self-directed as measured by the SDLRS instrument?
3. In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on student motivation as measured by Keller's ARCS instruments (CIS and IMMS)?

Review of Research Methods Used

The within-subjects research design used a mixed method approach involving both quantitative and qualitative data. Four surveys were used to measure motivation and self-directed learning: (1) the Course Interest Survey (CIS) developed by Keller; (2) the Instructional Materials Motivation Survey (IMMS) developed by Keller; (3) the Self-Directed Learning Readiness Scale (SDLRS) developed by Guglielmino, and; 4) the Self-

Directed Learning (SDL) survey, developed by this author to track experimental group students' participation and perceptions of the instructional strategies.

Test of Assumptions

Due to instructor differences, an interactive one-way Analysis of Variance (ANOVA) was selected to conduct the analysis on the first part of Research Question One. The model has the following assumptions (Horowitz, 1974):

1. Random samples;
2. Homogeneity of Variance, and;
3. Normality.

To conduct the analysis on the second part of Research Question One, the parametric bootstrap was selected. The resampling procedure is similar to Fisher's Exact Test; however, only one set of marginals is fixed. It has the assumption of homogeneity of variance and that under the null hypothesis, the true proportion of those who pass and those who fail are equal and are derived from the data (Davison and Hinkley, 1997).

To test the hypothesis for Research Question Two, a Two Independent Samples t-test was employed. This is a parametric test that looked at the change in pre/post difference in SDLRS scores between the treatment and control group. For comparison purposes, the nonparametric analog for this test, the Wilcoxon Rank Sum Test, was chosen. This test, also called the Mann-Whitney U-test, has the following assumptions (Wilcoxon et al., 1963):

1. Two groups are to be compared;
2. The scale is at least ordinal, and;
3. The two populations are identically distributed.

The present study meets all of these criteria and is therefore a good choice for the Wilcoxon Rank Sum Test. With regard to the assumption of normality, the data for all three dependent variables was scrutinized and determined to conform to the unimodal and symmetric requirements of this distribution. Concerning the homogeneity of variance assumption, a Levene's Test was conducted and found to be non-significant, thus giving comfort with this required assumption.

To conduct the analysis on Research Question Three, multivariate analysis of variance (MANOVA) was selected. MANOVA has the following assumptions (Stevens, 2002):

1. Independence;
2. Homogeneity of Variance;
3. Normality;
4. Linearity and Collinearity, and;
5. Sensitivity to Outliers.

The homogeneity of variance assumption was likewise tested for this research question and found to be tenable except in the case of CISR. In this case, adjusted degrees of freedom were used for the Student's-t. Data were also examined for outliers. The elimination of these few outliers had no impact on the analysis due to the large sample size.

Demographic Summary

The subjects in this study were undergraduate students enrolled at the United States Military Academy, a tuition-free, federally funded military school in West Point, New York. This empirical study was conducted over the course of one semester with 784 cadets, representing approximately 20% of the population at the academy. The study included 659 males and 123 females (18.7%). 575 students were classified as Caucasian, 70 were African-American, 58 were Asian, 3 were Hispanic, 3 were American Indian, 11 were classified as other, and 10 were unknown. The cadets ranged in age from 18.5 to 26.5 years, with a median age of 19.8 years. The sample in the present study was representative of the population in all demographic areas.

Data Analysis

The results of this study will be discussed systematically beginning with Research Question One and concluding with Research Question Three. Each research question analyzed separate dependent variables with one independent variable of access to technology-mediated instructional strategies, and had a preset alpha of .01.

Question 1: In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on academic performance as measured by course aggregate points (projects, homework, and examination grades throughout the semester)?

Research Question One examined the effect of TMIS on academic performance. Differences in academic performance were measured for those cadets who received traditional instruction (control) versus those who received traditional instruction *and* supplementary TMIS (treatment). The following hypothesis was suggested:

H_1: Treatment group students who access TMIS have significantly higher levels of academic performance (measured by course aggregate points including homework, projects, papers, and examinations) than control group students taught with traditional methods.

To answer Research Question One, data were analyzed for the graded courses and separate analysis occurred for the one course that was pass/fail. To minimize any potential confounding effects, instructor data were analyzed. There was no significant interaction between course and groups (p=.92), but there was a significant instructor interaction (p= less than .0001). As a result, an interactive model was used that includes the treatment variable and the interaction effect of the instructor as a second variable.

For the first part of Research Question One, an interactive two-way ANOVA was used to determine the effect of the treatment on academic performance. The mean academic performance score for students in the control group (N=298) was 83.53, and the mean academic performance score for students in the treatment group (N=301) was 84.14. See Appendix G, Table A-1 for details of academic performance by instructor. While there were no statistically significant differences between treatment and control group academic performance (p=.30), there is evidence of a treatment effect which is of practical importance (not attributable to sampling error) given the difference between the observed mean difference of .78 and the standard error of the difference of .57. See Table 4-1 for details.

Table 4-1: Summary of Effect of TMIS on Academic Performance- Control vs. Treatment

	N	Mean Performance	df_n	df_d	SE_Δ	Power[3]	FC	F	p
Control	298	83.53	1	571	.57	.77	6.68	1.09	.30
Treatment	301	84.14							

Since participation was voluntary and cadets had the choice of whether or not to access the strategies, it was hypothesized that cadets who accessed the instructional content portion of the TMIS would benefit from them most. Access was measured by self-reporting on the SDL survey. Due to differences in sample sizes, a reduction in power was expected.

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[3] It should be noted that while power levels are being reported for all tests, they are most meaningful for non-significant results.

The initial ANOVA of the differences between the treatment (N=298) and control (N=301) group showed no significant differences between the treatment and control groups. However, within the treatment group there were subjects who did not access the strategies. A second ANOVA was conducted segmenting the strategies treatment group into two groups: those who accessed the strategies (N=165) and those who didn't access the strategies (N=138). The ANOVA conducted on these three groups showed a significant effect for group (F=5.18, p= less than .005). A t-test of the paired means (presented in Table 4-2) shows the group who access the strategies significantly outperformed both the control group and the treatment group who reported they did not access the strategies at the p= less than .05 level. Table 4-3 reports details of the model.

