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An examination of the relationships among learning style, attitudes, and outcomes of computer-assisted instruction

Daniel Glen Wilson
University of Northern Iowa

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Wilson, Daniel Glen, D.I.T.

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U·M·I
300 N. Zeeb Rd.
Ann Arbor, MI 48106

AN EXAMINATION OF THE RELATIONSHIPS AMONG LEARNING STYLE, ATTITUDES, AND OUTCOMES OF COMPUTER-ASSISTED INSTRUCTION

A Dissertation

Submitted

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Industrial Technology

Approved by:

Dr. Charles D. Johnson, Advisor

Dr. M. Roger Betts, Co-Advisor

Dr. Douglas T. Pine

Dr. Andrew R. Gilpin

Dr. Sharon E. Smaldino

Dr. William P. Callahan

Daniel Glen Wilson

University of Northern Iowa

May 1994

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It is customary to thank those people directly involved in facilitating the completion of a dissertation. However, I would like to take this opportunity to thank those not directly involved, but without whom I would never have made it this far. These people include my uncommon parents Donald and Marilyn Wilson, my wife Katy, and also Dr. G, James, and Lisa--all have enriched my life in many ways.

DEDICATION

This work is dedicated to the memory of Bella Wohl.

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Dr. John W. Somervill
(Dean of the Graduate College)

Daniel G. Wilson

University of Northern Iowa

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ABSTRACT

This research was based upon a hypothesized Aptitude-Treatment Interaction (ATI). More specifically, the research investigated the relationships between student learning style (aptitude) and student outcomes with computer-assisted instruction (treatment). These outcomes included student achievement with computer-assisted instruction (CAI) and student attitude toward CAI.

To examine these relationships, a researcher-developed CAI program on light and color theory was validated and administered to 144 students in an educational media course at the University of Northern Iowa. Participants in the study were first asked to complete the Grasha-Riechmann Student Learning Style Scales (GRSLSS) inventory along with a demographic survey. Next, each participant completed a pretest, engaged in the CAI, and completed a posttest. Student achievement with CAI was defined as gain scores, a measure of the difference between pretest and posttest scores. Finally, attitude toward CAI was measured through the use of Allen's Attitude Toward CAI Instrument, a semantic differential tool.

A stepwise multiple regression analysis suggested that learning style as measured by the GRSLSS is an inadequate predictor of either student achievement with CAI or student attitude toward CAI. Furthermore, relationships examined

between specific learning style scales and either achievement with CAI or attitude toward CAI showed only one significant correlation: a positive relationship between the "Participant" learning style and attitude toward CAI. These relationships were examined using the partial correlation technique, which allowed the researcher to control for the demographic variables: (a) CAI experience, (b) computer experience, (c) gender, (d) year in school, and (e) GPA.

While student attitude toward CAI was positive overall, no significant relationship was found between attitude toward CAI and gain scores. This finding suggests that significant learning occurs regardless of student attitude toward CAI.

It was concluded that learning style, as measured by the GRSLSS, is an inadequate measure of factors related to aptitude for CAI. Other possible reasons for finding no effect include: (a) the sample of students participated as volunteers, and (b) the sample consisted of of teacher education majors, schooled in instructional design and media.

CHAPTER I

INTRODUCTION

This research focused upon a hypothesized Aptitude-Treatment Interaction (ATI). More specifically, the researcher investigated the effects of student learning style (aptitude) upon learning outcomes using the computer-assisted instruction method (treatment).

The idea that aptitude affects learning outcomes is not new. Henson and Borthwick (1984), in their historical perspective of learning style, indicated that in the early 1900s E. L. Thorndike had reported that student achievement was highly correlated with intelligence. This finding was said to have influenced educators' thinking about learning ever since that time. However, one significant limitation of Thorndike's findings was that the conditions under which these studies were carried out involved students being given the same type of instruction and the same amount of time to learn.

Henson and Borthwick (1984) further explained that Thorndike's findings led to the research of John B. Carroll. In a study reported in 1963, Carroll used a variety of teaching approaches and students were given as much time as they required to learn. Under these conditions student intelligence proved not to be a major factor in determining achievement. This research led to the concept of mastery

learning, a teaching concept by which achievement is held constant and teaching methods, materials, and time available remain flexible. This approach recognizes that individual learners have their own preferred learning styles, and that educators have the responsibility of considering these styles in their teaching. With these points in mind, Claxton and Murrell (1987) indicated that research on learning styles is urgently necessary to improve teaching and learning practices in higher education.

The focus of this research was to study how the learning styles of college students influence learning outcomes when using computer-assisted instruction (CAI). A study conducted by Frost and Sullivan (1984) provided evidence that CAI is an increasingly popular method of instruction, being used in nearly one half of all educational institutions. This research was undertaken because of the increasing use of CAI in colleges and the concern that teaching and learning practices in higher education require continual improvement.

Statement of the Problem

The problem of this study was to determine whether a relationship exists between and among the (a) learning styles of college students (as measured by the Grasha-Riechmann Student Learning Style Scales), (b) knowledge gained from computer-assisted instruction (CAI),

and (c) attitude toward the CAI method. Additionally, other factors including gender, year in school, familiarity with computers, level of experience with CAI, and GPA were examined to help assess relationships between student learning style, knowledge gains with CAI, and attitudes toward CAI.

Statement of Purpose

The purpose of this study was to provide teachers, instructional designers, and researchers with information concerning whether learning style can be used as an indicator of (a) potential performance and (b) receptiveness of students receiving CAI in a college setting.

Statement of Need

The need for this study was based on (a) a widespread use of CAI in education and industry, (b) a need for research on improving the effectiveness of CAI, (c) a need for research on the relationship between learning style and teaching methods, and (d) the need to assess the effects of attitudes of learners toward CAI. Below is an explanation of each of these factors as reported in the literature.

A Widespread Use of CAI in Education and Industry

As the computer has become increasingly common in education and industry, CAI has become a more popular technique for teaching in educational and training environments (Matta & Kern, 1989). As early as 1984, Frost

and Sullivan (1984) reported, after a nationwide survey, that CAI was in use in over 50% of the institutions in the United States. This statistic seems to be reflected in the literature, with researchers reporting the use of CAI in a wide variety of college courses. Examples found in the literature include statistics (Mausner et al., 1983), physical education (Stein, 1983), biomechanics (Boysen & Francis, 1982), chemistry (Cavin, Cavin, & Lagowski, 1981), physics (Kamm, 1981), textiles (Kean & Laughlin, 1981), and microcomputer keyboarding (Schultz, 1985). As a result of its widespread use, CAI has become an increasingly important topic of educational research.

A Need For Research on Improving the Effectiveness of CAI

Much of the research produced in the area of CAI has been designed to compare CAI to "traditional" classroom instruction. This type of research has been widely criticized by CAI researchers (Jolicoeur & Berger, 1988a; Reeves, 1986; Williams & Brown, 1990b). The following points have been included with these criticisms:

1. Despite 25 years of research, the results of such studies continue to show no significant difference between CAI and traditional instruction.

2. The results of these studies have been marginally useful (Reeves, 1986). For example, when one instructional method works better than another, it is rare for the

researcher to speculate on why the experimental method was more effective (Williams & Brown, 1990b).

3. Additionally, these studies commonly have problems with validity due to the variability of the human delivery of the subject matter (Reeves, 1986). It has been suggested by many CAI specialists that CAI researchers concentrate upon the specific characteristics that make CAI more effective (Jolicoeur & Berger, 1986; Matta & Kern, 1989; Solomon, 1981; Williams & Brown, 1990b).

While Jolicoeur and Berger (1988a) reported that there is very little empirical research available on the specific factors that make CAI effective, Williams and Brown (1990b) contended that CAI affords a unique opportunity for research with a high level of validity. CAI programs can be designed to hold variables like instructional design, content, delivery system, pacing, and many other variables constant. This allows the researchers to assess the variable under investigation with greater accuracy.

A Need for Research on the Relationship Between Learning Styles and Teaching Methods

The importance of appraising learner characteristics when designing instruction has been stressed in many instructional design models (Briggs & Wager, 1981; Dick & Carey, 1990; Gagne & Briggs, 1979). Authors of these models suggest that information on learner characteristics is

useful for designing appropriate instructional activities and methods (Dick & Carey, 1990). One technique used to assess student learning characteristics is to employ a learning style inventory. Learning style, according to Dunn, Beaudry, and Klavas (1989), can be defined as a "biologically and developmentally imposed set of personal characteristics that make the same teaching method effective for some and ineffective for others" (p. 50).

Several researchers have expressed a need for research on matching media and methods to appropriate learning style (Andrews, 1981; Cordell, 1991). Matta and Kern (1989), in discussing a framework for research in CAI, specifically suggested the need for assessing the impact of learning style on the performance of students using CAI. Similarly, Williams and Brown (1990a) discussed the importance of producing research which focuses on determining the types of learners that benefit most from CAI.

The Need to Focus on the Attitudes of Learners Toward CAI

Several authors writing on the design and development of CAI have stressed the importance of assessing attitude toward CAI. These authors believe that a learner's acceptance of the CAI medium is essential to the successful transference of knowledge (Clement, 1981; Criswell, 1989; Hannafin & Peck, 1988; Skinner, 1988). This belief is in accordance with the cognitive theory expressed by Kolesnik

(1976), which states that motivation and attitude influence the probability that learning objectives will be met.

A meta-analysis reported by Kulik, Kulik, and Cohen (1980) and Kulik and Kulik (1986) indicated that research has shown that college students have a generally positive attitude toward CAI. This finding was also supported by a study reported by Skinner (1988). While college students appear to have generally positive attitudes toward CAI, few studies have attempted to determine specific factors that affect attitudes toward CAI. One hypothesis of this research study is that learning style will be related to attitude toward CAI. Other factors that have been found to be related to attitudes toward CAI are succinctly described below, and in more detail in Chapter II.

Mathis, Smith, and Hansen (1970) concluded that college students who make many errors while being instructed by the computer are more likely to show a more negative attitude toward CAI. Also concluded in this same study was that college students with more experience with CAI tend to show a more positive attitude toward CAI. In another study, Hativa (1989) examined the effects of the variables of gender, grade level, and level of achievement in school on attitude toward CAI among elementary school students. Some minor effects among these variables were found.

Hypotheses

Research Hypotheses

This research centered around determining three central relationships. These include the relationship between (a) learning style and CAI achievement, (b) learning style and attitude toward CAI, and (c) attitude toward CAI and CAI achievement. Towards this end, three main hypotheses are stated as follows:

Hypothesis #1. The ability to learn from the CAI method (as assessed through knowledge gains) will be related to learning style in the following ways:

1a. The stronger the learner's independent style, the higher the learner's knowledge gain score will be.

1b. The stronger the learner's dependent style, the lower the learner's knowledge gain score will be.

1c. A relationship between the remaining learning styles and knowledge gain scores is not anticipated.

Hypothesis #2. Attitude toward CAI will be related to learning style in the following ways:

2a. The stronger the independent style, the more positively the student will report feeling about CAI.

2b. The stronger the dependent style, the more negatively the student will report feeling about CAI.

2c. The stronger the collaborative style, the more negatively the student will report feeling about CAI.

2d. The stronger the competitive style, the more negatively the student will report feeling about CAI.

2e. The stronger the avoidant style, the more positively the student will report feeling about CAI.

2f. A relationship between the participant learning style and attitude toward CAI is not anticipated.

Hypothesis #3. A significant positive correlation will exist between attitude toward CAI and knowledge gains.

A rationale for making these hypotheses is presented at the conclusion of Chapter II. Past research and other sources of literature on computer-assisted instruction and learning style are discussed in detail in Chapter II, and a more cohesive argument for these hypotheses can be given after presenting this information.

Null Hypotheses

1. No significant relationships between the investigated learning styles and CAI achievement will be found.

2. No significant relationships between the investigated learning styles and attitude toward CAI will be found.

3. No significant relationship between attitude toward CAI and knowledge gains will be found.

Delimitations

This study was delimited by the following factors:

1. This study was delimited to teacher education majors enrolled in an introductory educational media course at the University of Northern Iowa.

2. The study was delimited to a researcher developed CAI tutorial software program on the topic of light and color theory.

3. This research study was delimited to learning style as defined by the Grasha-Riechmann Student Learning Style Scales: a social-interactive model of college student learning style.

Assumptions

The following assumptions were made in pursuit of this study:

1. The sample of volunteer students investigated was representative of the population.

2. All participants in the study had at least an 8th grade reading level.

3. All participants in the study answered the instrument questions accurately and truthfully.

4. The learning style scales, gain scores, and attitude toward CAI scale each represented an interval level of measurement.

Limitation

The following is a limitation of this research study:

1. There are many variations of computer-assisted instruction. Generalization of this research data is limited by the use of a CAI tutorial with the following features:

   a. The program was designed in a branching format.

   b. The program utilized static color graphics and included no video or dynamic audio.

   c. Elaborative feedback was provided.

   d. The program was designed to be self-paced.

   e. The program focused students upon the theory of light and color.

   f. Completion of the program required about 40 minutes.

Statement of Methodology

The methodology used for this study is described below. This section is divided into (a) population, (b) sample, (c) materials and instruments, (d) variables, (e) procedure, and (f) research design.

Population

The population examined for this study is defined as all teacher education majors at the University of Northern Iowa.

Sample

The sample for this study consisted of volunteer college students enrolled in an educational media course at the University of Northern Iowa (UNI) in the fall semester, 1993.

Materials and Instruments

The materials and instruments used in this study included (a) the Grasha-Riechmann Student Learning Style Scales (GRSLSS), (b) a demographic survey, (c) a CAI program developed by the researcher on light and color theory, (d) a 20-item learner comprehension evaluation developed by the researcher (used as a pretest-posttest), and (e) an instrument to measure attitude toward CAI developed by Allen (1986). While validity and reliability information is described below, Chapter IV contains a more detailed description.

The Grasha-Riechmann Student Learning Style Scales. There are several factors that contribute to the researcher's decision to use the Grasha-Riechmann Student Learning Styles Scales (GRSLSS) instrument. First, reliability information was assessed in previous research and was readily available for inclusion in this study (Riechmann & Grasha, 1974). In this regard, Riechmann and Grasha reported that test-retest reliability coefficients for each style ranged from .81 to .89. Additionally,

construct validity has been determined and reported. Towards this end, Riechmann and Grasha reported having college students develop a Criterion Item Questionnaire to establish factors for correlation with GRSLSS items. To perform this factor analysis, 264 college students responded to both the Criterion Item Questionnaire and the GRSLSS. Significant correlations between the two scales provided evidence of construct validity. Additional validity data are reported by Riechmann (1974) in a separate study.

There are many different learning style instruments available and each tends to measure different student characteristics. In a study to compare four major learning style instruments, Ferrell (1983) examined four major learning style inventories in terms of underlying conceptualizations. She concluded that there were widely varying conceptions of learning style and that the investigated learning style instruments do measure styles to varying degrees in three domains; (a) cognitive styles, (b) affective styles, and (c) physical/physiological styles.

Unlike many learning styles instruments, the GRSLSS was developed specifically for use with college students (Hruska & Grasha, 1982). As reported by Ferrell (1983), the GRSLSS is the only instrument among the four major instruments investigated in her study to include an assessment of

affective styles (a major factor under investigation in this study).

The GRSLSS is a 90-item instrument designed to assess learners' social-interaction preference, that is, how they interact with students, teachers, and learning (Hruska & Grasha, 1982). There are three sets of learning style in which the student may vary in degree of preference: Independent-Dependent, Participant-Avoidant, and Collaborative-Competitive. Significant negative correlations have been found between Independent-Dependent, as well as between Participant-Avoidant. However, no significant negative correlation has been found between Collaborative-Competitive (Andrews, 1981).

