EXPLORATION OF A BRUNSWIK LEARNING ENVIRONMENT

DEVELOPED TO

INSTRUCT BASIC STATISTICAL CONCEPTS

by

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Abstract

An ongoing debate persists of the value of computerized delivery of instructional material. At the center of this debate about the value of computer-assisted-instruction (CAI) is (1) the lack of a theoretical base and (2) the question of whether CAI influences the learner. Research begun by Brunswik allows the value of accommodation of individual learning preferences to be applied. CAI also has the capacity to supplement the presentation of textbook content and support educators using a multimodal approach to teaching that accommodates individual preferences. This study examined the development of an environment to presented stimulation which could add to the motivation of learners.

This study investigated the relationship between the creation of a CAI learning environment based on Brunswik’s psychology and 102 master and doctoral students’ cognitive styles. The study investigated the ability of two cognitive measures to predict the CAI presentation method best suited for an individual’s cognitive ability. Two different cognitive measures were regressed against three different CAI presentation methods (text only, text and static graphics, and text and animated graphics). These three different methods were used for delivery of a basic instructional design since they were simple for the user to follow and easily created via a multimedia environment for the designer. Instruction using these methods was limited to three content areas: random sampling, systematic sampling, and skewness of distribution.

An Aptitude-Treatment-Interaction (ATI) analysis was used to study the interaction between participants’ cognitive attributes and CAI presentation types. While a significant effect was not found in most of the recall tests, many disordinal interactions demonstrated tendencies that warranted further study.
An ANCOVA was also performed using the total immediate recall scores showing significant differences among the CAI presentation types. The results of a one-way ANOVA found that participants assigned to the text only CAI presentation method tested better than their counterparts using the graphic additions to the textual instruction.
Acknowledgment

The difficulty of acknowledging the individuals responsible for completion of the journey called Doctor of Philosophy is placement. Whether listed first or last, others interpret position in their own manner. The importance each individual played within this journey of mine can only be understood as a puzzle. One piece missing and the puzzle is incomplete, so it is with the attainment of Doctor of Philosophy.

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Chapter I

"...a learning society would have a decided advantage in a
time of rapid change: while the learned usually find
themselves equipped to live in a world that no longer exists,
the learner adjusts himself readily to all sorts of conditions."
(Hoffer 1976, p.29)

Some educators agree that technology has the potential to
revolutionize instruction (Griffiths & Degner, 1995; Kulik, Kulik &
Cohen, 1980; Strom, Hocevar & Zimmer, 1990) Some authors such as
Torgesen (1986) believe that computers can present, in motivating ways,
an individualized instructional design to support teacher presented
instruction. Still others (Clark, 1994; Kettinger, 1991; Reeves, 1993)
question the practicality, cost, and delays that may be involved with the
development of this potential. Technology is envisioned as a primary
method for self-instruction, a vehicle for remediation, a way to provide
advanced placement opportunities, and a device to supplement the
regular instructional program. Examples of all of these instructional
uses of technology exist but, at present, there is not an economical
application of technology that serves all of the above functions. One
system that would serve these functions, yet accommodate
individualistic characteristics, is a modular system that is user friendly,
designed on a theoretical basis, and uses the available multimedia
technology.

**Computer-Assisted-Instruction**

The literature demonstrates that Computer-Assisted-Instruction
(CAI) can be beneficial when it allows the students to work at their own
pace (Carlson, 1991; Chung & Reigeluth, 1992), on their own time
(Tennyson & Rasch 1988), and without concern about being judged
(Packard, Holmes & Fortune, 1993). When compared to the textbook, CAI has the capability of altering presentation through different modalities (such as, graphic and animation) as well as interactivity. When compared to some lecturers, CAI possesses the capability of delivering an individualized lesson rather then addressing a classroom of students (Ross, 1984). The continuing challenge in education is to understand the relationship between the individual learner, and the environment of instructional design (Bovy, 1981; Scandura, 1984).

**Different delivery forms of CAI**

Many studies have previously investigated CAI delivery differences between textual, graphic, and animated presentation (Baek & Layne 1988; Jay, 1983; Rieber & Hannifin, 1988; and Wey & Waugh, 1993). These three different methods were used for delivery of a basic instructional design since they were simple for the user to follow and easily created via a multimedia environment for the designer.