Table 4-2: T-test of Paired Means- Effect of TMIS on Academic Performance by Group

	Diff. Between Means	95% Confidence Limit		Error df	Error Mean Sq.	Critical t
Treatment w/ Access to TMIS vs. Control	1.610	0.3955	2.825***[4]	583	40.6377	1.96
Treatment w/ Access vs. Treatment w/o Access	2.214	0.7634	3.664 ***			
Treatment w/o access vs. Control	0.604	-0.692	1.899			

Table 4-3: Summary of ANOVA Model for Effect of TMIS on Academic Performance

	DF	SS	Mean Sq.		R^2	F	p
Model	41	7302.92	178.09		.244	4.39	<.0001
Total	557	22585.15	40.55				
Corrected Total	598	29887.07					

For the second part of Research Question One, analysis occurred for EN302, the pass/fail course where students had up to three opportunities to pass the West Point Professional Writing Examination (WPPWE). To analyze the WPPWE data, a resampling method using the parametric bootstrap was employed. The process of generated

[4] *** p= less than .05

bootstrap samples, and calculating their associated test statistic, was repeated many times (i.e., N=10,000), thus yielding an approximate distribution for the test statistic and an approximate p-value for the original data's test statistic value. Though no significant differences were found (p=.11), it is likely due to a number of reasons including the small sample size (N=88). Also, the data may have been unreliable due to the grading process. Examinations were coded to protect the identity of each cadet. A team of five graders read and scored each essay examination as pass or fail. No precise grading criteria were given to the graders, some of whom were new to the process. In some cases, the team scored an examination with four fails and one pass, yet the course director passed the examination. A different cadet with the three fails and two passes had to retake the examination and was given two fails and two passes, only to be failed.

There were also instructor differences. All students in Instructor 15's sections who accessed the TMIS passed the WPPWE on their first attempt. Two cadets in the treatment group failed their first attempt, but they did not access the strategies. Instructor 14 chose to go to mediation for his cadets who had failed three times, reversing their grades to pass. Instructor 15 did not choose mediation for her failed cadets. These inconsistencies in grading impacted the results and caused the data to be unreliable; therefore, these data were excluded from Hypothesis 1. A summary of the analysis is provided in Appendix G, Table A-2.

Question 2: In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on proclivity to be self-directed learners as measured by the SDLRS instrument?

Research Question Two examined the effect of TMIS on proclivity to be self-directed as measured by the SDLRS instrument. Differences in proclivity to be self-directed learners (readiness for self-directed learning) were measured for those students who received traditional instruction (control) versus those who received traditional instruction *and* supplementary TMIS (treatment). Ninety-one randomly selected control group students and 104 randomly selected treatment group students completed the SDLRS near the beginning, and again, at the end of the semester, providing a pretest/ posttest measure. Change in the mean pretest and posttest SDLRS scores was measured for those who received traditional instruction (control) versus those who received traditional instruction *and* supplementary TMIS (treatment). The following hypothesis was suggested:

H_2: The change in the mean pretest and posttest SDLRS score of treatment group students is significantly higher than the change in the mean pretest and posttest score of control group students taught by traditional methods.

To answer Research Question Two, change in the mean pretest and posttest SDLRS score was measured for control and treatment group students. To test the hypothesis for Research Question Two, a Two Independent Samples t-test was employed.

This is a parametric test that looked at the change in pre/post difference in SDLRS scores between treatment and control groups. For comparison purposes, the nonparametric analog for this test, the Wilcoxon Rank Sum Test, was chosen.

Table 4-4: Summary of Change in Mean SDLRS Score Analysis

	N	SDLRS pretest mean	SD pretest	SDLRS posttest mean	SD posttest	Δ SDLRS score	SD Δ	p
Control	91	214.07	22.15	210.77	22.89	- 3.30	14.52	.004
Treatment	104	215.72	20.89	218.54	23.18	+ 2.83	15.07	

The pretest SDLRS scores were analyzed for a differential effect with respect to treatment/control group membership. This effect was found to be non-significant (p=.59) and the pretest scores were thus not used as a potential confounding variable of the posttest scores. The control group (N=91) had a mean pretest SDLRS score of 214.07 and the treatment group (N=104) had a mean pretest SDLRS score of 215.72 (see Table 4-4).

The analysis of posttest SDLRS scores showed treatment group cadets had significantly higher (p=.02) SDLRS scores than control group cadets. The control group (N=91) had a mean posttest SDLRS score of 210.77 and the treatment group students (N=104) had a mean SDLRS score of 218.54.

Further, there was a significant difference (p=.004) between the two groups' change in SDLRS scores, with control group scores dropping by 3.3 points and treatment group scores increasing by 2.82 points. The decline in cadets' proclivity to be self-directed learners was expected in accord with Preczewski's (1997; 1998) prior research which found that the undergraduate experience fails to positively affect SDL.

The difference between the observed mean difference and the standard error of the difference for the change in SDLRS scores (6.13-2.13 units) exceeds what one would expect attributable to nothing but sampling error and therefore constitutes evidence of a treatment effect which is of practical importance. Therefore, as hypothesized, the change in SDLRS scores was significantly greater for treatment group students than for control group students, suggesting that the TMIS positively affected student proclivity to be self-directed learners.

For comparison purposes, the nonparametric analog for the Two Independent Samples t-test, the Wilcoxon Rank Sum Test, was selected (see Table 4-5). This test likewise showed a significant difference (p=.001) between control and treatment group students' mean SLDRS scores.

Table 4-5: Summary Δ SDLRS Wilcoxon Rank Sum Test Analysis

	N	Mean Rank	Mann Whitney-U	Power	p
Control	91	82.91	3358.5	.96	.001
Treatment	104	110.39			

To more closely examine the data, pretest to posttest paired samples t-test analysis occurred for all three groups (see Table 4-6): control, treatment group students who did not access the strategies, and treatment group students who did access the strategies.

Control group cadets had a mean decrease in SDLRS scores of 3.3 (p=.03). While not significant at the .01 level, a standard error of the difference of 1.5 units can be thought of as what one would expect to see as attributable to nothing but sampling error. The fact that the observed difference was 3.3 units is evidence of a difference that exceeds what one would expect attributable to nothing but sampling error and therefore constitutes evidence of a treatment effect which is also of practical importance. This could also be explained in terms of the regression phenomenon where one would expect a drop in the direction of the mean reported by previous studies.