Definition of the GRSLSS learning styles. The following are definitions of each of the learning styles assessed by the GRSLSS instrument (Riechmann & Grasha, 1974, p. 221):

> 1. Independent--This response style is characteristic of students who like to think for themselves. They prefer to work on their own, but will listen to the ideas of others in the classroom. They learn the content they feel is important and are confident in their learning abilities.
>
> 2. Dependent--This style is characteristic of students who show little intellectual curiosity and who learn only what is required. They see teachers and peers as sources of structure and support. They look to authority figures for guidelines and want to be told what to do.

3. Collaborative--This style is typical of students who feel they can learn most by sharing their ideas and talents. They cooperate with teachers and peers and like to work with others. They see the classroom as a place for social interaction, as well as content learning.

4. Competitive--This response style is exhibited by students who learn material in order to perform better than others in the class. They feel they must compete with other students in the class for the rewards of the classroom, such as grades or teachers' attention.

5. Participant--This style is characteristic of students who want to learn course content and like to go to class. They take responsibility for getting the most out of class and participate with others when told to do so. They feel that they should take part in as much of class related activity as possible and do little that is not part of the course outline.

6. Avoidant--This style is typical of students who are not interested in learning course content in the traditional classroom. They do not participate with students and teachers in the classroom. They are uninterested or overwhelmed by what goes on in classes.

Demographic survey. The demographic survey was designed to determine each subject's (a) gender, (b) year in college, (c) level of computer experience (as perceived by the student and reported on a Likert-like scale), (d) level of experience with CAI (as perceived by the student and reported on a Likert-like scale), and (e) student reported GPA. These demographic variables were used to help assess relationships hypothesized by being used as partial correlates. The assumption that these variables may affect knowledge gained from CAI and attitude toward CAI was derived from studies by Hativa (1989) and Mathis et al. (1970).

Computer-assisted instruction program. The computer-assisted instruction program was designed and developed by the researcher on the subject of light and color theory. The lessons were designed in accordance with instructional design principles, pilot tested, and revised. No prerequisite knowledge was required by the participants for learning the information. However, it was assumed that the learners had at least an eighth grade reading level. The program was designed in a branching format which provides the learner with flexibility in controlling how the computer delivers the instruction. The program covered four topics as follows:

1. The nature of light and color
2. Additive theory of light
3. Subtractive theory of light
4. Practical applications

Evaluation of learner comprehension. A 20-item multiple choice/true-false instrument developed by the researcher measured how successfully learners met the objectives of the instruction. This evaluation instrument was validated by a panel of 6 experts. The experts on the validation panel were professors of graphic communications technology at United States universities, each having experience in teaching the content of the lesson. Each expert reviewed the CAI lesson and evaluated (a) the

accuracy and adequacy of the program for college level students and (b) the extent to which the test evaluates knowledge. As a result, the pretest-posttest appeared to be valid. Internal consistency of the instrument was found to have a Cronbach's alpha coefficient of .76.

Assessing attitude toward CAI. An instrument designed by Allen (1986) to measure a learner's attitude toward CAI was used in this study. The instrument is a semantic differential tool consisting of 14 bipolar categories of 28 terms. Validity of the instrument was reported to have been assessed through a panel of five judges. This panel of judges was reported to have included four known for their expertise in CAI and one psychometrician. Reliability of the instrument was reported to have a Cronbach's alpha coefficient of 0.853 using a sample of 107 college nursing students. The overall attitude assessed can be broken down into subscales consisting of (a) comfort, (b) creativity, and (c) function. However, only the global scale was used in this study.

Independent and Dependent Variables

Each of the variables assessed in this study is described below.

Independent variables. (1) Independent variables include each of the six learning style categories; (1a) Independent, (1b) Dependent, (1c) Collaborative, (1d)

Competitive, (1e) Avoidant, and (1f) Participant.
(2) Additionally, demographic variables investigated include (2a) gender, (2b) year in school, (2c) level of experience with computers, (2d) level of experience with CAI, and (2e) student reported GPA.

Dependent variables. Dependent variables investigated include (a) knowledge acquired through the use of CAI, and (b) attitude toward the use of CAI.

Procedure

The procedure used to gather data for analysis in this study is described below.

Subjects. The subjects used for this study were volunteer students from a University of Northern Iowa educational media course held in the Fall Semester, 1993. This course had an enrollment of 301 students. A total of 144 of these students participated in the study. Incentive in the form of extra credit was given to these students.

Human subjects clearance. Appropriate documentation was filed with the University of Northern Iowa to initiate clearance for the research to be undertaken. In accordance with university policy, each participant signed a consent form indicating his/her willingness to participate in the study.

Data collection. The organization of the data collection phase of this study was carried out in the following manner: First, a university computer room with a sufficient number of MS-DOS compatible computers was secured. Over a two-week period in 1993 beginning September 2nd and ending September 15th, participating students were asked to volunteer about 1 hour and 30 minutes of their time. During this time period, the following events took place:

1. Subjects took the GRSLSS inventory and responded to demographic information (20 minutes).

2. Subjects took a knowledge evaluation pretest (10 minutes).

3. Subjects engaged in computer-assisted instruction on light and color theory (40 minutes).

4. Subjects took a knowledge evaluation posttest (15 minutes).

5. Subjects filled out the attitude toward CAI instrument (5 minutes).

All of the instruments were combined into packets with written instructions. A monitor was present at each CAI session to get the students started. Provisions were made so that each student was given the same instructions in the same sequence regardless of which monitor was present. Specific questions on content were not answered so as not to

interfere with the variables under investigation. University student identification numbers were requested for data organization purposes only.

Research Design

A pretest-posttest design was used to determine knowledge gains. Attitude scores were obtained from the attitude instrument developed by Allen (1986). According to the results of the instruments, knowledge gain scores and attitude scores were examined as dependent variables. The six learning style scales were used as independent variables. Correlations among the variables were examined.

Statistical analysis of null hypotheses. To examine the relationship between learning style and both CAI achievement and attitude toward CAI, a step-wise multiple regression analysis was performed. This analysis is employed to determine the best regression equation between a set of predictor variables (in this case learning style) and a criterion variable (both CAI achievement and attitude). If a significant effect is shown, than the resulting regression equation can be used (with some degree of error) to predict, in this case, both CAI achievement and attitude from learning style scores (Mendenhall, 1987).

Each specific hypothesis was analyzed using a partial correlation. Partial correlation is a multivariate correlation technique that enables the researcher to measure

the strength between the dependent variable and one of many selected independent variables. The primary advantage of this technique is that the effect of selected independent variables can be held constant (Pfaffenberger & Patterson, 1987). For example, in this study the effect of the demographic variables on the dependent variables was held constant, allowing for a more accurate estimate of the strength of the relationship between the independent variable and dependent variable under investigation. Furthermore, a correlation matrix was generated to show Pearson correlation coefficients between any two variables under investigation in this study. Point-biserial correlations were determined to investigate relationships between gender and other variables.

Definition of Terms

The following terms are defined to clarify their use in the context of the study:

1. Computer-assisted instruction--Any instance in which instructional content or activities are delivered via a computer (Hannafin & Peck, 1988).

2. Learning Style--A biologically and developmentally imposed set of personal characteristics that make the same teaching methods effective for some and ineffective for others (Dunn et al., 1989).

3. Light and Color Theory--The theory of electromagnetic energy, the visible spectrum, and how colored light is affected by reflective and absorbative mediums.

4. Social-Interactive Learning Style--One category of learning style that is characterized by student preferences for classroom procedures, teacher-to-student interaction, and student-to-student interaction (Claxton & Murrell, 1987).

5. Teacher education major--Any person enrolled in a four-year college or university program of teacher preparation.

Summary and Description of Subsequent Chapters

This study was undertaken to gain a better understanding of the relationships among learning style, knowledge acquisition with CAI, and attitude toward CAI. A pretest-posttest research design was utilized, producing correlations among learning style, attitudes, and outcomes of CAI. The sample used consisted of 144 post-secondary education students at the University of Northern Iowa.

Chapter II provides an investigation into the literature on learning styles. Specifically, the chapter describes several learning style inventories and organizes them into two overall learning style models, one suggested by Curry (1983) and another by Keefe (1982). This chapter

also focuses upon CAI, providing a background, definition, and comparison with traditional classroom instruction. Also reviewed are various studies that reportedly investigated the relationships between learning styles and teaching methods. This chapter is summarized with a rationale for the hypotheses made in this study based upon the literature reviewed.

Chapter III contains a detailed description of the methodology used for data collection in this study. Additionally, further information on the validity and reliability of the research instruments is presented. Chapter IV contains a delineation of the research findings. Specifically, the data are statistically analyzed, presented, and discussed in this chapter. In Chapter V, the conclusions and recommendations resulting from the study are discussed. This chapter also includes recommendations for further research.

CHAPTER II

REVIEW OF LITERATURE

One purpose of this chapter is to examine the concept of learning style. Towards this end, two separate frameworks for understanding learning style will be presented along with a description of several learning style conceptualizations. These will include: Field dependence-independence; the Myers-Briggs Type Indicator; Kolb's Learning Style Conceptualization; Dunns' and Price's Learning Style Inventory; and the Grasha-Reichmann Student Learning Styles Scales (GRSLSS). Research reported in the literature which specifically focused upon each of these learning styles will be discussed. The GRSLSS will be discussed most extensively because of its use in this study.

Another purpose of this chapter is to provide a discourse on the development and present status of computer-assisted instruction. Furthermore, because the learners in this study were differentiated and defined by their reactions toward classroom procedures and learning, a framework for comparing CAI with more traditional approaches of classroom instruction will be discussed. Also, because one hypothesis of this study describes the possibility of attitudes affecting learning by CAI, a discussion of the literature on the relationship between attitudes and computer-assisted instruction will be reviewed. Associated

studies on the interactions between learning style and CAI are also reported.

Finally, this chapter is concluded with a rationale for the hypotheses made for this study. This rationale is based upon the literature reviewed.

Learning Style

There are various definitions of learning styles found in the literature. Bennett (1979) suggests that learning style is the way a student prefers to learn. It includes the cognitive and personality characteristics that influence how a student goes about learning. Dunn et al. (1989) define learning style as a "biologically and developmentally imposed set of personal characteristics that make the same teaching method effective for some and ineffective for others" (p. 50). These definitions are similar and rather broad. The difficulty in making sense of learning style is that many different kinds of learning style inventories are reported in the literature, and each appears to measure different factors. This observation is supported by Ferrell's 1983 study. She conducted a factor analysis using four major learning style inventories and concluded that these inventories clearly did not measure the same thing.

To define learning style more accurately, it is useful to have a framework from which various conceptualizations can be categorized. One such conceptual framework was

suggested by Curry (1983). This framework uses the metaphor of an onion, in which the layers of the onion are analogous to the various conceptualizations of learning style. At the core of the onion is the concept of personality differences. The middle layers represent the concepts of information processing and social interaction. Information processing describes how persons tend to take in and process information. Social interaction deals with how students tend to interact and behave in the classroom. The outer layer represents instructional preference, that is, the preferences a student shows for various instructional methods and techniques.

Another model for conceptualizing learning styles was offered by Keefe (1982). Keefe suggested analyzing learning styles in three categories: cognitive styles; affective styles; and physiological styles. One or all of these styles may be represented in a given learning style inventory.

Keefe (1982) defines cognitive styles as "information processing habits representing the learner's typical mode of perceiving, thinking, problem solving, and remembering" (p. 44). Affective styles focus on attention, emotion, and valuing. Furthermore, affective styles can be viewed as the learner's typical mode of arousing, directing, and sustaining behavior. Affective styles are thought to be the

products of the cultural environment, parental and peer influences, and personality factors. Keefe defines physiological styles as "biologically based modes of response that are founded on sex-related differences, personal nutrition and health, and reaction to the physical environment" (p. 49). Comfort levels associated with temperature differences and hunger tolerances are examples here.

Learning Styles Instruments

For the remainder of this investigation of literature on learning styles, several specific learning styles instruments will be examined. These few instruments were selected out of the many available because they are prevalent in the literature. Also, taken as a whole, they address all three aspects of Keefe's (1982) conceptualization model and each aspect of Curry's (1983) metaphorical model. Each will be discussed with examples of research that address the educational implications of assessing the learning style.

It should be stressed here that most learning styles are bipolar, representing a continuum from one extreme of a trait to the other. An individual is rarely diagnosed as having one style and not the other, but rather as having more of a tendency toward one style than the other (Keefe, 1982).

Field dependence and independence. According to Curry's (1983) model, the field dependence-independence conceptualization of learning style falls into the category of "personality types." Keefe's model (1982) places this learning style measurement under "cognitive styles."

According to Guild and Garger (1985), Herman A. Witkin has completed "the most extensive and indepth research on cognitive style conducted in the last 50 years" (p. xii). Specifically, Witkin and his colleagues developed the methods to measure field dependence-independence.

Two methods used to determine field dependence-independence are the rod-and-frame test and the embedded-figures test (Witkin, 1976). The rod-and-frame test involves the use of a luminous rod situated in a luminous frame viewed within a darkened room. Both the rod and frame can be pivoted independently, and the subject is asked to pivot the rod to a vertical position while the frame is held in a slanted position. Subjects who pivot the rod to a vertical position relative to the frame are considered field dependent. Subjects who pivot the rod to a vertical position relative to gravity are considered to be field independent.

In the embedded-figures test, the subject is shown a simple geometric figure, such as a square or rectangle, and then shown a more complex figure that has hidden within it

the more simple figure. Subjects who are able to pick out the simple figure in the more complex are considered to be field independent. Those who are unable to find the simple figure are considered to be field dependent.

According to Witkin (1976), field dependent persons are supposed to be more strongly influenced by authority figures and by peer groups than are field independents. Also, field dependent persons tend to differ from field independent persons in speech patterns, referring more to others than themselves as they talk. Studies in academic contexts have shown that field independent students favor areas of study that involve analytic skills, such as mathematics, engineering, and science. Field dependent students favor academic areas that call for more extensive interpersonal relations, such as teaching, counseling, and sales (Witkin).

Studies focusing on educators suggest that more field independent teachers prefer the lecture method, while more field dependent teachers prefer discussion methods (Witkin, 1976). Another significant finding is that students were found to prefer teachers that were more like themselves in terms of cognitive skills. Researchers who have attempted to determine whether matching students' field dependent or field independent style with preferred teaching styles improves learning, have shown varying results. For example, Macneil (1980) conducted a study of 64 undergraduates in a

recreation education program and found no interaction between teaching methods and the achievement of field dependent-independent students. In this study, independent variables included two types of instructional approaches (discovery and expository) as well as cognitive style. The researcher equally divided classes into randomly chosen field dependent and field independent students. With one class learning through the expository method and the other through the discovery method, it was hypothesized that field independent students would show greater achievement in the former and field dependent students would show greater learning in the latter. However, Macneil found that achievement did not vary as a function of style.

Abraham (1985), conversely, did find an interaction among field dependence-independence, teaching approach, and achievement. In a study of teaching English as a second language, Abraham hypothesized that a teaching method that did not emphasize rules would be of greater value to field dependent students. Abraham based this hypothesis on previous research that showed that field independent students are more adept at using rules than field dependent students. The researcher used two computer-assisted instruction lessons. One lesson was rule oriented and deductive. The other lesson provided more concrete examples and deemphasized rules. A pretest-posttest was used to

measure knowledge gains and it was concluded that field independent students did indeed perform better with the rule oriented, deductive approach. Field dependent students learned better with the concrete, example rich approach.