**Textual:**

In most instructional designs computer screens do not present text in the same manner as the printed page. The effects on learning by the reduction of density level of instructional text in CAI versus printed material was studied by Morrison, Ross, and O'Dell (1988). They found no difference in high textual or low textual density lessons presented as printed text or text delivered via computer. Low density text in either medium was as effective for learning, more popular with the learners, and reduced learning time (Ross & Morrison, 1989). Low density text is created by "chunking" in four basic steps (Morrison, et al., 1988), (1) removing unnecessary modifiers containing single phrases, (2) using outline form whenever possible, (3) deleting summary statements, and (4)
limiting the amount of new information presented. This reduces textual material without the loss of instructional value.

The creation of text only screen, equivalent to a textbook, should follow the cultural pattern of the learner (Winn & Solomon, 1993). They found that it was especially true for new and unfamiliar material. The influence of the English language on screen display was demonstrated in a study by Winn & Solomon (1993). Students were presented different nonsense sentences and they were asked to identify the important word within the sentence. Student viewers were influenced by what Winn and Solomon believed to be a right-to-left mentality and therefore assumed the important subject, especially with new material, would be presented at the top right of the display.

**Static Graphics:**

Various guidelines for the development of graphic material as teaching tools have been developed in the adult-learner literature. Dwyer (1978, 1987) examined visual paper presentations and suggested that too much information leads learners to ignore appropriate information or attend to inappropriate information. Mayer (1989) suggested that static graphics, when used with instructional text, improved the problem-solving abilities of students. Later Mayer & Anderson (1992) applied the name "contiguity principle" for a dual presentation of graphics and textual material. They found that college students were better able to solve transfer problems when graphics and text were simultaneously presented together. Their study used several different delivery methods: concurrent graphic and oral narration; successive graphic and narration; graphics only; narration only; and no instruction (control group). Because of the limited capacity of students' working memory, they were
able to construct better referencing connections when textual and graphics materials were presented together.

The influence of the introduction of graphic display to CAI has been studied by many educational researchers (Alesandrini, 1987; Kobayashi, 1986; Rieber & Kini, 1991). Others have found that graphics produce several advantages for computer-assisted instruction: they can act as positive mnemonics for verbal and concrete information (Paivio & Csapo, 1973); bring attention and appeal to instructional material (Surber & Leeder, 1988); and enhance performance (Alesandrini, 1987).

**Animation:**

Adding animated graphics into computer-assisted instruction must be understood in terms of their instructional and motivational values. Animation is defined as a series of rapidly changing computer screen displays that appear to human perception as if movement were occurring (Caraballo, 1985). Four practical reasons, were described by Rieber (1990) for application of animation in computer-assisted instruction: visual stimulation, practice, presentation, and cosmetic enhancement of the learning environment. Visual stimulation would heighten student’s attention, which Gagne (1985) suggested as an important initial event for instruction. Levie (1987) stated that two questions should be asked when considering visuals in designing instruction: Does it add to the learner’s motivation? And does it help the learner learn?

Because the human working memory is limited in how much information can be processed at one time, there are limitations in what can be done at one time. So the presentation of novel tasks or animation must be limited to insure processing of material. There is an inherent danger in the random addition of animation to the computer-assisted instructional unit. Too much "glitter" added to educational software can
be detrimental when the educational value has not been considered first (Rieber, 1989). Rieber and Kini (1991) clarified this warning suggesting the use of animation was an effective attention device but it must be informative. The learner, in order to gain knowledge, must be able to see the relevance of the animation to the instruction. This supports the earlier studies by Dwyer (1978, 1987) which stated too much information creates confusion in the focusing of attention to the proper material. Animation also offers a contrast to the textual information or the static background bringing attention to important lesson information (Hannafin & Peck, 1988).

There is no clear difference between static and animated graphics for educational concepts. One exception is in the area of changing concepts; in particular, is the change in shape or size of an object. A graph of a statistical distribution that alters its appearance when values are changed clearly demonstrates the effect of values on the distribution. In this case, animation conveys a more concrete image to the learner (Rieber & Kini, 1991).

In an earlier pilot study (Packard, Holmes & Fortune, 1995), a question was posed using a static graphic as an informative part of the question. The participants who received the animation of this particular concept had to separate the static image from the animation images when they were presented during instruction in order to answer the question. Since participants of the static condition received the identical image in the presentation stage and the assessment stage, it was an easier recall task compared to that of the participants viewing animation.