Table 4-6: Summary of Pretest to Posttest SDLRS Analysis by Group

	N	SDLRS pretest mean	SD pretest	SDLRS posttest mean	SD posttest	Δ SDLRS score	SD Δ	Power	p
Control	91	214.07	22.15	210.77	22.89	- 3.30	14.52	.48	.030
Treatment w/o Access	23	212.26	23.48	201.70	24.25	-10.57	12.56	.98	.001
Treatment w/ Access	81	216.70	20.40	223.32	21.07	+ 6.62	13.53	.99	.000

Treatment group cadets who did not access the TMIS had a mean decrease in SDLRS scores of 10.57 (p= less than .001). The difference between the observed mean difference and the standard error of the difference for the pretest to posttest difference in SDLRS scores (10.57-2.62 units) exceeds what one would expect attributable to nothing but sampling error and therefore constitutes evidence of a treatment effect which is of practical importance. Treatment group cadets who did access the TMIS had a mean increase of 6.62 (p= less than .001). Likewise, the difference between the observed mean difference and the standard error of the difference for the pretest to posttest difference in SDLRS scores (6.62-1.5 units) exceeds what one would expect attributable to nothing but sampling error and therefore constitutes evidence of a treatment effect which is also of practical importance.

Question 3: In applying the technology-mediated instructional strategies in the given instructional context, will TMIS have an effect on learner motivation as measured by Keller's ARCS instruments (CIS and IMMS)?

Research Question Three examined the effect of TMIS on motivation (measured by the CIS and IMMS and their attention, relevance, confidence, and satisfaction subscores). In order to gain a deeper understanding of the effectiveness of TMIS, the IMMS was administered to all participants. Control group participants gave their perceptions of instructional materials related to specific lesson objectives. Treatment group participants gave their perceptions of instructional materials *and* associated supplementary strategies related to specific lesson objectives. All students were asked to complete the CIS to assess their motivation as it related to their course. Hotelling's t-Squared Test was used for separate analyses of mean vector scores for the ARCS subscores on the IMMS and the CIS. Differences in motivation were measured for those cadets who received traditional instruction (control) versus those who received traditional instruction *and* supplementary TMIS (treatment). The following hypothesis was suggested:

H_3: Treatment group students have significantly higher mean vector scores for CIS and IMMS than control group students taught by traditional methods.

To analyze Research Question Three, mean vector scores of treatment and control groups were first compared for the Course Interest Survey. Each subscore (for Attention, Relevance, Confidence, and Satisfaction) was analyzed (see Appendix G, Table A-3) as a vector. While it was logical to examine the academic performance data for Research Question One in light of treatment group cadets who did or did not access the instructional content portion of the TMIS (as self-reported on the SDL survey), for Research Question Three all treatment group cadets received the motivational messages and therefore are included in the analyses as one group.

For the data analyses, SAS was used to conduct Hotelling's t-Squared Test and Multivariate Analysis of Variance. It produces four test statistics: Wilks' lambda, Pillai's trace, Hotelling-Lawley trace, and Roy's greatest root. All four returned identical p-values. The means for CIS total scores are different for treatment and control groups with a p-value of .009 (see Figure 4-1). The power level was .68. Univariate t-tests of the Attention, Relevance, Confidence, and Satisfaction subscores show the greatest difference to be with attention (p=.008). There is also moderate evidence of differences with satisfaction (p=.076), though there are no differences with relevance or confidence.

Therefore the hypothesis of a significant difference in mean CIS scores, with greater motivation levels in treatment group students, is partially supported.

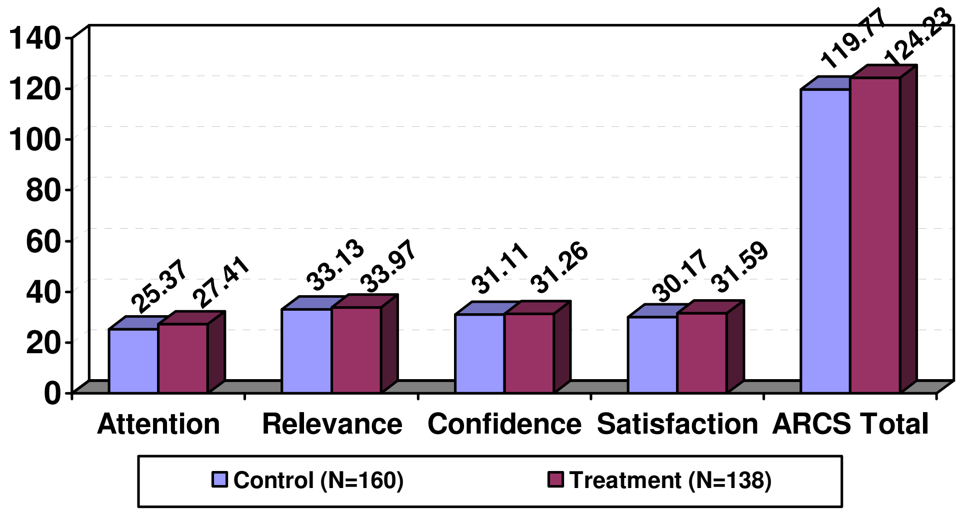

Figure 4-1: Comparison of Mean ARCS Scores on Course Interest Survey

The difference between the observed mean difference and the standard error of the difference for the pretest to posttest difference in CIS scores (4.46-2.65 units) exceeds what one would expect attributable to nothing but sampling error and therefore constitutes evidence of a treatment effect which is of practical importance.

To complete the analysis of Question Three, mean vector scores of treatment and control groups were compared for the Instructional Materials Motivation Survey. Like the CIS, the Attention, Relevance, Confidence, and Satisfaction subscores comprise a vector which was analyzed.

For the data analyses, SAS was used to conduct Hotelling's t-Squared Test and Multivariate Analysis of Variance. It produces four test statistics: Wilks' lambda, Pillai's trace, Hotelling-Lawley trace, and Roy's greatest root. All four returned identical p-values. Students in the treatment group had greater levels of motivation, as measured by the Instructional Materials Motivation Survey, than students in the control group. As shown in Figure 4-2, the means for IMMS total scores are different for treatment and control groups with a p-value of less than .0001 (see Appendix G, Table A-4 for details). Further, these significant differences are seen in each of the Attention, Relevance, Confidence, and Satisfaction subscores (p= less than .0001). The power level was greater than .9999. Therefore the hypothesis that students in the treatment group would have greater levels of motivation, as measured by the IMMS, is supported.

The difference between the observed mean difference and the standard error of the difference for the pretest to posttest difference in IMMS scores (14.98-2.2 units) exceeds what one would expect attributable to nothing but sampling error and therefore constitutes evidence of a treatment effect which is of practical importance.