The Myers-Briggs Type Indicator. According to Keefe (1982), the Myers-Briggs Type Indicator (MBTI) learning style conceptualization falls into both the "cognitive style" and "affective style" categories of his model. Curry (1983) places this learning style instrument into the category of "personality types."

Two women, Isabel Myers and her mother Katherine Briggs, developed the Myers-Briggs Type Indicator (MBTI) as a means of identifying the personality types described by Carl Jung in his book Psychological Types (1923) (Lawrence, 1982). The MBTI is a self-administered questionnaire. It was first published in 1962 by the Educational Testing Service as a research instrument. This instrument has been used extensively and has a research bibliography of over 600 entries. Among these entries are research studies examining personality type differences in academic aptitude, teaching, and learning (Lawrence).

Jung's theory states that the world can be perceived in two distinct ways: sensing or intuition. Furthermore, people use two distinct and contrasting ways to reach conclusions or make judgements: thinking or feeling. In

addition to the individual's preference on both of the above mental functions is a tendency toward extroversion or introversion and a preference for the person's attitude toward life, which can be either judging or perceptive (Lawrence, 1982).

These characteristics form four dichotomous scales: Extroversion versus Introversion (E-I); Sensing versus Intuition (S-N); Thinking versus Feeling (T-F); and Judging versus Perception (J-P). On the E-I scale, a person's preference for the direction of his or her energy and interest is either toward the outer world of persons and objects (Extroversion) or toward the inner world of ideas and concepts (Introversion). On the S-N scale, a person's preference is for perceiving the world primarily through the five senses (Sensing) or for perceiving the world through inferred meanings and possibilities (Intuition). On the T-F scale, a person's preferences are determined by whether he or she relies more on logical order in making judgements (Thinking) or more on personal values (Feeling). On the J-P scale, the preferences are characterized by planning and controlling events (Judging) or by being flexible and spontaneous (Perception) (Myers & Myers, 1980).

Researchers who have focused on the educational implications of the MBTI have found many interesting effects. Researchers studying students at the Florida State

University Development Reading School found that intuitive types score higher on aptitude measures based on reading and writing (McCaulley & Natter, 1980). This is because intuitive types quickly convert symbols into meaning; thus they grasp concepts and ideas faster from written words than do sensing types.

In a study examining teachers of different types, it was found that sensing educators choose to teach lower levels of education and are more likely to teach practical facts and details. Intuitive educators are more likely to be found in colleges and universities teaching abstractions and theory (Lawrence, 1982).

Kolb's Learning Style Inventory. Kolb's learning style inventory falls under the "information processing" category of Curry's model (1983). Keefe's model (1982) places Kolb's learning style into the category of "cognitive styles."

This learning style conceptualization was derived from a theory of learning called "experiential learning," originating from the works of John Dewey (Kolb, 1984). Dewey's theory, dealing with both learning and individual development and growth, emphasizes the need for learning to be grounded in experience.

From this theory, Kolb (1984) describes learning as having four phases. The first phase involves learners having "concrete experience." That is, being involved fully

in an experience. From this phase, the learner moves on to "reflective observation," at which time the learner reflects on the learning experience. This leads to an "abstract conceptualization," which involves forming theories as guides to further action called "active experimentation." This process repeats itself, moving to more complex levels.

The style of the learner becomes apparent when it is proposed that not all learners move through these four phases in the same way. In this regard, Kolb (1984) describes learning as having two key elements. The first is how the learner grasps experience and the second is how the learner transforms this experience to knowledge.

The style of the learner is differentiated in how an individual prefers to grasp an initial experience. Some may prefer to grasp the experience in concrete ways (concrete experience), while others may prefer ways that are more abstract (abstract conceptualization). The other preference occurs in how a person transforms information: through active experimentation or through reflective observation (Kolb, 1984).

From these basic preferences, Kolb (1984) categorizes four basic types of learners: divergers, assimilators, convergers, and accommodators. "Divergers" grasp experience through concrete experience and transform it through reflective observation. They are called divergers because

they are good at generating ideas and tend to be people oriented and emotional.

"Assimilators" grasp experience through abstract conceptualization and transform it through reflective observation. They are called assimilators because they like to assimilate diverse data. These types of learners are less interested in people and are more concerned with abstract concepts (Kolb, 1984).

"Convergers" grasp experience through abstract conceptualization and transform it through active experimentation. They are called convergers because they prefer to move quickly from a problem to a single answer. These types of learners tend to be unemotional and prefer dealing with things rather than with people (Kolb, 1984).

"Accommodators" grasp experience through concrete experience and transform it through active experimentation. They are called accommodators because they do well in situations where they must adapt to new circumstances. They are intuitive and are often impatient when presented with a problem that does not conform to their ideas (Kolb, 1984).

To assess the learning style of a person, Kolb (1976) developed an inventory in which subjects rank order nine sets of four words. Each of the words reflects a tendency toward one of the four phases of learning.

Research on 800 managers and graduate students showed that business majors tended to be accommodators. Engineers tended to be convergers. English and psychology majors tended to be divergers. Mathematics and chemistry majors tended to be assimilators (Kolb, 1981).

In research reviewed that has reported attempts to match teaching methods to learning style (Ballard, 1980; Fox, 1984), learning benefits have not been found. These findings have called into question the usefulness of this learning style conceptualization as a guide for educational design. However, the thesis of Kolb's model is not to match a particular educational technique to a learner's style with the goal of yielding the most learning benefit, but rather to provide ample opportunity for learners to deal with information in all four modes and to develop greater competency in each (Kolb, 1984).

Dunns' and Price's Learning Style Inventory. According to Keefe (1982), the Learning Style Inventory (LSI) is the most widely used instrument to measure learning style in elementary and secondary schools. The LSI falls into all three of Keefe's learning style categories; cognitive, affective, and physiological. The LSI could be placed into each of Curry's (1983) categories as well. The LSI is a 104-item self-reported questionnaire.

The LSI defines learning style in terms of four learning condition classifications: environmental; emotional; sociological; and physical. Each condition classification is defined by certain elements. For example, the "environmental" condition is defined by the element of light (among other elements), referring to a learner's lighting preference, ie. soft vs. bright (Dunn, 1982).

Under the environmental condition classification are four elements in which individuals may vary in preference. These include sound, light, temperature, and design. The emotional condition classification elements include motivation, persistence, responsibility, and structure. Sociological condition classification elements include self-oriented, colleague-oriented, authority-oriented, and team-oriented. Under the physical condition classification are four elements: perceptual, intake, time-of-day, and mobility (Dunn, 1982).

The focus of the LSI is primarily toward elementary and secondary level students. The authors of the instrument hold that these students should be taught in ways that agree with their learning style preferences. This practice, the authors assert, will result in increased academic achievement (Dunn, 1982).

The Grasha-Riechmann Student Learning Style Scales.

The Grasha-Riechmann Student Learning Style Scales (GRSLSS) is reported to be one of the few instruments designed to look specifically at student differences at the college/university level. This learning style inventory is based on students' response styles defined around three classroom dimensions: (a) students' attitudes toward learning, (b) their views of the teacher and/or peers, and (c) their reaction to classroom procedures. The instrument was developed over a period of two years through interviews with students at the University of Cincinnati (Grasha, 1972; Riechmann & Grasha, 1974). According to the framework suggested by Curry (1983), the GRSLSS fits into the category of "social-interactive" learning styles. According to Keefe's (1982) model, the GRSLSS measures both "cognitive style" and "affective style."

There are six styles which are defined around how students approach interaction and learning in the classroom. These learning styles are defined by Riechmann and Grasha (1974, p. 221) as follows:

> 1. Independent--This response style is characteristic of students who like to think for themselves. They prefer to work on their own, but will listen to the ideas of others in the classroom. They learn the content they feel is important and are confident in their learning abilities.
>
> 2. Dependent--This style is characteristic of students who show little intellectual curiosity and who learn only what is required. They see teachers and peers as

sources of structure and support. They look to authority figures for guidelines and want to be told what to do.

3. Collaborative--This style is typical of students who feel they can learn most by sharing their ideas and talents. They cooperate with teachers and peers and like to work with others. They see the classroom as a place for social interaction, as well as content learning.

4. Competitive--This response style is exhibited by students who learn material in order to perform better than others in the class. They feel they must compete with other students in the class for the rewards of the classroom, such as grades or teachers' attention.

5. Participant--This style is characteristic of students who want to learn course content and like to go to class. They take responsibility for getting the most out of class and participate with others when told to do so. They feel that they should take part in as much of class related activity as possible and do little that is not part of the course outline.

6. Avoidant--This style is typical of students who are not interested in learning course content in the traditional classroom. They do not participate with students and teachers in the classroom. They are uninterested or overwhelmed by what goes on in classes.

The authors developed this instrument by using a rational approach to scale construction. The rational approach emphasizes the importance of theory and devising items in relation to one's theory. To facilitate this process, judges are used to choose items that they feel rationally relate to the theory or constructs being considered (Riechmann & Grasha, 1974). This instrument was developed with the use of undergraduate students as judges, who were asked to sort items describing students' classroom behaviors into the six learning style categories:

Independent, Dependent, Participant, Avoidant, Collaborative, and Competitive.

To provide evidence of construct validity for the instrument developed, several small groups of undergraduate students developed a Criterion Item Questionnaire. This questionnaire was designed to predict the types of behaviors that students with each of the styles would exhibit. For example, an Avoidant student might miss a lot of classes or might doodle during lectures (Riechmann & Grasha, 1974).

Both the Criterion Item Questionnaire and the GRSLSS were administered to 264 sophomore psychology students. Significant correlations between the two instruments provided evidence of construct validity (Riechmann & Grasha, 1974). Additional construct validity was offered by Riechmann in her doctoral dissertation (1974). In a study of 151 psychology students, Riechmann reported significant correlations between various selected factors and each learning style. For example, the higher the Avoidant students scored on the scales, the less they tended to enjoy instructor-to-individual interaction relationships in the classroom. Avoidant students also tended to have lower grade point averages, while Participant students tended to have higher GPAs. Dependent style learners were found to have a strong preference for teacher-centered instructional

methods, while Independent learners preferred student-centered instructional methods.

The test-retest reliability coefficients for the GRSLSS (with seven day intervals between testing) were reported as follows (N = 119): Independent, .84; Dependent, .81; Participant, .89; Avoidant, .82; Collaborative, .81; Competitive, .84 (Riechmann & Grasha, 1974).

In a study to determine the variance of learning styles across disciplines (Creative Arts, Engineering, Business, Math/Science, and Social Sciences) Emmanuel and Potter (1992) found significant differences across majors for Dependent, Participant, and Competitive learning styles. Engineering students rated the Dependent style the highest, while Creative Arts students rated it the lowest. Creative Arts students were also the most highly rated Participant and Competitive students. Emmanuel and Potter also reported learning style differences between high school and college students. College students tended to be more Competitive and less Collaborative than high school students.

Significant gender differences have been found among learning styles as well. Kraft (1976) found that among physical education majors, males tend to be more Competitive, Avoidant, and Independent than females. Emmanuel and Potter (1992) reported similar findings, with the addition that females were likely to be more Participant than males.

Studies suggest that age may make a difference in learning style. Hruska and Grasha (1982) reported that students over the age of 25 were more Independent and more Participant in their learning styles. Similar findings were reported by Eison and Moore (1979) and Kraft (1976).

Andrews (1981) suggested that students may benefit more from classroom methods that match their learning styles. In this study, freshman students in an introduction to chemistry course were randomly assigned to two sections, each taught by different methods. One class was instructor-centered and the other class was student-centered. The instructor-centered class involved a lecture format, with a central role for the instructor. In the student-centered class, the instructor served more as a facilitator and a resource, and the students were responsible for presentations and student-to-student teaching.

Andrews (1981) found that students high on the Collaborative scale reported a stronger benefit from participating in the student-centered section. By contrast, students with a strong preference for the Competitive style reported more benefit from the instructor-centered section. Andrews also found that students with more "impersonal" styles (Independent, Avoidant, Competitive) found the text, handouts, and lectures to be most helpful. Those students

with strong "personal" styles (Collaborative, Participant, Dependent) found review sessions, study questions, and learning from other students to be most beneficial.

In regard to identifying specific classroom activities that may be most beneficial for each learning style, Hruska and Grasha (1982) suggested that Competitive students may prefer to be group leaders in group projects. Also, these students are likely to prefer a lecture-centered focus rather than discussion. Collaborative students are likely to prefer small seminars and student-centered discussion classes. They may also enjoy the discussion of course issues outside of class with other students.

Avoidant students are generally turned off by all classroom activities and are likely to prefer self-evaluation for grading or blanket grades where everyone gets a passing grade. Participant students prefer lectures with discussion and will prefer teachers who can analyze and synthesize material well (Hruska & Grasha, 1982).

Dependent students are likely to appreciate teacher outlines and notes on the board. They also prefer clear deadlines for assignments and teacher-centered classroom methods. Independent students are likely to prefer self-paced instruction and individual projects that challenge the student to think for himself/herself (Hruska & Grasha, 1982).

Computer-Assisted Instruction

Introduction

Even before the inception of the computer, educators had speculated on how machines might be used to teach human beings. One of the first and most noted of these people was B. F. Skinner, the behavioral psychologist. He devised a mechanical sliding panel to (a) present an instructional sequence, (b) accept a response, and (c) provide appropriate feedback to the response (Skinner, 1961). The influx of microcomputers into the educational system has brought about increasingly sophisticated instructional technology techniques. Modern instructional software packages are designed to utilize the unique abilities of the microcomputer to teach various kinds skills and knowledge. This unfolding technology is known as computer-assisted instruction (CAI) (Hannafin & Peck, 1988).

There are several other acronyms used to represent the use of computers to achieve educational or training objectives. Computer-based training (CBT) is a title that refers to CAI being utilized in training situations, rather than in an educational setting. Computer-managed instruction (CMI) refers to the computer as a tool to manage the instructional process by not only teaching lessons, but by keeping records and printing reports (Lillie, Hannum, & Stuck, 1989).

Types of CAI

There are three basic types of CAI: tutorial, drill and practice, and simulation. In tutorial lessons, the learner is provided with new information to assist with the acquisition of new knowledge and skills. Drill and practice programs are designed to reinforce and remediate already learned information. Typically the learner is presented with a question, enters a response, and receives negative or positive feedback on the quality of the response. Simulation differs from both tutorials and drill and practice in that the interactions of the learner are not responses to questions but rather decisions made in role-playing situations (Lillie et al., 1989).

Four Developmental Phases of CAI

Bramble and Mason (1985) described the development and future of CAI by illustrating four phases. The first phase, called the "experimental" phase, began in the early 1960s when only a small number of university educators were starting to explore CAI on mainframe computers. High costs, primitive software, and cumbersome equipment limited the adoption of CAI during this early phase.

The second phase, called the "popularization" of CAI, began in late 1970s. During this phase the first generation of commercially produced microcomputers were introduced and the computer became popularly accepted as an educational

tool. The microcomputers of this phase had relatively small memory and storage capacities. The CAI software available at this time was mainly short single-lesson packages (Bramble & Mason, 1985).

The third phase, called the "transition phase," began in the mid-1980s as educators were becoming increasingly computer-literate and were applying more critical standards to hardware and software designed for education. During this phase, microcomputers were beginning to be used to perform educational tasks reserved only for human teachers in the past, like lesson delivery, skill testing, and record keeping (Bramble & Mason, 1985).