A study by Rieber, Boyce and Assah (1989) found no significant differences in test scores based on to the type of visual presentation used during instruction. However, the participants in the animated graphic
condition responded quicker in their responses to posttest questions than those that needed visual elaboration. The participants in the visual group also indicated that the animation helped them focus on the questions. This would suggest that the process of encoding the information was aided by the animation, reducing the retrieval time. Therefore, quicker response time suggests that the animated presentation aided the students in the reconstruction process during recall (Rieber, 1989). The attention of the learner was easily directed to animated information and less distracted from the animation when the frame was broken down into textual and visual "chunks" (Rieber, 1989).

Problem solving was improved when static illustrations were used concurrently with instructional text (Mayer, 1989). Improvement in problem solving was also found with animation (Mayer & Anderson, 1991). Mayer and Anderson (1992) found that animation, when presented with concurrent narration, was associated with higher scores on transfer problems. Rieber (1990) suggests the presentation of the attributes of motion by animation reduces the processing demands of short term memory. Therefore, animation is expected to increase encoding of information into long-term memory.

**Theoretical concepts**

While a large number of studies has been conducted, using various instructional designs, combining computers and cognitive psychology, little theoretical work has been devoted toward incorporating individualistic learner traits into instructional design (Clark, 1985; Reeves, 1993). It is important that designs be developed with a theoretical base in mind to take advantage of expected learner characteristics. One model of learning which may help guide the computer-assisted-instruction (CAI) work is that of Egon Brunswik
Brunswik investigated the perception of individuals and the information available, a process he referred to as Probabilistic Functionalism.

Probabilistic Functionalism incorporates the interrelationship between organism and environment. Probabilistic functionalism attempts to predict the individual's successes and failures of the understandings of the cue (object) and the subsequent attainment of the goal. The environment was defined by Brunswik (1964) as the "...measurable characteristics" (p. 6) of that which surrounded the individual "...rather than the psychological environment or life space" (p. 6). He further defined cognition, which includes perception, as the acquisition of knowledge. Perception, the process of focusing on the intended object, according to Brunswik, is influenced by cues and distractions. He examined these influences using a three-dimensional model of the perception of space and all the things contained within it.

**Regionalism**

Brunswik referred to this three-dimensional model as Regionalism (Figure 1.1). Regionalism attempts to explain the locations of cues and goals in relationship to the individual. "Cues" were the stimuli found within the environment which allows an individual to make judgments about an object's characteristic(s). "Goals" were something that the individual wished to accomplish. Brunswik's fundamental concept of the environment was to segment its relationship to the individual. Those "cues" or "goals" that were removed from the individual he referred to as *distal* and those close to the individual were referred to as *proximal* or sensory. The "cues" explained the environment to the individual enabling goal acquisition decisions.
One other region must be mentioned, the *central*, which refers to events within the organism. To accomplish these acquisitions of goals, decisions must be made which are driven by *means-objects*. In a paper written by Tolman and Brunswik (1966) they describe these *means-objects* as "good, ambivalent, indifferent, and bad." For example, a "good" or "ambivalent" *means-object* leads to a high probability of a positive goal, while "indifferent" or "bad" mean reduces the efficiency of reaching a positive goal. The combination of "cues", "means-objects" and "goals" differs from individual to individual and therefore supports Brunswik's concept of probabilistic functionalism.

![Diagram](image)

**Figure 1.1: Regionalism adapted from Brunswik's functional unit of behavior (1952)**

**Brunswik's Lens Models**

Brunswik examined these influences called "means-objects" using a lens model which contained his three dimensional model of perception of space (Figure 1.1). The lens model, when combined with regional
referencing of the ecology, serves to explain the differential study routes taken by learners to master a given subject. The original single-lens model was designed to explain the perceptual paradigm (see Figure 1.2). As the individual perceives the initial focal variable (cue), the cue goes through the process of individualistic mediation and then is acted on to create the terminal focal variable (goal). As Figure 1.2 illustrates, the original perception can be influenced by stray causes and an individual’s mediation can also create stray effects. Neither are truly representative of the original instruction’s intent.

![Figure 1.2: Brunswik’s Single Lens Model (1952)](image)

*Figure 1.2: Brunswik’s Single Lens Model (1952)*

The double convex lens model in Figure 1.3 illustrates bringing the resulting array of cues from the distal object collects the cues and focuses the cue into a person’s perception. The filtering of cues (1st lens) and the use of means (2nd lens) are influenced by the learner’s environment. The learner’s innate characteristics are also a consideration. As a result, a basis is formed that any judgment will be made in an individualistic manner. Following the model from left to right, the path of cue information must travel through the first lens of recognition to the organism (learner) at which point a decision is made.
The learner can return to the object for more information or continue by responding and using personal, individualistic, or means of processing cues to obtain a distal goal.