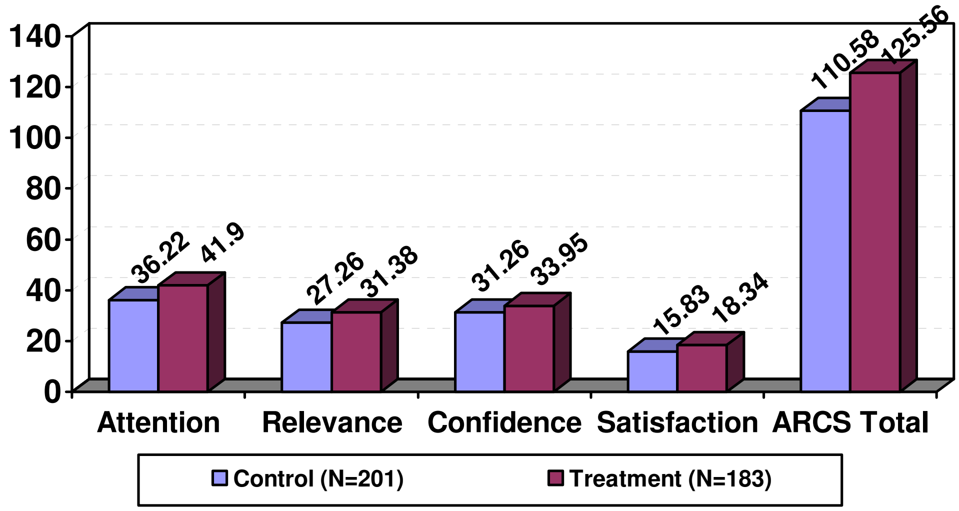

Figure 4-2: Comparison of Mean ARCS Scores on Instructional Materials Motivation Survey

Anecdotal Data

Qualitative feedback on the SDL surveys showed that cadets felt the strategies benefited their learning experience and they appreciated the TMIS. For example, cadet comments included:

- "The tutorial was concise and quick to read... to the point and quick--just what cadets need."
- "Seeing pictures to tie with the things we have heard about and were suppose (sic) to think about helped a lot. It made it more interesting."
- "The PDA is very helpful because you can always access your work and it has some interesting readings on it."
- "I am really enjoying the online discussions. In class, discussions are happening in real time, so a lot of very random thoughts are tossed out. However, on the web you have more time to think and contemplate what you are going to say before you say it. This ensures that the level of conversation stays in the intelligent realm."

- "WOW!!! about sums it up. The link to the tutor pages was awesome. They had so much information that I had to go back a few different times this weekend just to see all that was there. This is good stuff, just like all that has been coming our way in order to help prepare us to be successful for the lessons and WPRs (exams)."
- "I really appreciated all of the extra study material all year, and I think that it should be made accessible and encouraged for all classes of basic chemistry."
- "The questions give the reader an idea of what to look for and also causes (sic) the reader to think more in depth on a subject or event he might have overlooked."
- "I enjoy the threaded discussions better than just writing out a journal entry. It helps to get different perspectives on the material from classmates as opposed to only hearing the instructor's side of the work."
- "It was fun!!! Made learning more interactive."

Qualitative data provided insight as to how beneficial cadets perceived the strategies to be. Most were highly positive, though a handful of comments were negative, particularly with regard to frustration about using the technologies. Whenever a cadet made comments on the SDL questionnaire about problems with the technologies, the researcher contacted the cadet to help resolve the issue. Most problems were resolved through email or phone dialogue, though a few cadets needed to bring their PDAs in to have the researcher repair them. Aside from that, many comments included the value of more interactivity and its impact in making the learning experience more enjoyable.

Follow-up Interview Results

In fall 2003, follow-up research was conducted primarily via email, but also by telephone. Six questions were asked that were customized for each randomly selected cadet. An example of the questions and responses is provided in Appendix F. The questions were intended to determine if cadets in the treatment group may have shared the TMIS with cadets in the control group, and to follow-up to ascertain their feelings about the strategies.

All cadets reported that they did not share the strategies with cadets in the control group. Several said that they talked about the TMIS to students in the same treatment group class they were in, and that they may have worked through the interactive strategies together. The sharing of TMIS with cadets in the same treatment group was not discouraged since they also share the instructional content in the classroom-based portion of their courses. Only one cadet said he may have talked about the TMIS to a cadet in the control group, though he did not share the strategy itself with the other student.

Many cadets responded by saying that they appreciated the TMIS and that it made learning "fun," though three cadets did not remember the study or the TMIS. A few answered an open-ended question by saying that they felt the TMIS improved their study habits even today. Several cadets said that the TMIS helped them feel more confident in using technology such as the PDA. Some cadets said they were disappointed because their current classes do not use such interactive strategies.

Finally, a handful of cadets said that due to lack of time, they didn't appreciate the extra instructional content. Here is an example of such a cadet response:

"I appreciated the effort in trying to help us use different technological strategies, however, at the time I was a plebe and just trying to survive the academic year. It was more efficient for me to (for timely reasons) use my old methods of organization, etc... I didn't appreciate it really at the time, because I had so little time to get used to it. My old ways were working just fine."

Examples of typical cadet responses include:

"I remember how interactive they were and how much fun they made learning."

"I think the strategies helped my learning the most but they also helped motivation too due to the change of learning styles."

"…I wish we would have more interactive material like this."

"I had previously failed this class, so I also think that the strategies gave me confidence to succeed."

"I liked the PDA content. Since the class ended, I have stopped using the PDA, sadly."

"…the technology based strategies made it more interesting to learn."

"I think I learned more simply due to a higher motivation to learn since I had technology.

"I thought it was very helpful and I was glad I was part of the experimental group because I think it helped my success in the class."

"Participating in the study helped me learn my PDA. I enjoyed being able to down load other content."

"Having it on the PDA made it easier. I could take it anywhere. The PDA was easier than a textbook, or computer. I could take it with me easily and in case I had time, I could read it."

"I like anything that's interactive that helps me from doing the regular learning of reading from a textbook. I like to deal with things that grab my attention like moving demonstrations, things on the computer, etc."

Summary of Research Findings

Quantitative research findings indicated that there were significant differences ($p=.0045$) in academic performance of those students who accessed the technology-mediated instructional strategies compared to those who did not access the strategies.