The fourth phase, called the "infusion" phase, was expected to begin by the year 2000. Bramble and Mason (1985) speculated that by this time the computer would no longer be a supplemental tool for education, but would become an integral part of educational procedures. It would regularly be used as a device to deliver individualized lessons, provide remedial education, and maintain records of student progress. It was also predicted that by this time most common machines (automobiles, washing machines, printing presses, etc.) would be equipped with sophisticated microprocessors and electronic memory devices used to provide instruction on control functions to the user.

Hannafin and Peck (1988) have written that the future for CAI looks promising. Computers have revolutionized life in many countries and most jobs entail some degree of contact with computers. The nature of the technologically changing workplace is forcing the need for continual training and retraining for many people. This trend is expected to continue. Because CAI is now gaining greater acceptance in education, it will likely become increasingly important in the future as the number of CAI applications increase and the inhibiting factors of cost and unfamiliarity are reduced.

CAI vs. Traditional Instruction

To examine CAI more clearly, its unique capabilities will be compared with those of traditional instruction. According to Steinberg (1991), traditional classroom instruction differs from CAI in three major ways, including (a) modes of communication, (b) instructor-student interactions, and (c) environment.

Modes of instruction. One major difference between traditional classroom instruction and CAI is the type of communication between a student and instructor (or instructing medium). In a traditional classroom, an instructor uses oral and physical means to communicate. For example, the instructor may write on the chalk board, draw diagrams, display illustrations, and/or communicate by

nonverbal, physical gestures. By contrast, during CAI the computer (instructing medium) communicates primarily in one mode: visual. While this has been true in the past, new technologies are making audio CAI presentations more feasible. Interactive videodiscs which have both audio and video motion are gaining popularity. Nevertheless, at present, most CAI lessons are still communicated to the learners in primarily a visual mode (Steinberg, 1991).

Instructor-learner interaction. An important aspect of classroom instruction is the interaction between an instructor and a student. An instructor can monitor student understanding by asking questions while (normally) one student at a time responds overtly. Other students can respond covertly (to themselves). An instructor can judge progress in learning by observing student behavior. A computer cannot see a student. The most common way that a computer monitors understanding is by asking questions (programmed into the application) and evaluating the student's response by comparing it with a programmed match (Steinberg, 1991). To accomplish this, a computer lesson requires overt responses.

Judging student responses also varies between a traditional classroom and CAI. Human instructors can apply judgement in evaluating a student's response. He/she can accept an answer that is correct even if it is not the one

that he/she anticipated. Instructors know if an answer is partially correct and can provide appropriate feedback (Steinberg, 1991).

In CAI, answers can be flexible, but this requires a flexible response to be programmed into the computer. Most CAI at this time is not very flexible. Computers cannot answer spontaneous questions posed by a student. Instructors, however, can usually answer students' questions, but if not, can suggest resources for finding the answers (Steinberg, 1991).

Instructor-learner interaction is also different in CAI because the responsibility for managing instruction is often shifted to the student. Conversely, classroom learning is group-based. It is basically teacher-controlled, even in small group instructional situations. The teacher determines (a) the sequence of instruction, (b) the pace of instruction, (c) when to continue to another topic, and (d) when to assess misunderstandings. Instruction follows the same path for every learner. By contrast, CAI is individually paced and can allow the student to choose between multiple instructional paths. The flow of instruction can be controlled by the computer program, but most designs give the student the flexibility to control pace and direction of the instruction (Steinberg, 1991).

Environmental factors. In the classroom, the quality of one's performance is often self-evident. For example, a learner can measure his/her progress by glancing ahead in a textbook to see how much remains to be done. The status of a student's knowledge and performance relative to the performance of other students is generally self-evident. In CAI, this kind of feedback is only possible if programmed into the application. Knowing how one compares to others is not always self-evident (Steinberg, 1991).

Students are familiar with the mechanical aspects of learning in the classroom from previous experiences. They know how much time they have to make responses, how to get help, and how to correct answers. This is not necessarily so in CAI (Steinberg, 1991).

Students also learn by observing and interacting with others in a classroom. A student who is unable to answer a question posed by the teacher can often learn by listening to another student's response. The give and take of classroom learning is generally not present in CAI (Steinberg, 1991).

The capacity for individualized instruction gives CAI a significant advantage. Lessons allow each learner to progress at a self-determined pace, moving quickly through topics that are easily understood and slowly through more difficult ones. A concept missed or not thoroughly

understood can be repeated. By contrast, students in a classroom move along at basically the same pace. Faster students have to wait for slower ones and slower ones may be unable to keep up with the group (Steinberg, 1991).

Research on the Effectiveness of CAI

Kulik et al. (1980) and Kulik and Kulik (1986) performed a meta-analysis to examine the results of hundreds of studies that focused upon the effectiveness of CAI at the college level. A meta-analytic technique involves (a) locating appropriate studies, (b) determining salient features that will be globally examined, (c) coding study outcomes on a common scale, and (d) using statistical methods to relate study features to outcomes.

Both meta-analyses cited above showed that CAI at the college level produces small, but positive effects on student learning when compared to more traditional forms of instruction. The general design of these studies was either experimental or quasi-experimental, where a control group was administered "traditional" instruction and the treatment group administered CAI. No significant difference was found between studies using experimental and quasi-experimental designs.

Learning Style and CAI Achievement

Several studies that have examined the relationship between various types of learning styles and CAI achievement

are reported in the literature. Many of the findings are varied and inconclusive. For example, Woodridge (1990) examined Kolb's four learning style types as predictors of achievement in a CAI program on electric circuits. A significant difference was found in gain scores, with assimilators scoring higher than divergers, convergers, and accommodators. However, Woodridge concluded that assimilators' dominant learning abilities are abstract conceptualization and reflective observation. Their greatest strength is the ability to create theoretical models and to use inductive reasoning. Therefore, it was unclear as to whether the difference in learning was due to the method (CAI) or the content. Woodridge concluded the difference was probably due to content.

In another study that utilized Kolb's learning style inventory, Cordell (1991) found no significant difference between the four learning style types and CAI achievement. The content of the CAI lesson was on weight management, which appears not to favor or inhibit any one type of learner.

In a study to determine the relationships between the four Myers-Briggs Types and knowledge gains from CAI, Howard (1986) found that while students did learn from the computer, there was no significant difference between the four personality types in terms of knowledge gains. Nor was

there a difference between the personality types in terms of attitudes toward CAI.

Post (1987) conducted a similar study to determine the effects of field independence-dependence on CAI achievement. He found a significant difference in learning between the field independent and the field dependent learners. Field independent students scored significantly higher than the field dependent students on a posttest measuring the learning of logic circuits. Post also compared IQ scores as a predictor of achievement with the predictive capacity of field independence-dependence. It was concluded that field independence-dependence is a better predictor of achievement from CAI than are IQ scores. No reference was made to the possibility of lesson content having an effect upon the differences in gain scores found between learning styles.

Student Attitudes and CAI

Clement (1981) speculated that personal attitudes toward computer-assisted instruction are critical to successful learning outcomes. In support of this theory, Knapper (1978) observed that students resistant to computer implementation at the beginning of instruction learn less than they would with more familiar, traditional techniques.

College students' attitudes toward CAI have been shown to be consistently positive. Kulik and Kulik (1986), in a meta-analysis of studies dealing with the effectiveness of

CAI, found that nine of the thirteen studies reporting attitudes found that students felt more positively toward CAI than the traditional instruction they received.

A study by Skinner (1988) showed that student ratings of instruction by computer were "overwhelmingly positive" (p. 12). In speculating on the reasons for these positive attitudes, Skinner offered three theories: (a) students like CAI because they tend to perform well on tests as a function of CAI; (b) students enjoy the interactive nature of CAI, receiving immediate feedback to their responses; and (c) CAI creates a "safe" learning environment for students, allowing them to progress at their own pace and to make mistakes without embarrassment. These theories are nearly identical to those offered by Clement (1981).

Mathis et al. (1970) provided some insight into why some students may respond unfavorably to CAI. In an experimental study of 108 psychology students, it was found that students generally felt positively toward CAI. However, those students who made more mistakes and offered more wrong answers while engaged in the instruction felt less positively toward CAI. Additionally, it was found that students who had experienced CAI felt more positively toward it than students who had not experienced CAI.

Few studies available in the literature, with the exception of Hativa's (1989), attempt to assess the effects

of individual differences upon attitudes toward CAI. Most studies compare some measure of learner attitude in a group receiving CAI with another group receiving traditional instruction.

In a study to determine whether grade school students' individual differences affect attitude toward CAI, Hativa (1989) found the following results: (a) high achievers tended to feel more positively toward CAI; (b) there was almost no significant difference between the attitudes of boys and girls; and (c) there were inconsistent results found when comparing the attitudes of students of different grade levels. However, there was some evidence of an increasingly more positive attitude as the grade level increased.

Summary and Rationale for Hypotheses

As indicated previously, there are various learning style concepts. This study was limited to the use of learning style as defined by Grasha and Riechmanns' GRSLSS, which assesses learning style in terms of social-interactive behavior (1974). Specifically, this learning style is defined by how college students react to classroom procedures and by their interaction with teachers and other students. Towards this end, students are supposed to fall into three dichotomous style groups which include: Independent-Dependent, Participant-Avoidant, and

Collaborative-Competitive. Statistical analysis has shown that the Independent-Dependent scales and the Avoidant-Participant scales are negatively correlated. However, the Collaborative-Competitive scales appear to be independent of one another (Andrews, 1981).

This study was concerned with examining relationships between learning style as defined by the GRSLSS and learning outcomes from computer-assisted instruction. To hypothesize relationships for this study, it was necessary to have an understanding of the unique characteristics of CAI. Steinberg (1991) described how computer-assisted instruction differs from traditional classroom instruction in terms of (a) modes of instruction, (b) instructor-student interaction, and (c) instructional environment. By exploring these aspects of instruction, several key differences emerge that define CAI as a unique instructional method. One unique characteristic of CAI is its limited ability to communicate in primarily a visual mode. While many CAI applications include video and dynamic audio, the CAI program used for this research study was limited to the use of textual elements and static illustrations. Another unique characteristic of CAI is the individualization of instruction. Students commonly work alone with the computer and are limited in their interaction with human teachers and students. While CAI can be administered to allow for more

student-to-student and teacher-to-student interaction, the CAI used for this research involved students working alone with the computer. CAI also requires students to be more actively involved in instructional decisions by empowering them with the ability to control both the sequence and pace of instruction. Additionally, social interaction is limited with CAI as students are generally not aware of how other students are progressing. Also, generally, students do not receive immediate feedback from a human authority.

With these points in mind, one can begin to formulate hypotheses on how social-interactive learning style might influence student reaction to CAI and subsequently the capacity to learn by the CAI method. No studies found in the literature have examined the relationship between CAI achievement and a social-interactive learning style model. However, the literature shows that other learning style models have been examined as predictors of CAI achievement. Nevertheless, only one study reviewed (Post, 1987) showed a significant effect. That study examined the field dependent-independent learning style conceptualization.

Restatement of Hypotheses, Discussion, and Rationale

There were three sets of hypotheses made at the outset of this study. The first of these hypotheses predicted the relationship between learning style and learning outcomes (specifically gain scores). The second set predicted

relationships between learning style and attitudes. The third hypothesis predicted the relationship between attitude and achievement. In light of the literature reviewed, the reasoning behind each restated hypothesis is stated below.

Hypothesis 1a. The stronger the learner's Independent style, the higher the learner's knowledge gain score will be.

Hypothesis 2a. The stronger the Independent style, the more positively the student will report feeling about CAI.

Hruska and Grasha (1982) indicated that the Independent style is characterized by students who prefer to work on their own and like to learn the content that they feel is most important. Furthermore, it is also suggested that these students would prefer self-paced instruction, and classroom situations which are student-centered. Because CAI so closely matches these students' preferences as a self-paced, individualized, and student-centered form of instruction, it was theorized that students with a more Independent style would respond positively to CAI by showing both higher achievement and more positive attitudes.

Hypothesis 1b. The stronger the learner's Dependent style, the lower the learner's knowledge gain score will be.

Hypothesis 2b. The stronger the Dependent style, the more negatively the student will report feeling about CAI.

Conversely from Independent style, the Dependent style is characterized by students who look to the teacher for structure and support. These types of students prefer to be told what to learn (Hruska & Grasha, 1982). It is hypothesized that these students would respond negatively to instruction in which they would be required to make their own decisions on the sequence of content and would receive little feedback from a human authority. Furthermore, these characteristics of CAI were expected to cause Dependent students such disharmony that they would show both lower achievement and more negative attitudes.

Hypothesis 1c. A relationship between the remaining learning styles and knowledge gain scores is not anticipated.

A relationship between the remaining learning styles (Competitive, Collaborative, Participant, Avoidant) and CAI achievement was not anticipated, and reasons for this are explained below. However, relationships between the remaining learning styles and attitude toward CAI was expected. The reasoning behind each of these hypotheses is discussed below.

Hypothesis 2c. The stronger the Collaborative style, the more negatively the student will report feeling about CAI.

Collaborative students are characterized by a preference for classroom situations in which group projects are assigned and plenty of opportunities for classroom socialization is provided (Hruska & Grasha, 1982). CAI is a form of individualized instruction, supporting an environment with little student-to-student interaction (Steinberg, 1991). For these reasons, the more Collaborative student was expected to show a more negative attitude toward CAI. However, the CAI environment was not expected to affect Collaborative students so adversely as to inhibit their ability to learn.

Hypothesis 2d. The stronger the Competitive style, the more negatively the student will report feeling about CAI.

Competitive students are characterized by preferring learning situations in which they are group leaders. Also, these students prefer situations where they can compare their progress with other students (Hruska & Grasha, 1982). The CAI instructional environment is one in which students are isolated and are generally not able to compare their progress with other students' progress (Steinberg, 1991). For these reasons it was expected that the more Competitive student would show a more negative attitude toward CAI. However, the Competitive students' characteristics were not expected to be so incapacitating in a CAI environment as to

impact these students' ability to learn (and subsequently their gain scores).

Hypothesis 2e. The stronger the Avoidant style, the more positively the student will report feeling about CAI.

Avoidant students tend to be uninterested in learning course content in the traditional classroom. They are characterized by being overwhelmed by normal classroom activities and by not enjoying interaction with teachers (Hruska & Grasha, 1982). The more Avoidant students have also been shown to have lower GPA's (Riechmann, 1974). Because CAI is self-paced and involves little student-to-student or teacher-to-student interaction, it was expected that Avoidant students would find in the CAI environment a "safe haven" for learning. This hypothesis was made on the assumption that all human beings have an innate desire to learn. For these reasons, it was expected that Avoidant students would respond positively toward the CAI by showing a more positive attitude.

Hypothesis 2f. A relationship between the Participant learning style and attitude toward CAI is not anticipated.

The more Participant student is characterized by the desire to get the most out of learning situations. These students like to go to class and want to take part in as much class-related activity as possible (Hruska & Grasha, 1982). It was hypothesized that the more Participant and

the less Participant students would be undifferentiated in attitude toward CAI. It was reasoned that Participant students are characterized as such specifically by their social-interactions. Because CAI provides an environment that is primarily non-social, these students' participant-related preferences were expected to be neglected. However, any negative feeling that these students may have felt toward CAI was expected to be offset by their eagerness to engage in learning situations. Thus, no relationships were expected.

Hypothesis #3. A significant positive correlation will exist between attitude toward CAI and knowledge gains.

With regard to the third hypothesis, several authors have suggested that a relationship exists between attitude and achievement. Kolesnik (1976) wrote that research indicates that motivation and attitude strongly influence the probability that learning objectives will be met. More specifically with regard to CAI, Clement (1981) suggested that attitude toward computer-assisted instruction is critical to successful learning outcomes. Skinner (1988) agreed with these statements. Furthermore, he offered the theory that students like CAI because they tend to perform well on tests as a function of CAI. With these points in mind, it was hypothesized that a positive correlation would exist between CAI attitude and learning outcomes.