Figure 1.3: Extension of the lens model to behavior (adaptation of Brunswik's functional unit of behavior)

"Cues" found in the learner's environment are not always perceived as they are intended by the instructor. Before they can be acted on by the learner, they undergo a transition that may or may not be true to the "original" idea. Each individual must sort through strengths and weaknesses of their personal perception of the object before making any decision on whether or not to use the object or "cue" in their attainment of their "distal goal." The uncertainty of these influences as they differ in each individual suggests that the reception of any cue is probabilistic. The hierarchy of cues shown in Figure 1.4 are just a few possible functions which might occur during the individual's need to organize.
before making a decision. Even after any decision about the "cue" is made by the learner, the actual event of the instructional intent matching the decision by the learner is only probable.

![Diagram of Brunswik Lens Model]

**Figure 1.4: Organization of Cue Understanding of the Brunswik Lens Model**

Figure 1.5 shows the process of acting on any decision by the learner. Once again the means for each individual differs and the figure shows a single combination of means that might mediate the attainment of the distal goal. There are many possible combinations of means even within the individual. If the original "cue" is new to the individual, familiarity, skill level, and prior knowledge cannot be used in the attainment of the distal goal. No matter what the individual's motivation and need for completion of the "proximal goal," the distal goal will be
harder to accomplish than with an individual whose background is
familiar with the new "cue."

Figure 1.5: Mediation of the Distal Goal of the Brunswik Lens Model

The style of education suggested by students of Brunswik treats
human behavior as probabilistic in the responses to cues as well as the
selection of distal cues. Brunswik's lens model describes how education
may become more autonomous, and more individualistic. An
investigation of the different methods of looking at distal cues (new
knowledge) and the processes that integrate cues into existing knowledge
structures or memory, will demonstrate learning differences. The
original perception of a new cue depends on its proximity to the
individual. Calculus is easier to understand if the individual has a
mathematical background. Reception of new knowledge also depends on how it is presented. For an auditory learner, lecture is a good means of delivery but it is an ambivalent means for another who might prefer a visual presentation.

The means of delivery aids or inhibits. Outside interference has the effect of “blurredness” according to Brunswik’s Len model which causes the reception of the delivery to be distorted creating a delay in the access of existing knowledge. Integration of existing knowledge and new knowledge requires proper feedback, both immediate and incomplete. This creates an encouraging learning environment that spurs the individual to integrate new knowledge. Incomplete feedback helps a learner to understand the possible complexities of an answer. Brunswick recognized individual differences and, therefore, emphasized the need for the opportunity for multiple-cues selection within the learning environment. Likewise instruction should be characterized by enrichment using a variety of cues during instruction delivery.

**Cognitive Styles Interaction With Computer-Assisted Instruction**

CAI can provide a rich learning and motivating environment for learners. The research begun by Brunswik should encourage educators to consider the "value of ideographic analysis of teaching and learning in terms of observed behavioral cues and inferred personal traits" (p.1) when designing and/or delivering instruction (Snow, 1968). CAI facilitates accommodation of individual learning preferences.

Some research on cognitive styles has focused on the creation of a complex system of individualistic accommodation. Snow summed up this complexity by simply stating “no matter how you try to make an instructional treatment better for someone, you will make it worse for someone else” (Snow, 1976, p.292). In the studies of cognitive style and
their relationship to education, two cognitive measures have been frequently investigated: locus of control and field-dependence and field-independence (FD/I). It is important to look at the relationship of these two styles to CAI research.

**Locus of Control**

One cognitive characteristic that has been shown to influence the ability for students to learn is locus of control (Rotter, 1966). Rotter looked at the individual differences in terms of control, specifically external and internal loci of control. The differences refer to the manner in which individuals perceive their degree of control in a causal relationship between the manner of the individuals’ behavior and the reward. Persons with internal control believe that their outcome depends on their choice in behavior. An individual with an external locus of control believes that luck, chance, or the influence of others control outcomes, and that behavior is irrelevant.