There were significant differences between the change in pretest and posttest SDLRS scores (p=.004), indicating increased levels of proclivity to be self-directed learners for those cadets who were in the treatment group. Further, control group students' mean SDLRS scores decreased from pre to posttest measures (p=.03), in accord with earlier research findings. Treatment group cadets who accessed the TMIS had a significant increase in SDLRS scores (p= less than .001) from pretest to posttest measures. There were also significant differences between treatment group students' and control group students' motivation levels as measured by Keller's CIS (p=.0091) and IMMS (p= less than .0001) instruments. These significant differences were seen in the IMMS Attention, Relevance, Confidence, Satisfaction subscores and total score.

Earlier it was noted that Keller (1999a) argues that although motivation is idiosyncratic, learner motivation can also be affected by external factors. These factors include systematic instructional design of tactics and strategies intended to improve motivation and performance, as well as encouragement and support by instructors, tutors, or peers. This research study confirmed that it is feasible that after conducting a motivational analysis of learners, appropriate strategies can be developed to improve motivation, performance, and SDL. Further, new technologies such as the PDA can help improve the efficiency of delivering such strategies.

CHAPTER V

DISCUSSION

Introduction

Chapter Five provides a summary of results of the current study, an interpretation of these results, and limitations of the study. The chapter concludes with discussion of implications of the results and suggestions for future research.

Interpretation and Discussion

The present study was designed based upon the concept that if instruction itself cannot be easily revised, systematically designed technology-mediated instructional strategies can help improve motivation, performance, and self-directed learning. Further, when motivational design is built into supplementary course instruction, students appreciate the instruction and perceive that they learn more.

The intention of Research Question One was to examine the effect of TMIS on academic performance (measured by course aggregate points including homework, examinations, projects, and other grades). Specifically, the objective was to determine if the systematically designed interventions would help improve academic performance.

Results showed that there were significant differences in academic performance of treatment group students who accessed the TMIS compared to control group cadets and treatment group students who did not access the interventions. These findings confirm previous research findings that suggest that motivation plays a critical role in performance (Song & Keller, 2001). These differences would be expected to be greater in a population that is more heterogeneous.

Research Question Two examined the effect of TMIS on proclivity to be self-directed learners, as measured by the SDLRS. Results showed that there was a significant improvement in proclivity to be self-directed learners for treatment group cadets. Further, control group cadets' desire to be self-directed declined, as did treatment group cadets who did not access the TMIS, which is in accord with previous research (Preczewski,1997; 1998) in this environment. Also, despite the focus on the need to be self-directed learners at the academy and in the Army (Educating Army Leaders for the 21st Century, 1998), research had shown that cadets do not spend their free time pursuing outside learning activities (Cadet Time Survey Results, 1998). These interventions appear to have helped improve cadets' desire to be self-directed learners.

There were two parts to Research Question Three. The first part of the question examined the effect of TMIS on motivation in the course as measured by the Course Interest Survey and its ARCS subscores. Results showed that cadets in the treatment group had significantly higher levels of motivation than control group cadets. The greatest difference in subscores was with attention.

The second part of Research Question Three examined the effect of TMIS on motivation in the instructional materials as measured by the Instructional Materials Motivation Survey and its ARCS subscores. Results showed that cadets in the treatment group had significantly higher levels of motivation than control group cadets. Further, all of the attention, relevance, confidence, and satisfactions subscores revealed significantly higher levels of motivation among treatment group cadets.

These findings confirmed decades of research that show that motivation is one of the most critical concerns in how and why people learn (Efklides, Kuhl, & Sorrentino, 2001; Keller, 1979; Wlodkowski, 1999). Also, despite the idiosyncratic nature of motivation, external factors can have a positive effect on learners. Therefore, improved performance can be expected to occur when motivational design is included in instruction. Additional benefits can be expected when TMIS are developed to enhance desired outcomes.

Implications of the Research Findings

In summary, a review of the existing literature revealed much discussion of the importance of motivation, but little empirical research that examines motivation in technology-mediated learning environments. Specifically, there were three gaps in the literature that were addressed in this study: (1) the situational context of learning; (2) the social context of learning including the motivational needs of learners, and; (3) the systematic design and development of interventions to improve motivation, performance, and SDL.

Keller (1999a) notes that instructional designers are faced with even greater challenges in self-directed learning environments than with traditional instruction, especially with regard to satisfying the motivational needs of learners. This study used blended instruction to enhance traditional classroom-based instruction with supplementary technology-mediated instruction that cadets could access at their own convenience.

Visser (1990, p. 18) stated, “The *clinical use of motivational messages* is a strategy which consists of the use of messages, designed by well defined means, such that their content has a desirable effect on the learner's disposition to engage in learning tasks.” This approach was emulated in the TMIS design, using the systematic design of motivational messages to encourage students to access supplementary instructional content outside the classroom.

The interventions in this study were supported by the problem-solving conceptual framework of Keller’s ARCS model of motivational design and were inspired by prior research on the motivational messages support system (Visser, 1990; Visser & Keller, 1990; Visser, 1998; Visser et al., 2002; Visser et al., 1999). This study confirms that the use of systematically designed technology-mediated instructional strategies can be an effective and efficient method of improving motivation, performance, and self-directed learning.

However, rather than merely providing supplementary instructional content, it is recommended whenever feasible to revise instruction itself to include more interactive, technology-based motivational tactics and strategies. This suggestion of fostering active learning would benefit not only blended learning but also classroom-based and distance learning environments.

Finally, this research was one of the first empirical studies to use new technologies such as the Personal Digital Assistant (PDA) for instructional content. Knowledge about the impact of technology-mediated interventions presented in this study could be of benefit to instructional designers of technology-enhanced environments.

Limitations of the Study

The limitations of the study will be described in terms of generalizability, group equivalence, and power and sample size.

First, the results of this study are intended to generalize to a population sharing the descriptive characteristics of the sample. Specifically, this study involved undergraduate students at a public military school. Only a handful of studies have examined motivation in this context, and the present study appears to be the only study since Preczewski (1997; 1998) to examine self-directed learning at a military academy. No prior studies were found that used an experimental methodology in this context. As previously stated, limitations include the fact that the population of cadets is homogeneous. All were unmarried, had no children, had no disabilities, and were aged 18 to 27. The results are not likely generalizable beyond this context. However, this homogeneity also provided increased scientific control of the internal validity of the research. Even though students were relatively homogeneous, all classes but one were graded on a curve, thus providing variance in the criterion measure. Further studies should include a greater range of talent in the samples.