The literature reviewed in this chapter provided a foundation from which to hypothesize relationships between learning style and CAI achievement and attitudes. Indeed, a synthesis of the literature proved essential to establish hypotheses, as no studies found in the literature have predicted relationships between a social-interactive learning style and CAI outcomes.

CHAPTER III

METHODOLOGY AND PROCEDURES

This study was designed to examine the relationship between the learning styles of college students and both achievement from CAI and attitude toward CAI. It was hypothesized that students with a stronger tendency toward certain learning styles would show an increased aptitude for learning from CAI and/or an increased attitude toward CAI. To examine the relationship of these variables with more ecological validity, several demographic variables were assessed and statistically controlled.

This chapter contains a description of the methodology and procedures used to perform this study. It is divided into the following sections: sample and population, software and instrumentation, data collection, and null hypotheses and data analysis.

Sample and Population

The sample for this study was drawn from an educational media course at the University of Northern Iowa. In soliciting volunteers to participate in the study, a short presentation was given to the class in which the purpose of the study was described along with an explanation of what was expected of volunteers. Students were given an incentive for participating in the form of extra credit points toward their grade for the course.

Students who volunteered were asked to sign up for a one-hour instruction and testing session. They were also asked to pick up a packet consisting of a demographic survey and the GRSLSS learning styles instrument which was to be completed before they arrived for the CAI session. During the one-hour session, the students (a) completed a pre-test, (b) engaged in a CAI program on light and color theory, (c) completed a post-test, and (d) filled out a semantic differential scale designed to assess student attitude toward CAI.

About 190 students initially signed up to participate. Of those students, 145 showed up at their prearranged CAI session and completed the requirements. One student's response forms were not useable and were therefore not included as data. The sample, consequently, is composed of 144 educational media students.

As the educational media course was required for most teacher education majors at UNI, it was assumed that all of the participating students were teacher education majors, though from various specializations. Therefore, the results of the study can be generalized only to students majoring in teacher education at the University of Northern Iowa.

Software and Instrumentation

This section begins with a short discourse on the development of the CAI software used in this research study.

A description of the software's validation will also be presented. This information will be followed by a description of the instruments used for this research. Specifically, evidence for each instrument's validity and reliability will be presented as reported in the literature or as determined by the researcher.

Computer-Assisted Instruction Program Development

The CAI program used for this study was developed by the researcher on the topic of light and color theory. This topic comprises theories of the physical nature of color, including the electromagnetic spectrum, the additive properties of light, and the subtractive properties of solid pigments and filters. The program was developed through a four phase instructional design process which consisted of (a) a needs assessment, (b) the design of instructional content, (c) the production and evaluation of the software, and (d) the validation of the CAI.

The first phase in this developmental process was to complete a needs assessment. This assessment included an analysis of the learners for which the instruction was intended. It also entailed a detailed review and analysis of the content and the selection of instructional objectives for which the learners were to meet.

During the second phase of development the instruction was designed through a storyboard technique. This technique

allowed the developer to visualize various solutions to instructional problems. The order of the instructional steps was selected and the script for instructional delivery written.

The third phase of development involved the production of the software. In this step, the program was flowcharted and authoring of the software was carried out. This production included creating digital illustrations, producing screen designs, laying out the typography, and programming feedback mechanisms. Programming and designing the CAI software was accomplished through the use of an authoring program called IBM LinkWay (Version 2.01).

Once the initial software was completed, the developer completed a formative evaluation. Towards this end, a class of about 20 students were asked to use the CAI program and report on a form with critical remarks. The resulting criticisms made were used to guide revision of the software.

In the last phase of development, the software was examined by a panel of content experts whose names are listed in Appendix F. These experts rated the accuracy of the content and the appropriateness of the CAI program for college students. On a rating scale of 1 (poor) to 9 (excellent), the experts' mean rating of the software yielded a score of 7.66 (see Table 1).

Table 1

Validity Ratings of the CAI Software on a Scale of 1 to 9

Expert	Software Rating
1	8
2	9
3	8
4	8
5	7
6	6
M	7.66

Instrumentation

There were several instruments used to collect data for analysis in this study. These included, (a) the Grasha-Riechmann Student Learning Styles Scales (GRSLSS), (b) the Attitude toward CAI semantic differential tool developed by Allen (1986), (c) a researcher developed pretest-posttest used to measure knowledge gained from a CAI program on light and color theory, and (d) a researcher developed demographic survey. Validity and reliability information will be

presented below for each of these instruments with the exception of the demographic survey.

The Grasha-Riechmann Student Learning Style Scales. In 1974, Riechmann and Grasha published an article in the Journal of Psychology describing how they had developed and assessed the construct validity of a learning styles instrument. Since that time, other studies have been completed that suggest that the GRSLSS are valid.

The initial 1974 study reported the use of a group of undergraduate psychology students who were asked to select items individually from a pool of statements that they felt were associated with the six theoretical constructs described by Reichmann and Grasha. A 70% agreement rate among the students was used as a cut-off point to select items for the instrument. In addition, another group of college students were divided into several small groups and asked to develop a Criterion Item Questionnaire. This questionnaire was designed to predict the types of behaviors that students with each of the styles would exhibit. For example, an avoidant student might miss a lot of classes or might doodle during lectures.

Once this was completed, both the Criterion Item Questionnaire and the GRSLSS were administered to 264 sophomore psychology students. Significant correlations between the two instruments provided evidence of construct

validity. Predicted correlations were most significant for the Avoidant (.86), Collaborative (.67), and Participant (.60), and less significant for the Dependent (.50), Independent (.47), and Competitive (.23) scales (Riechmann & Grasha, 1974).

Additional construct validity was offered by Riechmann in her doctoral dissertation (1974). In a study of 151 psychology students, Riechmann reported significant correlations between various factors measured by other research instruments and each learning style. For example, the higher the Avoidant students scored on the scales, the less they tended to enjoy instructor-to-individual interaction relationships in the classroom. Avoidant students also tended to have lower grade point averages, while Participant students tended to have higher GPAs. Dependent style learners were found to have a strong preference for teacher-centered instructional methods, while Independent learners preferred student-centered instructional methods.

Another researcher, Andrews (1981), conducted a factor analysis using a varimax rotation on the GRSLSS. The results supported the GRSLSS's division into six scales, in that 82 percent of the 90 items loaded positively on the expected factor. Also, negative correlations were found to exist between the Avoidant and Participant scales (-.69) and

the Independent and Dependent scales (.-37). A significant negative correlation was not found between the Competitive and Collaborative scale. Each of these correlations was interpreted at an alpha level of .01.

Andrews (1981) also found that students with more "impersonal" styles (Independent, Avoidant, Competitive) rated textbooks, handouts, and lectures to be most helpful in their learning. Those students with strong "personal" styles (Collaborative, Participant, Dependent) rated review sessions, study questions, and learning from other students to be most beneficial. These findings are consistent with the theoretical constructs upon which the GRSLSS are based.

The test-retest reliability coefficients for the GRSLSS (with seven day intervals between testing) were reported as follows (N = 119): Independent, .84; Dependent, .81; Participant, .89; Avoidant, .82; Collaborative, .81; Competitive, .84 (Riechmann & Grasha, 1974).

The complete GRSLSS instrument was published in Berquist and Phillips' A Handbook for Faculty Development (1975). A reproduction of the instrument is presented in Appendix A.

Allen's Attitude Toward CAI Instrument. Allen (1986) designed a semantic differential tool for assessing student attitude toward CAI (see Appendix B). The semantic differential technique involves the use of a set of bipolar

adjectives chosen to describe a given concept, with a series of seven steps between them on which to rate the concept. Nunnally (1978), a psychometrician, agrees that the semantic differential scale is a valid tool for measuring the human perception of concepts.

The Attitude Toward CAI semantic differential tool is made up of 14 bipolar scales evaluating the concept of "CAI." These adjectives included rigid-flexible, useful-useless, stimulating-boring, meaningful-meaningless, pleasant-unpleasant, valuable-worthless, creative-unimaginative, personal-impersonal, efficient-inefficient, appropriate-inappropriate, comfortable-uncomfortable, nonthreatening-threatening, easy to control-overpowering, and time saving-time consuming.

To determine the validity of the instrument, a list of 26 bipolar scales was sent to a panel of five judges who were asked to rate each scale for its relevance toward measuring attitude toward CAI. The judges included four people nationally known for their expertise in CAI for nursing education. The fifth was a psychometrician with expertise in developing semantic differential scales.

Fourteen of the 26 bipolar scales are reported to have met the content-validity criteria of 80% agreement among the judges. Additionally, a factor analysis of the tool showed one strong initial factor that accounted for 60.2% of the

total variance. This is reported to support the claim that the tool primarily measures a single evaluative component of attitude toward CAI (Allen, 1986).

Reliability for the instrument was assessed by computing Cronbach's alpha. After administering the instrument to 107 nursing students, Allen (1986) reported a reliability coefficient of 0.853. This, Allen suggested, indicated an acceptable level of internal consistency.

Pretest-Posttest on light and color theory. A 20-item comprehension evaluation instrument was developed by the researcher. This instrument was designed to measure the extent to which the subjects who completed the CAI program on light and color theory met the instructional objectives. The evaluation instrument was used as both a pretest and a posttest in the study. Reliability of the test was determined by computing Cronbach's alpha on the posttest results of the sample (n = 144). This computation yielded a coefficient of .763 using Testat's Analysis of Test Scores software (Stenson, 1990).

Validation of the instrument was established through a jury of experts (listed in Appendix F). To accomplish this, six graphic communications professors were contacted one week prior to the 1993 conference of the International Graphic Arts Education Association (IGAEA). Each agreed to serve as a juror while at the conference.

At the IGAEA conference (held at Clemson University), a room equipped with computers supporting the MS-DOS operating system was secured. The jurors were given a briefing on the research study and were asked to (a) examine the instructional objectives, and to (b) go through the CAI program and test.

A form was given to the jurors asking them to rate the extent to which the comprehension evaluation measured the acquisition of knowledge as stated in the instructional objectives on a scale from 1 (poor) to 9 (excellent) (see Appendix D). The jurors' mean rating on the comprehension evaluation test was 8 out of a possible 9 (see Table 2).

These ratings suggest that the comprehension evaluation test has content validity. It also suggests that the content of the CAI program is accurate and that the CAI software is suitable for use in a college setting.

Demographic survey. There were several demographic factors examined in this study. These included each subject's (a) gender, (b) year in school, (c) level of experience with computers (self-reported), (d) level of experience with CAI (self-reported), and (e) grade point average (self-reported). The questions regarding demographic information were combined with the learning styles questionnaire form (see Appendix A).

Table 2

Validity Ratings of the Pretest-Posttest on a Scale of 1 to 9

Expert	Test Rating
1	8
2	8
3	8
4	8
5	8
6	8
M	8

Data Collection

Several steps were necessary to coordinate the collection of data for this study. First, during the second week of classes in the 1993 Fall semester, the researcher spoke to an educational media class of 301 students to solicit volunteers for the study. During this short presentation, the purpose of the research project and the responsibilities of the volunteers were explained. The students were told that they would receive extra credit

points toward their grade in the course if they were to participate.

Prior to this presentation, a table with sign-up sheets was set up outside the auditorium where the class met. The students were asked to sign-up for a one-hour CAI session at which time they would (a) complete the pretest, (b) engage in the CAI program, (c) complete the posttest, and (d) complete the Attitude Toward CAI instrument. There were 27 individual sessions for the volunteers to choose from. Most of these sessions were held on weekday evenings or on Saturdays.

In addition to signing up for a CAI session, each student was asked to pick up a packet containing (a) a consent form to be signed, (b) the learning styles questionnaire, and (c) a computer scan sheet on which to answer the questions. Information on participating in the study and instructions on how to complete the consent form and questionnaire were incorporated into the packet (see Appendix E). The students were asked to bring the completed packet to their pre-arranged CAI session. A total of 190 students signed up to participate in the study. Of those 190 students, 145 showed up at the CAI sessions, and 144 students accurately completed all of the required forms.

Ten MS-DOS compatible computers were secured for each of the CAI sessions. Upon arrival at the CAI session, each

student was given an instruction sheet and was debriefed on the procedures. The average amount of time necessary for volunteers to complete the CAI session requirements was about 50 minutes.

The pretest and the posttest were each answered on separate computer scan sheets. The students were asked to place their university student number on each sheet so that they could be matched. Pretest scan forms were coded with a "pre" to differentiate the forms. After completion of the posttest, students were asked to complete the Attitude Toward CAI instrument. This form was written on directly by the participant, and later hand scored.

Labeled folders were used to accumulate and organize the following sheets for each student: (a) the learning style questionnaire computer scan sheet, (b) the signed consent form, (c) the pretest computer scan sheet, (d) the posttest computer scan sheet, and (e) the Attitude Toward CAI instrument.

After completion of all CAI sessions, the individual forms were coded to provide organization in scanning and interpreting the data. Learning styles scan sheets were coded as "1," pretest scan sheets were coded as "2," and posttest scan sheets were coded as "3." These forms were further coded "001" through "144" for each student. The Attitude toward CAI instrument was hand scored and recorded for each student "001" through "144." The Information

Systems and Computer Services department at the University of Northern Iowa scanned the computer sheets and placed the data in a file on the university mainframe computer for data analysis.

Null Hypotheses and Data Analysis

This study was designed to test three null hypotheses. They are as follows:

Null Hypothesis #1. No significant relationships between the investigated learning styles and CAI achievement will be found.

Null Hypothesis 2#. No significant relationships between the investigated learning styles and attitude toward CAI will be found.

Null Hypothesis 3#. No significant relationship between attitude toward CAI and knowledge gains will be found.

These hypotheses were tested through two statistical techniques. The Statistical Package for the Social Sciences (SPSS/VAX) was used for data analysis. All of the results were interpreted at an alpha level of .05. The first analysis completed was a stepwise multiple regression analysis. This test was conducted to determine whether the predictor variables, comprising "learning styles" were significantly correlated with either of the two criterion variables "gain score" or "attitude toward CAI." "Gain score" was defined as the difference between pretest and

posttest scores. Had a significant effect been found, a prediction equation would have been determined. This equation could be used to predict both CAI achievement and attitude from learning style scores.

Secondly, a partial correlation was computed and interpreted. This statistical technique permitted the examination of individual correlations between selected variables while controlling for demographic variables. For example, correlations between (a) specific learning styles and (b) knowledge gains were assessed while holding variables like GPA, experience with computers, and experience with CAI constant. This same test was used to examine the relationships between specific learning styles and attitude toward CAI. Further, the relationship between knowledge gains and attitude toward CAI was investigated.

Numerous other statistical analyses were performed in support of this study. These included a paired sample t test between pretest and posttest scores to determine whether significant learning occurred as a result of the CAI treatment. Additionally, various descriptive statistics were reported on the sample to provide a profile of the participants in the study. A Cronbach's alpha coefficient was computed from the results on the posttest to determine internal consistency. Also, correlations between various demographic variables and selected independent and dependent variables were examined to assess relationships.

CHAPTER IV

PRESENTATION, ANALYSIS, AND DISCUSSION OF THE DATA

This chapter is written to (a) present the findings of this research, and to (b) analyze these findings in light of the hypotheses. Towards this end, the chapter is divided into three major parts. First, a presentation of demographic information on the sample is included to provide a profile of the subjects used for the study. Secondly, the results of the statistical tests on the hypotheses are reported and interpreted. Thirdly, incidental findings are reported and discussed.