**Early Research on Locus of control:**

Parent, Forward, Canter, and Mohling (1975) attempted to create an environment that was more ecologically balanced for students. Their study suggested that optimum student performance was achieved when there was a complementary fit between the student’s level of internalized discipline and the external conditions assigned. Two different factors were used to determine student performance and satisfaction: (1) Rotter’s locus of control as a cognitive measure and (2) the discipline structure of the teaching strategy (low and high). Low-discipline conditions existed when students were handed specific study material and told to work at their natural pace within time allotment (example 2-hours). High-discipline students were presented rules governing their classroom
behavior by the teacher. The material was presented at a rapid pace and quizzes were administered at regular intervals. Internal locus of control students performed significantly better under the low discipline conditions while externals performed better in the high discipline. Students assigned to their preferred discipline demonstrated a significantly greater satisfaction.

Daniels and Stevens (1976) looked at two methods of college instruction and two levels of locus of control. Students from an undergraduate psychology class were divided into two instructional methods: teacher controlled and student controlled. The disordinal interaction between instructional methods and level of locus of control supported the Parent et al. (1975) study. External students performed better under teacher controlled conditions and internal student did better under the contract plan.

A similar study by Holloway (1978) measured learner's locus of control using Rotter's locus of control questionnaire and assigned students to high-internal and high-external groups. The high-internal students performed better under self-imposed structure than they did under a prescriptive structure. He concluded that internal-oriented learners perform best when asked to capitalize on their ability to assume responsibility for their own learning. A later study by Ryback and Sanders (1980) looked at teacher-centered and student-centered instruction with undergraduate psychology students. They also found that internally oriented students preferred student-centered instruction and external preferred teacher-centered instruction.

These studies of college students lead readers to believe that external LOC individuals learn more in a highly structured atmosphere, which is highly structured as opposed to internal LOC individuals who
learn more in a less structured environment. Investigation into the usefulness of cognitive measures of locus of control and CAI instructional delivery is warranted.

**Field-independence/dependence:**
Another cognitive ability that has been heavily investigated is been field-independence-dependence (MacGregor, Shapiro, & Niemiec, 1988). Khoury and Behr (1982) define field-independence as a predisposition to observe the "environment analytically or in a differentiated fashion" (p.4) and field-dependence as a predisposition to observe the "environment in a global and undifferentiated fashion" (p.4). Some of the characteristics of field-independence/dependence and their relationship to learning were identified by Thompson (1988). He suggested that field-independent learners benefit from fully sampling from the “cues" to organize material. He further suggested field-independent learners are more active and work to generalize material leading to better acquisition of concepts. Thompson went on to describe an overall view of field-dependent individuals who are influenced in a general sense by the organization of the task being presented. He suggested that field-independent individuals tend to analyze and re-structure the task and, therefore, are not “easily influenced by a structure that is present” (Thompson, 1988) p.2)

Achievement scores from 46 college students were obtained along with their field-dependent/independent (FD/FI) scores in a study by Stevens (1983). She found a significant positive correlation between achievement scores and FD/FI scores. It was suggested that field-independent individuals were more academically successful than their field-dependent counterparts. Participants were part of an instructional
computer class and the subject matter and the strategies used to teach may have favored field-independent students.

Field-independent students seem to restructure concepts presented to them, thus, enabling a deeper encoding of the concepts when compared to passive FD students (Carrier, Davidson, Higson, & Williams 1984) The restructuring of information requires both attention and activity which increases encoding into long term memory (Ashcraft, 1989, p.57).

Unlike a field-independent student, the field-dependent student needs a structure to focus attention and opportunities to practice. MacGregor et al. (1988) looked at FD/FI differences using two different instructional methods (computer-augmented instruction and traditional instruction) to investigating success in algebra. The treatments took place over a sixteen-week elementary algebra course with four hours of classroom instruction per week. The field-dependent students performed better using the computer-augmented environment and the indiscriminate students did better using the problem-solving environment. Computer augmentation included a commercially produced drill-and-practice and tutorial using Apple Ile microcomputers for one hour a week. Traditional instruction students received teacher-created problem-solving techniques for one hour a week. This study lends support to previous findings that field-dependent students prefer directions when learning specific information that is presented in a structured format.

The better performance of field-dependent learners within controlled conditions was also presented in the findings of Burwell's study (1991). Students of FD/Fi were paired with two different treatments (program control without options and interactive design
where the student had options over pace, path, and amount of exposure). Although it appeared that field-dependent individuals became active learners, they took longer in both treatment groups. It also appeared that they took advantage to the directives of the highlighted cues, spent a longer time in the options given and, thereby, took longer to process information. Burwell states that field-dependents do well in personal control conditions when provided with advisement. This was suggested by the earlier mentioned study of Carrier, et al. (1984), who found FD students selected proportionately more additional examples than did FI students.