Two instructional methods, not necessarily equivalent in content, were implemented in this study. For example, it is possible that the technology itself affected treatment group cadets' levels of motivation, though these same technologies were available to all cadets before the study began. The supplementary content was designed to be interactive and to engage learners, as well as to get students interested in the content to the point that they would want to learn beyond the requirements of their course. Therefore, it is possible that cadets who accessed multiple chunks of the strategies learned material that was beyond the course objectives.

A concern in this study is of self-selection bias. Approximately 45 percent of treatment group cadets did not access any strategies. Ideally every treatment cadet would have accessed the TMIS in order to provide for balanced comparison. However, participation in this study was strictly voluntary. The only way to ensure greater compliance would have been to provide extra credit opportunities for both groups or to modify the instruction itself rather than supplying supplementary instructional content.

Statistical significance was found in each of the hypotheses. This could also be explained in terms of the regression phenomenon where one would expect that as sample sizes become larger, the data tend toward the direction of the mean.

Instructors were discouraged from offering any extra credit for their students to access the TMIS, though one instructor chose to do so. He offered different extra credit opportunities for his control group cadets. Academic performance results indicate that he was able to maintain objectivity despite not being blind to which sections were control group and which were treatment.

These concerns including instructor differences were addressed in the design experiment where the interaction effect of the instructor was included in the analysis. Also, separate analyses occurred to see if treatment group students who accessed the strategies differed from those who did not access the TMIS.

Recommendations for Future Research

The benefit of scientific control was evident with this population at a military academy in the northeast United States, where most instructors teach two to four sections of the same course and have identical syllabi and course content. This study could be replicated to see if significant differences in motivation, performance, and self-directed learning would be found with a different population.

The design of TMIS in this study could be analyzed in more detail to see which TMIS are most effective in which context. For example, PDA-based instructional content may be more motivationally effective in English classes and less so in the hard sciences.

Another empirical study of interest would be to see if such interactive technology-mediated learning improves motivation and self-directed learning over time. The present study took place over the course of one semester that was five months long. Qualitative data collected 18 months after the study provides some evidence that participants perceive that their study habits and proclivity for self-directed learning have improved. More in-depth analysis could occur including reassessing motivation and SDL.

APPENDIX A

SELF-DIRECTED LEARNING SURVEY

Post-Strategy Questionnaire Example

***Note, this survey is electronic, so depending on the cadets' selections, it will direct them to the appropriate question.

1. Did you access the SkillBrief (PDA) on Leadership? ☐ Yes ☐ No

If No,

1b. Why didn't you access the material?

☐ Not enough time ☐ Didn't feel like it ☐ Technical problems

☐ Other __________

<end of survey for No responses>

If Yes,

2. How much time did you spend on the material?

☐ < 5 minutes ☐ 5-10 minutes ☐ 10-15 minutes ☐ 15+ minutes

3. Did the supplementary material pique your curiosity to learn?

☐ Yes ☐ No

4. How would you rate this supplementary activity?

	1	2	3	4	5	
not helpful	☐	☐	☐	☐	☐	very beneficial

5. Is there anything you would like to add? ___________________________

Thank you for responding to the survey. If you have any questions, contact Donna Gabrielle at Donna.Gabrielle@usma.edu or ext. 4257.

APPENDIX B

MOCK SCRIPT FOR INSTRUCTORS

Mock Script for SDL Research

This script is intended as a guideline for how to introduce your class to the research project. Please feel free to ad lib or change as needed.

Hello everyone. I'd like to introduce you to someone who works at USMA and who will be working with me on some new ideas for this class. This is Donna Gabrielle. Throughout the semester you will be getting information from her related to the course through your PDAs (*plebes and cows only*), email, and other technology.

This project is strictly voluntary and it is not required that you participate. However, I strongly encourage you to take part by accessing the materials she sends you because they are directly related to the course and may help you better achieve.

Even though you will be providing personal information to her, Donna Gabrielle will keep all of this information confidential. Do you have any questions?

If not, please sign and date the informed consent forms, and make sure your cadet ID # is legible, then pass them to the front of the room when completed. Thank you.

APPENDIX C

INFORMED CONSENT FORM

Informed Consent

Topic: Motivational Strategies via Technology
Researcher: Donna M. Gabrielle

I, ___________________________, do hereby consent to participate in this study to be conducted at the United States Military Academy (USMA). I understand that my participation is strictly voluntary. I also understand that the researcher will be working with my course instructor to develop strategies related to my course material, and that if I choose to participate, I will be asked to complete surveys regarding my participation. I am aware that the researcher will code any information I provide in order to ensure confidentiality.

I have been afforded the opportunity to ask questions and to discuss my participation in this study with the researcher and with my course instructor. By signing this informed consent form, I agree to participate.

Signature _______________________

Cadet ID # _________________

Date _________________

APPENDIX D

HUMAN SUBJECTS COMMITTEE APPROVAL FORM

FLORIDA STATE UNIVERSITY *Application No.:*

Human Subjects Application
to the INSTITUTIONAL REVIEW BOARD
for RESEARCH INVOLVING HUMAN SUBJECTS

The Federal Government and University policy require that the use of human subjects in research be monitored by the Institutional Review Board (IRB). **The following information must be provided** when humans are used in research studies, whether internally funded, extramurally funded or unfunded. Research in which humans are used may not be performed in the absence of IRB approval.
PLEASE COMPLETE AND SUBMIT PAGES 1 AND 2 plus YOUR ANSWERS TO THE QUESTIONS (on page 3) IN TYPEWRITTEN FORM TO:HUMAN SUBJECTS COMMITTEE, Mail Code 2763, or 2035 E. Paul Dirac Drive, Box 15

100 Sliger Bldg., Innovation Park
Tallahassee, FL 32310

Researcher: Donna M. Gabrielle **Date:** April 10, 2003
Project Title: The Effects of Technology-mediated Instructional Strategies on Motivation, Performance, and Self-Directed Learning

Project Period (starting/ending dates): 01/2002 – 12/2003

Position in University (faculty, etc.) If student, please indicate FSU Faculty Advisor:
Dr. Robert Branson- FSU Faculty Advisor
Department: Educational Psychology and Learning Systems
Telephone: 850-656-3703, 850-321-8222 **E-Mail Address:** gabrielle@mailer.fsu.edu
(where you can be reached in case of a problem with your application)
Mailing Address (where your approval will be mailed):
P.O. Box 12861, Tallahassee, FL 32317-2861
Project is (please check one): ___X__ **dissertation** _____ **teaching** ______ **thesis** _____ **other**
Project is: _____X____**unfunded** _________ **funded** *(if funded, please complete the following):*
Funding Agency (actual/potential): 1. ____________________________ 2. _________________________
Contract/Grant No. (if applicable): ____