Presentation of Demographic Information

Several demographic variables were assessed on the sample. These included year in school, gender, grade point average (GPA), level of experience with computers, and level of experience with computer-assisted instruction (CAI).

Year in School of the Sample

Most of the volunteers used in the study were upperclasspersons (see Table 3). The educational media course that the sample was derived from is a required course for many education majors and not a general education course. The largest portion of students were juniors, followed by sophomores, and then seniors. No freshman participated in the study. There was one missing value from the sample.

Table 3

Year in School of the Sample

Year in School	(n)	Percentage
Freshman	0	0%
Sophomore	40	28%
Junior	68	48%
Senior	35	24%
	143	100%

Gender of the Sample, Educational Media Class, and Population

The gender of the sample is presented in Table 4. The sample was drawn from student volunteers taking an educational media class required of most teacher education majors at the University of Northern Iowa (UNI). The population for this study was defined as all teacher education majors at UNI. The gender of the sample was closely proportionate to both the educational media class and the population for the study. The sample, the educational media class, and the population was composed of about one-third males and two-thirds females.

Table 4

Gender of the Sample, Educational Media Class, and Population

Gender	(n)	Percentage
Gender of the Sample		
Males	50	35%
Females	93	65%
Total Volunteers	143	100%
Gender of the Educational Media Class		
Males	107	36%
Females	194	64%
Total Students	301	100%
Gender of the Population		
Males	966	31%
Females	2171	69%
Total Population	3137	100%

Note. There was one missing value from the sample.

Level of Computer Experience

Level of computer experience was measured on a five point Likert-like scale. The scale ranged from 1 to 5. Students were asked to rate their knowledge and experience with computers as either 1 (no knowledge and experience), 2 (little knowledge and experience), 3 (somewhat knowledgeable and experienced), 4 (fairly knowledgeable and experienced), or 5 (highly knowledgeable and experienced). As a whole, participants in the study rated themselves as having a medium to high level of computer experience (see Table 5).

Table 5

Self-Reported Level of Computer Experience

Computer Experience (n = 144)	
M	3.3
SD	.76

Note. Minimum possible score = 1.
Maximum possible score = 5.

Level of CAI Experience

The level of CAI experience reported by the subjects was unexpectedly high (see Table 6). This is perhaps

testament to the fact that CAI use has increased in educational institutions (Frost & Sullivan, 1984). It may more likely be due to an exposure to CAI in educational methods courses within the teacher education major at UNI. For example, experiences with CAI are incorporated into the educational media course from which the sample came. However, this data was collected very early in the semester, before any such information was covered.

The subjects rated their level of experience on a Likert-like scale from 1 to 5. Specifically, students were asked to rate their level of experience with CAI as either 1 (no experience), 2 (little experience), 3 (somewhat experienced), 4 (fairly experienced), or 5 (highly experienced).

Table 6

Self-Reported Level of CAI Experience

	CAI Experience (n = 144)
M	3.5
SD	.8

Note. Minimum possible score = 1.
Maximum possible score = 5.

Grade point average (GPA) was reported by the subjects as being between either (a) 0.0-0.7, (b) 0.8-1.5, (c) 1.6-2.3, (d) 2.4-3.1, or (e) 3.2-4.0. All of the subjects that reported their GPAs were between the last three ranges, (c), (d), and (e). For ease in interpreting this data, Table 7 shows these ranges in frequency counts. Three subjects did not report their GPA. Because participation in this study was on a volunteer basis, no effort was made to encourage these students to report their GPA. It should be noted here that students in the education major at UNI must have a 2.5 GPA to continue in teacher education. This fact may explain why so few students reported GPAs under 2.4.

Table 7

Self-Reported GPA

Range	Frequency (n = 141)	Percentage
0.0-0.7	0	
0.8-1.5	0	
1.6-2.3	9	6%
2.4-3.1	73	52%
3.2-4.0	59	42%

Hypothesis Testing

There were three central hypotheses made for this study. The first of these predicted specific relationships between learning styles and knowledge gains. The second hypothesis predicted relationships between learning styles and attitude toward CAI. The final hypothesis predicted the relationship between knowledge gains and attitude toward CAI. These three sets of hypotheses are restated from Chapter I as follows:

Hypothesis #1. The ability to learn from the CAI method (as assessed through knowledge gains) will be related to learning style in the following ways:

1a. The stronger the learner's Independent style, the higher the learner's knowledge gain score will be.

1b. The stronger the learner's Dependent style, the lower the learner's knowledge gain score will be.

1c. A relationship between the remaining learning styles and knowledge gain scores was not anticipated.

Hypotheses #2. Attitude toward CAI will be related to learning style in the following ways:

2a. The stronger the Independent style, the more positively the student will report feeling about CAI.

2b. The stronger the Dependent style, the more negatively the student will report feeling about CAI.

2c. The stronger the Collaborative style, the more negatively the student will report feeling about CAI.

2d. The stronger the Competitive style, the more negatively the student will report feeling about CAI.

2e. The stronger the Avoidant style, the more positively the student will report feeling about CAI.

2f. A relationship between the Participant learning style and attitude toward CAI is not anticipated.

Hypothesis #3. A significant positive correlation will exist between attitude toward CAI and knowledge gains.

To organize, report, and test the significance of the findings of this study, each of the three hypotheses are stated in null form, followed by results of the statistical tests. The rationale for specific hypothesized relationships has been presented in Chapter II.

Null Hypothesis #1. No significant relationships between the investigated learning styles and CAI achievement will be found.

To begin an examination of the first hypothesis, it is prudent to determine whether learning did indeed occur as a result of students engaging in the CAI. Therefore, the first statistical test reported is a t test for paired samples between the pretest and posttest to determine whether statistically significant learning occurred as a result of the CAI treatment (see Table 8). This test

suggests that significant learning did indeed occur (p value < .001) as a result of the CAI.

Table 8

Learning as Measured By The 20-Item Pretest-Posttest

Notation	Pretest	Posttest	Gain Scores
(n)	144	144	144
M	9.6	16.78	7.19
SD	2.5	2.88	2.90
SE	.21	.24	.24

Paired sample t test between pretest and posttest:

t = 29.68 df = 143 p<.001

To determine whether the six learning styles assessed by the GRSLSS could be used to predict CAI achievement, a stepwise multiple regression analysis was computed. The results of this test suggest that the GRSLSS learning styles cannot be used as a predictor of gain scores (see Table 9). In fact, there was almost no statistical relationship found between the learning styles and CAI achievement.

Table 9

Stepwise Multiple Regression Analysis Between Learning Style and Knowledge Gains

Criterion Variable: Knowledge Gains (Posttest-Pretest)
Predictor Variables: Independent, Dependent, Participant, Avoidant, Collaborative, Competitive

n = 144 Multiple r = .17 F value = .67 Sig. F < .67

	Analysis of Variance		
	df	Sum of Squares	Mean Square
Regression	6	34.56	5.76
Residual	133	1139.59	8.56

To examine specific relationships between investigated learning styles and gain scores, a partial correlation was computed (see Table 10). The variables GPA, computer experience, CAI experience, gender, year in school, and attitude toward CAI were partialed out to more accurately measure the correlations between the variables under investigation.

Table 10

Partial Correlations Between Learning Style and Gain Scores

GRSLSS Scales	Pretest	Posttest	Gains
Independent	.05	.05	.00
Dependent	-.19**	-.08	.08
Participant	-.06	-.04	.01
Avoidant	-.03	-.01	.01
Competitive	.00	-.11	-.10
Collaborative	-.04	-.07	-.02

Note. Controlling For Gender; GPA; CAI Experience; Computer Experience; Attitude *p<.10. **p<.05. ***p<.01. (132 df).

This statistical test indicated that there were no significant hypothesized relationships among the variables. In fact, there was almost no statistical relationship at all between any of the learning styles and gain scores, with non-significant correlations ranging from -.10 to .08. This finding, coupled with the finding that significant learning from CAI did occur, suggests that learning from CAI results regardless of a student's learning style as measured by the GRSLSS. Even students with a strong Avoidant learning style, which has been shown to be negatively correlated with

GPA (Riechmann, 1974), appear to have experienced significant learning with the CAI method, being undifferentiated from other learning styles.

With regard to hypotheses made on specific relationships between learning style and knowledge gains, it was expected that Independent learners would benefit most from CAI. This was hypothesized because this style is characteristic of students who like to work on their own and like to think for themselves (Riechmann & Grasha, 1974). This style has also been correlated with students who enjoy self-paced, student-centered learning best (Riechmann, 1974). CAI provides a self-paced, learner guided instructional mode (Steinberg, 1991). However, no relationship was found.

Similarly, Dependent students were expected to benefit less from CAI because this style is characteristic of students who strongly require teachers as authority figures for direction. In light of the absence of a relationship, it is theorized that perhaps the computer provided the authoritative structure necessary for the Dependent students. No specific relationships were expected between any of the remaining learning styles and knowledge gains and none were found.

Null Hypothesis #2. No significant relationships between the investigated learning styles and attitude toward CAI will be found.

Attitude toward CAI was assessed on a 7 point scale. A score from 1 to 3.5 would indicate a more negative attitude, while a score of 3.5 to 7 would indicate a more positive attitude. Table 11 shows the mean and standard deviation for the sample. This data suggests that students in the sample had an overall positive attitude toward CAI. This finding is consistent with the findings of other researchers

Table 11

Attitude Toward CAI

Attitude Toward CAI (n = 144)	
M	5.7
SD	.77

Note. Minimum possible score = 1.
Maximum possible score = 7.

who have suggested that a pervasively positive attitude toward CAI exists among college students (Kulik & Kulik, 1986; Skinner, 1988).

To determine whether the six learning styles assessed through the GRSLSS could be used to predict attitude toward CAI, a stepwise multiple regression analysis was computed

(see Table 12). While the relationship between learning style and attitude was stronger than the relationship between learning style and knowledge gains, the results interpreted at an alpha level of .05 suggest that the GRSLSS cannot be used as a predictor of attitude toward CAI.

Table 12

Stepwise Multiple Regression Analysis Between Learning Style and Attitude Toward CAI

Criterion Variable: Attitude Toward CAI

Predictor Variables: Independent, Dependent, Participant, Avoidant, Collaborative, Competitive

n = 144 Multiple r = .27 F Value = 1.86 Sig. F < .09

	Analysis of Variance		
	df	Sum of Squares	Mean Square
Regression	6	6.44	1.07
Residual	137	78.94	.58

To examine specific relationships between learning styles and attitude toward CAI, a partial correlation was computed (see Table 13). The variables of GPA, computer experience, CAI experience, gender, year in school, pretest, and posttest were held constant. This test indicated that there was only one statistically significant relationship.

Table 13

Partial Correlations Between Learning Style and Attitude Toward CAI

GRSLSS Scales	Attitude Toward CAI
Independent	.11
Dependent	.08
Participant	.22***
Avoidant	-.13
Competitive	-.11
Collaborative	.03

Note. Controlling For Gender; GPA; CAI Experience; Computer Experience; Pretest; Posttest.

*p<.10. **p<.05. ***p<.01. (131 df)

There was a positive relationship between the Participant scale and attitude. This suggests that the more Participant a student, the more positively he/she views CAI. The Participant style is characteristic of students who are eager to participate in classroom activities, so the correlation is compatible with the theoretical construct (Hruska & Grasha, 1982).

Other relationships were expected, but not found. A positive relationship was anticipated between the Independent style and attitude toward CAI because this style is characteristic of students who like to learn independently. This hypothesis was not supported by the data. The opposite relationship was anticipated between the Dependent style and attitudes. This was because Dependent learners look to teachers and peers as sources of support in learning (Riechmann & Grasha, 1974). Again, there was no significant relationship.

Because Collaborative students tend to learn best by sharing their ideas and by working with others (Riechmann & Grasha, 1974), it was expected that a negative correlation would be found. It was also anticipated that the more Competitive students would show low scores on the attitude toward CAI scale. This was hypothesized because these students tend to be motivated to learn through competition with other students (Riechmann & Grasha, 1974). CAI does

not provide this kind of environment. However, neither of these learning style scales was correlated with attitudes.

Avoidant learners were expected to feel more positively toward CAI. This was expected because students with a more Avoidant style do not enjoy participation in the classroom. They also tend to be overwhelmed by classroom procedures (Riechmann & Grasha, 1974) and to attain lower GPAs (Riechmann, 1974). It was hypothesized that CAI would provide these students with a "safe haven" for learning and hence they would show a positive attitude. While this did not occur, perhaps the fact that only a slight non-significant correlation of -.10 was found, coupled with the finding that significant learning outcomes have transpired, suggests that CAI may be a positive instructional method for more Avoidant students.

Null Hypothesis #3. No significant relationship between attitude toward CAI and knowledge gains will be found.

It was predicted that students who showed greater achievement on the comprehension evaluation test would find CAI more enjoyable. This hypothesis could be interpreted to suggest that students who have a more positive attitude toward CAI will learn better due to their affirmative outlook. The alternate interpretation is that students with positive attitudes toward CAI learn better from CAI. Table

14 shows that students who scored higher on the posttest rated CAI significantly higher as a teaching method.

This significant positive correlation, however, was not the case with gain scores. One reason for this discrepancy may be that those students who felt that they had answered most of the test questions correctly rated CAI higher than those students who had similar gains, but still marked several questions wrong. Marking several questions wrong on a test, even though significant learning had occurred, could be rather dejecting. This finding supports Skinner's (1988) theory that college students feel more positively toward CAI because of a tendency toward higher test scores.

Table 14

Pearson Correlations Between Attitude Toward CAI and Test Scores

	Pretest	Posttest	Gain Scores
Attitude Toward CAI	.10	.21***	.12

Note. *p<.10. **p<.05. ***p<.01. (142 df).

Incidental Findings

Several other interesting findings became evident upon analysis of the data. Some of these findings support previous research done on the GRSLSS. Other findings have not been reported in the literature. Each of these is discussed below.

Intercorrelations Among Learning Styles

The GRSLSS was designed to assess learning style in three negatively correlated categories; Independent-Dependent, Participant-Avoidant, and Collaborative-Competitive. Independent studies have reported significant negative correlations between the Independent-Dependent and the Participant-Avoidant learning style scales. However, a relationship between the Collaborative-Competitive scales has not been found (Andrews, 1981; Riechmann, 1974). These findings are supported by data collected for this study. Table 15 shows the intercorrelations among the learning style scales. The Avoidant-Participant scales are significantly negatively correlated, as are the Independent-Dependent scales, though to a lesser degree.

Table 15

Intercorrelations Among Learning Styles

GRSLSS Scales	GRSLSS Scales				
	Dep.	Par.	Avd.	Col.	Com.
Independent	-.20**	.30***	-.16*	.02	.13
Dependent	--	.36***	-.19**	.10	.06
Participant		--	-.78***	.38***	.01
Avoidant			--	-.34***	-.02
Collaborative				--	.07

Note. *p<.10. **p<.05. ***p<.01.

Learning Style and GPA

Several other interesting correlations were discovered among the data. For example, GPA was significantly correlated with both the Avoidant and Participant learning styles (see Table 16). These same relationships have been found in a previous study. Riechmann (1974) reported that Participant students tend to have higher GPAs, while Avoidant students tend to have lower GPAs. Relationships between the other learning styles scales and GPA have not been found.

Table 16

Pearson Correlations Between Learning Style and GPA

Learning Style	GPA
Independent	.05
Dependent	-.11
Participant	.16**
Avoidant	-.31***
Collaborative	-.10
Competitive	.00

Note. *p<.10. **p<.05. ***p<.01.

Learning Style and Gender

Studies designed to examine the relationships between the GRSLSS and gender have shown that males tend to be more Competitive, Avoidant, and Independent than females. Also, females tend to be more Participant than males (Emmanuel & Potter, 1992; Kraft, 1976). Unlike Kraft's study, the data for this research did not show a relationship between the Competitive scale and gender. However, males do appear to be more Independent and Avoidant. This study showed a relationship not reported in other studies (see Table 17); females were found to be more Collaborative than males. In

corroboration with Emmanuel and Potters' study, the data show that females tend to be more Participant than males.

Table 17

Point-Biserial Correlations between Learning Style and Gender

Learning Style	Gender
Independent	-.33***
Dependent	.10
Participant	.15*
Avoidant	-.29***
Collaborative	.20**
Competitive	-.11

Note. Positive correlations indicate female dominance. Negative correlations indicate male dominance.

*p<.10. **p<.05. ***p<.01.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This research was based on a theorized Aptitude-Treatment Interaction. Specifically, aptitude as measured by the Grasha-Riechmann Student Learning style Scales (GRSLSS) was expected to be related to student achievement with CAI and attitude toward CAI. To examine these relationships, a CAI program was administered to 144 educational media students at the University of Northern Iowa. These students completed a pretest and posttest, along with various instruments used to assess learning style, attitude toward CAI, and various demographic information. The anticipated effects were not found. A summary of the findings related to the research hypotheses are described below.

One hypothesis of this research predicted the existence of a relationship between learning style and CAI achievement. Specifically, it was hypothesized that Independent learners, who are characterized by their preference for self-managed, student-centered activities (Hruska & Grasha, 1982), would benefit most from CAI. It was also expected that Dependent students, who tend to require authoritative structure and motivation (Hruska & Grasha), would benefit less from CAI. While statistically

significant learning was found to have transpired as a result of the CAI treatment, the Independent and Dependent students were undifferentiated in their learning.

Another hypothesis of this study focused upon the interactions between learning style and attitude toward the CAI method. It was expected that students with a more Independent style would feel more positively toward CAI. Conversely, the Dependent students were expected to feel more negatively toward the CAI method. Also, students with the Collaborative style, which is characterized by students who prefer to learn by sharing their ideas with others (Hruska & Grasha, 1982), were expected to feel more negatively toward CAI. Competitive students also were expected to rate CAI negatively. This is because these students are motivated by a need to perform better than other students in the classroom (Hruska & Grasha), and CAI does not afford this type of social-interaction.

Avoidant students are characterized by their tendency to be overwhelmed by normal classroom activities (Hruska & Grasha, 1982). These students tend to have lower GPAs and do not enjoy participation in learning (Riechmann, 1974). It was expected that this type of student would enjoy the self-paced and non-judging environment of CAI.

The Participant student was expected to feel neutral toward the CAI. These students are characterized by feeling positively about going to class, and by liking all classroom activities (Hruska & Grasha, 1982). No correlation between attitude and learning style was expected because (a) it was expected that CAI would not provide the social learning atmosphere that Participant students enjoy, and (b) Participant students would find it difficult to rate any kind of learning method negatively. These two factors were expected to neutralize each other, thus showing a lack of relationship. However, this line of reasoning appears to have been erroneous.

None of the hypothesized effects were found between learning style and attitudes toward CAI. Furthermore, there was only one significant relationship: that showing a positive correlation between the Participant style and attitude toward CAI. This was not surprising, as Participant students tend to have higher GPAs (Riechmann, 1974) and are characterized by their eagerness to engage in learning situations (Riechamnn & Grasha, 1974).

Finally, no significant relationship was found between attitude toward CAI and knowledge gains. However, students who scored higher on the posttest had significantly higher attitudes toward CAI. This finding supports Skinner's (1988) theory that students rate CAI highly due to a

tendency toward higher test scores. However, Clement's (1981) statement that positive attitudes toward CAI are essential for positive learning outcomes is not supported by this study. Students appear to have learned equally well (as measured by gain scores) regardless of their attitude toward the CAI method.

Conclusions

Perhaps the most important finding to be drawn from this research was the lack of a relationship between Avoidant learners and either CAI achievement or attitude toward CAI. One must keep in mind that these students have been shown to have lower GPAs and are generally uninterested in learning (Riechmann, 1974). A mean gain score of about 7 was found to exist among students taking the 20-item test. This significant learning, coupled with the statistic of non-correlation between Avoidant learners and gain scores, suggests that Avoidant learners benefited from the CAI and were undifferentiated from other learning styles in terms of learning benefit. Also, Avoidant learners did not feel negatively (nor positively) toward the instruction. This finding suggests that CAI is a very viable instructional method for excessively Avoidant students. In support of this theory, Claxton and Murrell (1987) point out that matching styles to methods is particularly important when working with poorly prepared college students.

Beyond this finding, the data suggest that CAI is an effective instructional method for students with any of the learning styles assessed. Additionally, the findings reported by other researchers suggesting that CAI is widely accepted by college students as a positive instructional method (Clement, 1981; Skinner, 1988) is supported by the data.

One possible reason that no effect was found is that the GRSLSS does not measure significant factors related to aptitude for CAI. Several studies reviewed in Chapter II had found varying results in attempting to find an Aptitude-Treatment Interaction between various learning style conceptualizations and CAI achievement. This research study also found no significant effects.

Another possible reason that hypothesized relationships were not found may be due to the sample used for the study. This sample was composed of volunteers who were given extra credit for participating. This fact may have affected the sampling distribution, specifically for the Avoidant, Participant, and Dependent scales. Avoidant students, who are characterized by their tendency to shun learning situations (Hruska & Grasha, 1982), may not have been adequately represented by the sample of volunteers. Students who are more Participant may have been more likely to be represented in the sample due to their eagerness to

participate in learning activities. Students low on the Participant scale may not be represented. Dependent students tend to do only what is expected in a course, and tend not to do extra work (Grasha & Riechmann, 1974). Therefore, the more Dependent students may not be represented in the sample. However, the effects of these characteristics of the sample may have been minimized or eliminated by the large sample size (n = 144).

It is also possible that the teacher education majors used for this study may have affected outcomes. An education major may view the CAI somewhat more analytically than another sample of college students. For example, these students might report attitudes toward the CAI's soundness of instructional design, where another sample of students may react more purely to the method itself.

Regardless of the lack of a conclusive effect, this researcher believes that research on the effects of learning style on student acheivement with various teaching methods is still necessary. Information about learning style can help the educator to become more sensitive to the unique differences that students bring to the classroom. An awareness of learning style can also provide an instructor with insight into why particular students do not do well with their classroom methods. Teachers tend to use teaching methods consistent with the methods from which they are

comfortable learning (Claxton & Murrell, 1987). A sensitivity to the differences that students bring to the classroom may focus more educators on varying their teaching methods to reach more students.

It should also be stressed that the goal of understanding the effect of learning style on achievement when using various teaching methods is not merely to make students more comfortable in their learning environment. To the contrary, many learning style experts agree that students should be given opportunities to learn in situations that do not fit their style of learning. This practice may work to broaden a student's ability to learn in various situations, producing greater growth and development (Grasha, 1984; Kolb, 1984).

Recommendations

Upon completion of this study, several recommendations are made for further research on the effects of learning style on CAI outcomes. They are as follows:

1. Perhaps one reason that this research did not show significant findings where hypothesized is that the CAI was not administered over an extended period of time. It is doubtful that the novelty of CAI interfered with the effect because (a) level of CAI experience was controlled for and (b) the demographics of the sample showed that the students had a medium to high level of previous experience with CAI.

However, the GRSLSS are assessed on the basis of classroom preferences. If an entire week of coursework were delivered via CAI, perhaps some of the hypothesized effects would begin to show.

2. A replication of this study is recommended with the exception of replacing the GRSLSS with various other learning style conceptualizations. This may show that other learning style factors are better predictors of CAI achievement and attitudes.

3. It is recommended that a study comparing the Avoidant and Participant learning styles with regard to CAI achievement and traditional classroom achievement be carried out. This may ascertain further whether Avoidant students benefit significantly from CAI.

4. It is recommended that a replication of this study be completed with a different sample. It is possible that the sample used for this study, teacher education majors, might view CAI somewhat more analytically than another sample of college students. Perhaps a different sample would produce different outcomes and deepen our understanding of the effects of learning style upon student achievement with CAI.

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APPENDIX A

DEMOGRAPHIC SURVEY AND LEARNING STYLE INSTRUMENT

Student Learning Styles Questionnaire

Directions: Using the attached computer answer sheet, answer the following questions by filling in the appropriate spaces and circles in #2 pencil. The following information will remain strictly confidential. This information will not be traced back to you. Please answer each item as accurately as possible.

First, be certain to fill in the following information on the computer sheet:

- **Your Name**
- **Your Sex**
- **Your Year in School (13=Freshman, 14=Sophomore, 15=Junior, 16=Senior)**
- **Your UNI Student Number (under *special codes*)**

Fill in the circle corresponding to the response which in your judgement best answers the question.

1. I would rate my knowledge of and experience with computers as . . . . .

   a. Highly knowledgeable and experienced
   b. Fairly knowledgeable and experienced
   c. Somewhat knowledgeable and experienced
   d. Little knowledge and experience
   e. No knowledge and experience

2. I would rate my level of experience with using computer-assisted instruction (tutorials, educational games) as . . . .

   a. Highly experienced
   b. Fairly experienced
   c. Somewhat experienced
   d. Little experience
   e. No experience

3. My college grade point average at this time is between . . . . . (if you don't have one yet, leave blank)

   a. 0.0 - 0.7 b. 0.8 - 1.5 c. 1.6 - 2.3
   d. 2.4 - 3.1 e. 3.2 - 4.0

Continue on to the next page . . . . .

Student learning styles questionnaire

Directions: The following questionnaire has been designed to identify your feelings toward various learning situations. Formulate your answers with regard to your general attitudes and feelings toward courses that you have had.

Indicate your answers on the attached computer answer sheet with a #2 pencil. To the right of each question number, fill in the circle cooresponding to the answer that best explains how you feel about the statement as follows:

Mark **a** if you **strongly disagree** with the statement.
Mark **b** if you **moderately disagree** with the statement.
Mark **c** if you are **undecided.**
Mark **d** if you **moderately agree** with the statement.
Mark **e** if you **strongly agree** with the statement.

4. Most of what I know, I learned on my own.
5. I have a difficult time paying attention during class sessions.
6. I find the ideas of other students relatively useful for helping me to understand the course material.
7. I think a teacher who lets students do whatever they want is not doing his job well.
8. I like other students to know when I have done a good job.
9. I try to participate as much as I can in all aspects of a course.
10. I study what is important to me and not necessarily what the instructor says is important.
11. I feel that I have to attend class rather than feeling that I want to attend.
12. I think an important part of classes is to learn to get along with other people.
13. I accept the structure a teacher sets for a course.
14. To get ahead in class, I think sometimes you have to step on the toes of the other students.
15. I do not have trouble paying attention in classes.
16. I think I can determine what the important content issues are in a course.
17. If I do not understand course material, I just forget about it.
18. I think students can learn more by sharing their ideas than by keeping their ideas to themselves.
19. I think teachers should clearly state what they expect from students.
20. I think students have to be aggressive to do well in school.
21. I get more out of going to class than staying home.
22. I feel that my ideas about content are often as good as those in a textbook.
23. I try to spend as little time as possible on a course outside of class.
24. I like to study for tests with other students.
25. I like tests taken right out of the book.
26. I feel that I must compete with the other students to get a grade.
27. I attend classes because I want to learn something.

Mark **a** if you **strongly disagree** with the statement.
Mark **b** if you **moderately disagree** with the statement.
Mark **c** if you are **undecided.**
Mark **d** if you **moderately agree** with the statement.
Mark **e** if you **strongly agree** with the statement.

28. I am confident in my abilities to learn important course material.
29. School does not really interest me.
30. I think students should be encouraged to work together.
31. I feel that facts presented in textbooks and lectures are correct.
32. I like the teacher to notice me.
33. I feel that classroom activities are generally interesting.
34. I like to think things through for myself before a teacher lectures on course material.
35. I seldom get excited about material covered in a course.
36. I prefer not to work alone on assignments.
37. Before working on a class project, I try to get the approval of the instructor.
38. To do well in a course, I have to compete with the other students for the teacher's attention.
39. I do my assignments before reading other things that interest me.
40. I do not like a lot of structure in a class.
41. I have given up trying to learn anything from going to class.
42. I like to hear what other students think about the issues raised in class.
43. I think teachers are the best judges of what is important in a course.
44. During class discussions I feel that I have to compete with the other students to get my ideas across.
45. I think classes are very worthwhile.
46. I work on class related projects (e.g., studying for exams, preparing term papers) by myself.
47. I feel that classroom activities are generally boring.
48. I prefer to work in groups rather than alone on class projects.
49. I try my best to do assignments the way the professor says they should by done.
50. I like to see if I can get the answers to problems or questions before anybody else in class does.
51. I am eager to learn about areas covered in class.
52. I do assignments my own way without checking with other students about how they are going to do them.
53. I do not feel that I miss anything if I cut class.
54. I like to talk to other students outside of class about the ideas and issues raised in class.
59. I am in school only to get a degree.
60. I try to get to know other students in my classes on a personal level.

Mark **a** if you **strongly disagree** with the statement.
Mark **b** if you **moderately disagree** with the statement.
Mark **c** if you are **undecided.**
Mark **d** if you **moderately agree** with the statement.
Mark **e** if you **strongly agree** with the statement.

55. I tend not to think or work on problems or issues in a field unless they were first covered in the text or lectures.
56. I think a student is hurting himself if he shares his notes and ideas with other students before an exam.
57. I feel that I can really learn something in a course.
58. I feel that too much assigned work keeps students from developing their own ideas.
61. I think too much class discussion prevents the teacher from covering enough required material.
62. I like to know that I have done better than other students in my class.
63. I do my assignments whether I think they are interesting or not.
64. My ideas about content issues are often as good as those of the instructor.
65. I sit where the teacher is unlikely to notice me.
66. I feel that students and teachers should develop the kind of relationship where a student can tell his teacher if he feels a course is not going well.
67. I feel that I can learn what is important by doing what the professor says.
68. I think students should be graded according to how well they do in a class.
69. I try to do the best that I can in my courses.
70. I do not like a teacher to tell me what I have to learn.
71. I study just hard enough to get by in a course.
72. I like courses where students are encouraged to discuss course material.
73. I seldom try to learn things related to the course that are not covered in the text or letures.
74. I like to know how well the other students are doing on exams.
75. I feel that I can get something out of going to class.
76. I like courses where students are allowed to pursue topics that interest them.
77. I prefer that the teacher never calls on me.
78. I think learning should be a cooperative effort between faculty and students.
79. I think the teacher should emphasize the content that I must learn.
80. I only help other students when I feel it will not hurt me.
81. I sit where I can be sure to hear the professor and see what he writes.
82. If a topic raised in class interests me, I will go out on my own to find out more about it.
83. I think one of the most important things about a course is how easy it is for me to get a good grade.
84. I try to help other students when they have a hard time understanding course material.

85. I enjoy class sessions that are highly organized.
86. I do not like the instructor to deviate from his lectures.
87. I work on reading assignments until I feel I understand the material.
88. I have my own ideas about how a course should be run.
89. I feel that school is not relevant to what I want to do when I graduate.
90. I feel a responsibility to help other students learn.
91. I try my best to write in my notes everything the teacher says.
92. I try to do assignments better than other students.
93. I do my assignments as soon as possible after assignments are made.

This concludes this survey. Be sure to check the time for your computer-assisted instruction!