FOR EVALUATION OF YOUR PROJECT, PLEASE CHECK THE FOLLOWING WHICH APPLY:

	Mentally or Physically Challenged Subjects		Subjects studied at FSU
	Children or Minor Subjects (under 18 years old)	X	Subjects studied at non-FSU location(s)
	Prisoners, Parolees or Incarcerated Subjects	X	Students as Subjects
	Filming, Video or Audio Recording of Subjects		Employees as Subjects
X	Questionnaires or Survey(s) to be administered		Pregnant Subjects
	Review of Data Banks, Archives or Medical Records		Fetal, placental or surgical pathology tissue(s)
	Oral History		Involves Blood Samples (fingerpricks/venipuncture, etc.)
	Subjects' major language is not English		Subjects to be paid
	Involves Deception (if yes, fully describe at Question No. 7)		
	Exclusion of Women or Children		
	Subjects (must explain why they are being excluded)		

This document is available in alternative format upon request by calling (904) 644-8633

APPENDIX E

EXAMPLES OF TMIS

Hello again EN 102 Cadets,

I hope you did great on your last WPR! Thanks to all of you who have responded to the strategies so far (again, if you haven't, it's never too late). Most of you said you appreciated the distraction of the last strategy, but some said you would rather have more difficult strategies that would better benefit your learning. Based on your input, we are working to improve the strategies to try to make them as helpful as possible to learning the course material.

You have been working on producing videos for your class to find meaningful connections between Homer's text and your own life narratives here at West Point. Strategy 5 has leading questions about the upcoming readings that may help you toward that end, and it is provided in both web-based and PDA-based formats. Please give us your honest opinion on this supplementary material no later than COB 15 April. *Remember that even if you choose not to access the strategy, you should complete the brief questionnaire.* We would also strongly encourage you to provide your comments in the additional space provided on the web-based questionnaire.

1. Access **Strategy 5**: <link> which is a study guide for Homer's *Odyssey*. The site offers thoughtful questions on each book which you can use to guide your reading. It also provides links to a mythological dictionary and images. If you would like to add the web site to your PDA, click here to automatically add it to your existing channels when you HotSync: <link> Hint: when using your PDA on pages with lots of text, use the search function to quickly find what you need.
2. Complete the brief online questionnaire: <link> and please provide comments to give us beneficial feedback.

Thanks...and don't hesitate to contact me or CPT <Instructor 1> if you have any questions or if you need any technical assistance. Good luck on your recitation #5!

Take care,
Donna Gabrielle

Hello again PE 210 Cadets,

I hope you are doing great! Thank you for your feedback on Strategy 1 (and for those of you who haven't accessed it yet, it's not too late). Most of you said that Strategy 1 was very helpful. I appreciate your feedback, and again, you can always revisit the strategies at your convenience, though we'd still love to hear your input no matter when you are able. Now it is time to focus on the next strategy. After you have accessed the material, you'll complete a quick online survey about the strategy. The entire process should take you no more than 10-15 minutes (though you are welcome to spend more time on it if you would like), and hopefully you will find the strategies helpful to learning the course material.

In class this week you watched a video presenting two different views of ephedra. It is a hot topic and is in the news constantly. There are a few additional articles that you should find interesting and helpful in Strategy 2. Please give us your honest opinion on this supplementary material no later than COB 29 April. *Remember that even if you choose not to access the strategy, you should complete the brief questionnaire.* We also strongly encourage you to provide your comments in the additional space provided on the web-based questionnaire. Here is all you need to do:

1. Access **Strategy 2**: <> which is on ephedra.
2. Complete the brief online questionnaire: <> and please be sure to add comments so we get the best feedback possible.

Thanks...and don't hesitate to contact me or Dr. Pim if you have any questions!

Take care,
Donna Gabrielle

Hello again PL 100 Cadets,

I hope you had a fantastic spring break and that you are getting back into the swing of things after over a week back at West Point! Thanks to all of you who have responded to the strategies so far (if you haven't, it's never too late). Most of you said you appreciated the last strategy, but some said you preferred the crossword puzzle because it was different than the routine. Based on your input, we are working to improve the strategies to try to make them as helpful as possible to learning the course material. The entire process of accessing the strategies and completing the questionnaires should take you no more than 10-15 minutes per week (though you are welcome to spend more time if you'd like), and hopefully you will find it helpful to learning the course material and relevant beyond your life at USMA.

Last week you attended a guest lecture by Mr. Morris Dees on "Appreciating Diversity and Teaching Tolerance." The next strategy is a follow-up to the discussion which should help you think about how you can make a difference in promoting tolerance. Please give us your honest opinion on this supplementary material no later than COB April 18. We also strongly encourage you to provide your comments in the additional space provided on the web-based questionnaire.

1. Access **Strategy 3**: First, visit Mr. Dees' website to explore 10 ways you can help fight hate in America: <> (be sure to click on the hyperlinks to fully explore), then take a look at this map: <> which shows all the hate groups right here in NY (including the KKK as close as Newburgh, unfortunately). Finally, visit the Civil Rights Memorial on the same website under "Dig Deeper." Consider ways that you, as a U.S. Army officer, will need to be cognizant of these issues. Also, think about how you can get involved as a cadet to make a positive difference in promoting tolerance.

2. Complete the brief online questionnaire: <link> and please provide comments so we can benefit from your feedback.

3. Consider the entire lesson on tolerance and prejudice, including the supplementary strategy. Please complete this brief instructional materials motivation survey <link>.

Thanks...and don't hesitate to contact me or LTC Hampton if you have any questions!

Take care,
Donna Gabrielle

APPENDIX F

EXAMPLE OF FOLLOW-UP INTERVIEW

Date: Sun, 28 Sep 2003 00:14:15 -0400
To: <email removed>@usma.edu
From: "Donna M. Gabrielle" <gabrielle@mailer.fsu.edu>
Subject: Follow-up from USMA Study

Dear CDT <name removed>,

In spring 2002, you took part in a study on motivational strategies using technology. At the time, I worked at USMA and with the help of your instructor, MAJ Bozic, I developed technology-mediated strategies to try to improve motivation and learning. I am writing to follow-up with you about your input on this study. I know how valuable your time is, so I appreciate your responses to the following 6 questions.