APPENDIX B

ATTITUDE TOWARD CAI INSTRUMENT

Attitude Toward Computer-Assisted Instruction
Example Page

How to use this opinionnaire: This is not a test; there are no right or wrong answers. The purpose of the scales below is to measure the value which you attach to certain aspects of a given concept. To illustrate how this works, an example is presented below.

Theater

Powerful :___:___:___:___:___:___:___:___: Weak

If you feel the concept is very closely related to one end of the scale, you should place your mark as follows:

Theater

Powerful :X:___:___:___:___:___:___:___: Weak

If you feel the concept is somewhat closely related to one end of the scale, you should place your mark as follows:

Theater

Powerful :___:___:___:___:___:X:___:___: Weak

If you feel that the concept is only slightly related to one end of the scale, you should place your mark as follows:

Theater

Powerful :___:___:___:___:X:___:___:___: Weak

If you feel that the concept is neutral or irrelevant, you should place your mark in the middle of the scale as follows:

Theater

Powerful :___:___:___:X:___:___:___:___: Weak

Attitude Toward Computer-Assisted Instruction

*** Student Number** _____

Make an independent judgment on each descriptive scale. Try to work at a fairly high speed, recording your first impression or feeling about each item. Do not put more than one mark on a single adjective scale.

Computer-assisted instruction

Rigid .:____:____:____:____:____:____:____: Flexible

Useful .:____:____:____:____:____:____:____: Useless

Stimulating .:____:____:____:____:____:____:____: Boring

Meaningless .:____:____:____:____:____:____:____: Meaningful

Pleasant .:____:____:____:____:____:____:____: Unpleasant

Valuable .:____:____:____:____:____:____:____: Worthless

Creative .:____:____:____:____:____:____:____: Unimaginative

Impersonal .:____:____:____:____:____:____:____: Personal

Efficient .:____:____:____:____:____:____:____: Inefficient

Inappropriate .:____:____:____:____:____:____:____: Appropriate

Comfortable .:____:____:____:____:____:____:____: Uncomfortable

Non-threatening .:____:____:____:____:____:____:____: Threatening

Overpowering .:____:____:____:____:____:____:____: Easy to control

Time-saving .:____:____:____:____:____:____:____: Time-consuming

APPENDIX C

COMPREHENSION EVALUATION INSTRUMENT

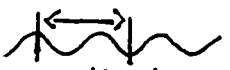
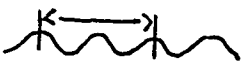
Comprehension Test on Light and Color Theory

Directions: Read each of the following statements and questions completely before responding. Answer each item by (1) selecting the best response to the statement or question and (2) writing the corresponding letter in the space provided to the left of the question number.

Hint - It may be helpful to draw diagrams on the provided blank sheet where appropriate.

1. Which of the following statements about electromagnetic energy is false.
   a. it travels in the form of waves
   b. it is categorized according to wavelength, resulting in a spectrum which includes radio waves, microwaves, light, and X-rays.
   c. it travels at 1000 Kilometers per hour.
   d. it is reflected from the page that you are reading.

2. Below are several diagrams illustrating how a wavelength is measured. Which is correct?

   a. 
   b. 
   c. 
   d. 

3. Electromagnetic energy waves are measured in millimicrons. Which statement below is an accurate conversion of the measure of a millimicron?

   a. one thousandth of one inch
   b. one millionth of one inch
   c. one millionth of one meter
   d. one thousandth of one meter

4. Light comprises a small portion of the electromagnetic spectrum. Scientists call this portion . . .

   a. the light range
   b. the electromagnetic vision
   c. the illuminated spectrum
   d. the visible spectrum

5. The correct range of the visible portion of the electromagnetic spectrum is from ...

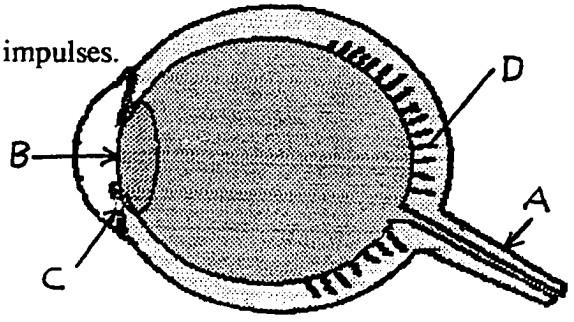
a. 400 to 700 millimicrons b. 200 to 1000 millimicrons
c. 500 to 800 millimicrons d. 100 to 900 millimicrons

(Questions 6 - 8) Below is a diagram of the human eye. Match the correct description listed on the left with the appropriate part of the eye.

6. Light stimulates these, creating chemical/electrical impulses.

7. This part focuses the light entering the eye.

8. This part transports impulses to the brain.



9. The rods in the retina of the eye are responsible for enabling us to see color.

a. true b. false

10. White light results from the combination of all visible colors of light.

a. true b. false

11. If the visible portion of the electromagnetic spectrum was divided into approximate thirds, the following three colors would result:

a. yellow, blue, green b. red, green, blue
c. red, magenta, yellow d. green, cyan, magenta

12. According to the additive theory of light, a green spotlight combined with a blue spotlight results in the color. . . .

a. cyan b. magenta
c. red d. white

13. According to the subtractive theory of light, a transparent cyan ink printed atop a transparent magenta ink on white paper appears to be what color?

a. red b. blue
c. green d. black

14. According to the subtractive theory of light, a yellow filter placed in line with a cyan filter allows what color to pass?

a. blue
b. green
c. cyan
d. red

15. If a printed ink appears as the color magenta under white lights, what colors are being reflected from the ink?

a. green and blue
b. red and blue
c. red and green
d. yellow and green

16. A blue object absorbs what color(s) of light if viewed under white light?

a. red
b. green and blue
c. red and green
d. green and magenta

17. If a transparent yellow ink is printed atop a transparent magenta ink on white paper, what color will the ink appear to be while being viewed under white light?

a. red
b. green
c. blue
d. black

18. If a piece of paper appears yellow under white light, what color is being absorbed by the paper?

a. blue
b. green
c. red
d. magenta

19. If a blue box were to be placed in a room illuminated with yellow light, what color would the box appear to be?

a. blue
b. black
c. yellow
d. red

20. If a magenta box were placed into a room illuminated with blue light, what color would the box appear to be?

a. black
b. yellow
c. red
d. blue

APPENDIX D

SOFTWARE AND TEST VALIDATION FORM

August 1, 1993

Daniel G. Wilson
1609 West 31st. St.
Cedar Falls, IA. 50613

XXXXXXXXXXXXX
XXXXXXXXXX
XXXXXXXXXXXX

Dear Dr. XXXXXXX,

Thank you for agreeing to act as a juror to determine the validity of a portion of my dissertation instrumentation. You have been selected for your expertise in the area graphic communications education with the assumption that you are also knowledgeable about light and color theory.

You will be asked to go through a computer-assisted instruction program which has been developed by the researcher on the topic of light and color theory. The evaluation that you will be asked to complete consists of two parts. The first part is an evaluation of the programs's content. The second part is an evaluation of the extent to which the 20-item test measures the acquisition of knowledge as specified in the instructional objectives (which are listed on Page 4).

A response form is included which can be completed and signed to document this evaluation for reporting my research. Please read through the documentation provided on the attached pages which will briefly describe my dissertation topic. Once again, thank you in advance for your time and effort in assisting me with this research study.

Very Sincerely,

Daniel G. Wilson
Candidate, Doctor of Industrial Technology
University of Northern Iowa

Overview of the Research Study

Research title: An Examination of the Relationships Among Learning Style, Attitudes, and Outcomes of Computer-Assisted Instruction (CAI)

Problem of the study

The problem of this study is to determine whether a relationship exists between and among (a) learning style (as measured by the Grasha-Reichmann Student Learning Style Scales), (b) knowledge gained from computer-assisted instruction, and
(c) attitude toward the CAI method.

The Purpose of this Research Project

The purpose of this research project is to provide teachers, researchers, and instructional designers information concerning whether learning style can be used as an indicator of (a) potential performance, and (b) receptiveness of students receiving CAI in a college setting.

Methodology

About 150 university level education students enrolled at the University of Northern Iowa will be participating in the study. Each will be asked to engage in the computer-assisted instruction program which has been developed by the researcher on the topic of light and color theory. Once each student has completed the program, they will be asked to complete each of the four instruments listed below.

1. The Grasha-Reichmann Student Learning Style Scales
2. The Attitude Toward CAI Semantic Differential Tool
3. A researcher constructed demographic survey
4. A researcher constructed knowledge evaluation test

Validity and reliability information has been established for both the learning style instrument (#1) and the attitude instrument (#2). However, the knowledge evaluation instrument (#3) requires validity and reliability assessments.

The data compiled will be analyzed for correlations between the strength of a particular learning style and the strength of attitudes towards CAI. Correlations will also be analyzed between the strength of learning style and knowledge gains as measured by the knowledge evaluation instrument.

Comments on the Development of This Software

The impetus for designing this computer-based instruction tutorial stems from some frustration that I have experienced in teaching graphic communications students about light and color. Students often have great difficulty grasping the concepts presented. This subject requires analysis and reflection which may be learned best in the self-paced manner offered in a Computer-based instruction format.

A thorough understanding of light and color theory is quite important to the graphic communications student as these concepts are used so extensively in graphic arts photography and reproduction processes. This software was designed to enhance the student's understanding of this subject. It may be used as a stand alone instructional tool, or as a supplement to lecture and discussion.

The design and production of this computer-assisted tutorial required an enormous investment in time. Indeed, many hundreds of hours were spent researching content, designing flow charts, creating graphics for almost every screen, pilot testing the program, and revising the program. It is requested that this software not be copied or used in any other manner than for the review and evaluation solicited. Further programs are under development and in the near future it is hoped that this software will be commercially available to graphic arts educators.

Profile of the Learner

This instructional unit is intended for college/university level students. The learner is expected to have at least an eighth grade reading level.

Instructional Goal

The learner will develop a conceptual knowledge of light and color theory and will use this knowledge in the analysis of hypothetical problems.

Instructional Objectives

Upon completion of this computer-based tutorial on light and color theory, the learner will be able to:

1. Identify general characteristics of electromagnetic energy.
2. Identify an illustration of wavelength measurement.
3. Identify the range of the visible spectrum in millimicrons.
4. Agree that the visible spectrum is a small part of the electromagnetic spectrum.
5. Identify a conversion measure of a millimicron.
6. Upon examining a diagram, identify basic elements of the human eye and their functions.
7. Identify a description of white light.
8. Given various combinations of the primary colors of light (RGB), correctly identify the secondary color produced according to additive color theory.
9. When presented with a cyan, magenta, or yellow pigment, identify which primary colors (RGB) are reflected to the eye, and which are absorbed by the pigment.
10. Utilize the principle of both the additive theory of light and the subtractive theory of light to solve basic application problems.

August 1, 1993

Name
Address

The following rating scale and signature will serve as documentation for the review and evaluation of (1) the content of the computer-assisted instruction program entitled Light and Color Theory and (2) the accompanying knowledge evaluation instrument.

Disclaimer: This evaluation form will remain strictly confidential. Your name will be reported only as a member of the jury. Data will be reported without reference to individuals.

Content Evaluation Rating

Please rate the content of the computer-assisted instruction program entitled Light and Color Theory in terms of accuracy and educational acceptability for university level students.

Circle one number (1-9):

Poor			Acceptable				Excellent	
1	2	3	4	5	6	7	8	9

Knowledge Evaluation Rating

Please rate the degree to which the knowledge evaluation instrument developed for the computer-assisted instruction program entitled Light and Color Theory measures knowledge as indicated in the accompanying instructional objectives.

Circle one number (1-9):

Poor			Acceptable				Excellent	
1	2	3	4	5	6	7	8	9

_____ _____

Signature of Juror Date

APPENDIX E

HUMAN SUBJECTS CLEARANCE FORM AND LETTER

Informed Consent Statement

The Purpose of This Research Project
The purpose of this research is to give teachers a better understanding of the kind of students that like or dislike computer-assisted instruction (CAI). Also, the research may show that students with particular learning preferences learn better using CAI than others. Hopefully, this research will lead to teachers using CAI in more effective ways.

Your Rights
Participation in this research is voluntary. You are free to discontinue participation at any time. All of the information which you will be providing will be kept strictly confidential. None of this information can be traced back to you.

How You Will Be Asked to Participate
First, it is asked that you fill out the attached "Student Learning Style Questionnaire". This form consists of several questions about yourself including your year in school and your grade point average. Also, this form will indicate your personal learning situation preferences. Secondly, you will be asked to use a computer-assisted instruction program at a pre-arranged time. In addition to completing the program, you will be asked to answer a 20-item test on the subject matter, and a 14-item opinionnaire of the CAI media.

Researcher: Mr. Daniel G. Wilson
Research Advisor: Dr. Charles D. Johnson

Department of Industrial Technology
University of Northern Iowa
Department Phone #: (319) 273-2561
Office Phone #: (319) 273-2509

If you have any questions about the research or your rights in participating, please contact the office of the Human Subjects Coordinator, University of Northern Iowa, (319) 273-2748

I am fully aware of the nature and extent of my participation in this project as stated above. I hereby agree to participate in this project. I acknowledge that I have received a copy of this consent statement.

_____ _____
Your Signature Date

_____
Please Print Your Name Above

_____
Signature of Researcher

Please bring this signed consent form plus your completed answer sheet to your scheduled computer-assisted instruction session in SEC rm. 123A (inside the student computer lab)

The University of Northern Iowa

August 17, 1993

Mr. Daniel G. Wilson
1609 W. 31st ST.
Cedar Falls, IA 50613

Dear Mr. Wilson:

Your project, "An examination of the relationships among learning style, attitudes, and outcomes of computer-assisted instructions.", which you submitted for human subjects review on July 26, 1993 has been determined to be exempt from further review under the guidelines stated in the UNI Human Subjects Handbook. You may commence participation of human research subjects in your project.

Your project need not be submitted for continuing review unless you alter it in a way that increases the risk to the participants. If you make any such changes in your project, you should notify the Graduate College Office.

If you decide to seek federal funds for this project, it would be wise not to claim exemption from human subjects review on your application. Should the agency to which you submit the application decide that your project is not exempt from review, you might not be able to submit the project for review by the UNI Institutional Review Board within the federal agency's time limit (30 days after application). As a precaution against applicants' being caught in such a time bind, the Board will review any projects for which federal funds are sought. If you do seek federal funds for this project, please submit the project for human subjects review no later than the time you submit your funding application.

If you have any further questions about the Human Subjects Review System, please contact me. Best wishes for your project.

Sincerely,

Norris M. Durham, Ph.D.
Chair, Institutional Review Board

cc: Dr. David A. Walker, Associate Dean
Dr. Charles D. Johnson

Graduate College 1 Seerley Cedar Falls, Iowa 50614-0702 (319) 273-2748

APPENDIX F

LIST OF JURORS

List of Jurors

The following is an alphabetical list of the names and positions of the jury of experts used for the CAI software and pretest-posttest.

Dr. Lenore D. Collins, Assistant Professor, Department of Industrial Technology, Rhode Island College.

Dr. Ronald D. Dahl, Associate Professor, Department of Manufacturing and Industrial Technology, Arizona State University.

Dr. Ervin A. Dennis, Professor, Department of Industrial Technology, University of Northern Iowa.

Dr. Thomas E. Gray, Professor, Department of Graphic Arts Technology, Murray State University.

Dr. Olusegun Odesina, Assistant Professor, Department of Industrial Technology, Central Connecticut State University.

Dr. Virgil R. Pufahl, Professor, Department of Communication, University of Wisconsin-Platteville.

APPENDIX G

CAI PROGRAM SAMPLE SCREENS