1. Did you appreciate having the technology-mediated strategies including PDA-based content?
Yes, it helped a lot. It helped me learn and made it real easy to help me clarify what I didn't know. I remember how interactive they were and how much fun they made learning.

2. You were in the experimental group. Did you share any of the strategies with other cadets?
No. I might have talked about the strategies with other cadets in my class, but I didn't think we were supposed to share it outside the classroom. I might have told other people about it, but I didn't share it with them.

3. If you shared any of the strategies with other cadets, is it possible they may have been in the control group sections? *N/A*

4. Your input in the study was important to improve the strategies as the semester progressed. Some of your input included the fact that you really enjoyed the interactive chemistry components as a learning tool. You said in your feedback responses, "WOW!!! about sums it up. The link to the tutor pages was awesome. They had so much information that I had to go back a few different times this weekend just to see all that was there. This is good stuff, just like all that has been coming our way..." (Thank you for your positive feedback)! What did you like most about the strategies in general? *I wish that all my classes would help me focus my learning like this one did. I think it has helped me beyond the class with my study skills.*

5. Did you feel like the strategies helped improve your learning or your motivation to learn?
Yes, it helped give me direction and made me feel more confident and motivated. It was more to the point than the regular class. I went from an F to almost a B+ because it helped me focus.

6. Do you have anything you would like to add? (I welcome anything you would like to say!).
Just that I wish we would have more interactive material like this. It makes learning fun.I had previously failed this class, so I also think that the strategies gave me confidence to succeed.

Thank you so much for your time and attention to these questions. By the way, MAJ Bozic is in Baghdad now. We correspond regularly via email, and he is doing great.

Sincerely,

Donna M. Gabrielle
Doctoral Candidate, Florida State University

APPENDIX G

TABLES

Table A-1: Grade Summary for Control, Treatment, and Treatment with TMIS Usage

Instructor	Control	Treatment Total	Treatment with usage of TMIS
1	85.51	87.85	87.95
2	85.51	84.91	86.60
3	78.65	83.15	84.29
4	77.94	78.18	84.97
5	79.05	81.37	77.39
6	90.98	92.01	92.23
7	85.36	85.82	90.40
8	81.83	82.27	92.08
9	86.08	84.59	85.59
10	84.98	83.73	86.17
11	80.62	80.16	80.34
12	81.78	82.91	82.08
13	84.88	85.50	85.25
14	83.84	83.26	83.19

Table A-2: Summary of Effect of TMIS on Academic Performance for Pass/Fail Course

Instructor	WPPWE 1		WPPWE 2		WPPWE 3	
	P	F	P	F	P	F
15 Control	9	4	4	0	0	0
15 Treatment	22	4	4	0	0	0
15 Treatment w/ Access	9	4	4	0	0	0
16 Control	17	6	6	2	0	2
16 Treatment	21	2	2	1	0	1
16 Treatment w/ Access	12	0	0	0	0	0

Table A-3: Control Group CIS Mean Vector Scores

Dependent Variable	N	Mean	Std Dev	Minimum	Maximum
CIS Attention	160	25.37	6.79	8.0	40.0
CIS Relevance	160	33.13	7.67	12.0	45.0
CIS Confidence	160	31.11	5.31	18.0	40.0
CIS Satisfaction	160	30.17	7.19	10.0	45.0
CIS Total	160	119.77	23.95	54.0	166.0

Table A-4: Treatment Group CIS Mean Vector Scores

Dependent Variable	N	Mean	Std Dev	Minimum	Maximum
CIS Attention	138	27.41	6.22	8.0	40.0
CIS Relevance	138	33.97	6.31	12.0	45.0
CIS Confidence	138	31.26	5.38	14.0	40.0
CIS Satisfaction	138	31.59	6.50	14.0	45.0
CIS Total	138	124.23	21.51	59.0	170.0

Table A-5: Control Group IMMS Mean Vector Scores

Dependent Variable	N	Mean	Std Dev	Minimum	Maximum
IMMS Attention	201	36.22	8.06	12.0	59.0
IMMS Relevance	201	27.26	6.65	9.0	45.0
IMMS Confidence	201	31.26	5.92	10.0	45.0
IMMS Satisfaction	201	15.83	5.44	6.0	30.0
IMMS Total	201	110.58	22.22	44.0	178.00

Table A-6: Treatment Group IMMS Mean Vector Scores

Dependent Variable	N	Mean	Std Dev	Minimum	Maximum
IMMS Attention	185	41.90	7.33	20.0	60.0
IMMS Relevance	185	31.38	5.69	13.0	44.0
IMMS Confidence	185	33.95	5.42	19.0	45.0
IMMS Satisfaction	185	18.34	5.24	6.0	30.0
IMMS Total	185	125.56	19.76	63.0	179.0

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BIOGRAPHICAL SKETCH

Donna M. Gabrielle has worked in the fields of education, communication, instructional design, and distance learning since 1987. Her career began in public television and radio and progressed to network news reporting, producing, directing, and nonlinear editing, particularly of documentaries. She has designed over 80 web-based courses and taught dozens of classes in communication, education, and technology at a community college and two universities.

Gabrielle worked as ITV/ Distance Learning Administrator for Bay County Schools. She also worked in State of Florida government including as head of training and development for the Department of Agriculture and Consumer Services, training manager for the Department of Revenue, and Project Manager/ Instructional Technologies Administrator for the Department of Corrections and the Justice Distance Learning Consortium, a $10 million STAR Schools project that brought educational opportunities via distance learning to incarcerated youth. Her most recent position was as Associate Director of the Center for Teaching Excellence and Instructor at the United States Military Academy at West Point, New York.

Gabrielle has been a small business owner since 1990 when she opened a video production company. She currently runs Gabrielle Consulting, a company specializing in web-based instructional systems design, human performance technology, and distance learning.

In her spare time, Gabrielle enjoys spending time with family and friends and swimming with the Atlantic Bottlenose dolphins off of Florida's Emerald Coast-especially one pod she has been swimming with since she was a young girl. She also enjoys SCUBA diving, traveling, hiking, bicycling, kayaking, working on classic cars, driving her vintage Mustang (which her dad's twin, her Godmother and Aunt Connie, bought brand new), and volunteering her time to charitable organizations.

Gabrielle's goal is to combine her interests of education and technology to bring educational opportunities to those who couldn't otherwise be easily reached (i.e. homebound disabled, people living in poverty). She loves to teach and plans to be a professor and a lifelong learner. She can be reached at gabrielle@gabrielleconsulting.com.