Presentation type made a difference for FD/FI students in a study done by a Wey and Waugh (1993). When using the text/graphic mode, there was no significant difference comparing the result (simple fact-based questions on topics from a course in Western Civilization) obtained by independent or dependent participants. However, when the medium was text only the field-independent students fared better. The graphic helped the dependent learner to isolate the important issue from the background.

These studies of college students’ cognitive differences are important in terms of the instructional design. Structure effects individuals differently in both locus of control and field-dependence/field-independence as needs to be addressed. Instructional navigation is a positive addition to those individuals with need of structure and appears not to effect those with a cognitive preference of low structure. Presentation of simple, straightforward instruction would enable field-dependent learners to secure the new knowledge while not interfering with those individuals measured field-independent.
Chapter II

Introduction to the problem

An ongoing debate persists of the value of computerized delivery of instructional material (Clark, 1994; Kozma, 1994). At the center of this debate about the value of computer-assisted-instruction (CAI) are (1) the lack of a theoretical base and (2) the question of whether CAI influences the learner. An additional issue is the importance of how individual learning style relates to the presentation and understanding of concepts being presented. The importance of attending to these individual cognitive differences was suggested by Cronbach and Snow (1969).

"Assume that a certain set of outcomes from an educational program is desired. Consider any particular instructional treatment. In what manner do the characteristics of learners affect the extent to which they attain the outcomes from each of the treatments that might be considered? Or, considering a particular learner, which treatment is best for him?" (Cronbach & Snow, 1969, p.6)

CAI has the capacity to supplement the presentation of textbook content and support educators using a multimodal approach to teaching that accommodates individual preferences. These different modalities can strengthen textbook instruction by offering animation and interactivity. When compared to the lecture hall, CAI has the capability of delivering individualized lessons "rather than being restricted to normative characteristics of a class of students" (Ross, 1984, p.42). The continuing challenge for educators is the capacity of adjusting for the individualistic characteristic (Bovy, 1981). CAI programs can give the learner the flexibility of access in the home, in the library, or in a computer lab at the college or university. Programs developed to
remediate subject matter and accommodate the student's individualized traits can enable the correction of content weaknesses in any subject matter.

**Purpose**

Part of the difficulty in creating a valuable CAI instructional presentation exist in the interrelationship of the individual learner and the instructional design (Scandura, 1984). This study investigated the relationship between a CAI learning environment and two measures of cognitive styles among post-secondary students. The underlying instructional design was theoretical and based on Brunswik's psychology. The study investigated the ability of a cognitive measure to predict the CAI presentation method best suited for an individual's cognitive ability. Two different cognitive measures were regressed against three different CAI presentation methods (text only, text plus static graphics and text plus animated graphics). These three different methods were used for delivery of a basic instructional design since they were believed to be familiar to the learner and more easily created by the designer for a multimedia environment for the designer. The three methods were only used to instruct in three content (subsets) areas of random sampling, systematic sampling and skewness of distribution. Both immediate and delayed recall total test scores on statistical concepts of sampling and distribution shapes were examined. The subset measures consisted of 5 questions isolated by content area. Nine additional questions were added to form an aggregate for the total test.
Experimental Hypotheses

Hypothesis One: (Aptitude x Treatment Interaction)
There would be disordinal interaction between types of CAI presentation methods using scores of immediate and delayed recall as dependent variables and the scores of locus of control as the independent variable.

Hypothesis Two: (Aptitude x Treatment interaction)
There would be disordinal interaction between types of CAI presentation methods using scores of immediate and delayed recall as dependent variables and the scores of field-dependence/field-independence as the independent variable.

Hypothesis Three (ANCOVA)
1. There would be significant differences in the three types of presentation and the scores of total immediate and delayed recall tests.

Secondary Analysis
a) There would be significant differences in the three types levels of locus of control and the scores of immediate and delayed recall.
b) There would be significant differences in the three levels of field-dependence/field-independence and the scores of immediate and delayed recall.
Chapter III

Method

Participants
A total of 102 masters and doctoral students (53 females, 49 males) enrolled in various graduate education classes at Virginia Polytechnic Institute and State University volunteered to participate in the study. Each participant was systematically assigned to one of three treatment groups with an expected sample population in each treatment of thirty-four individuals. There were 42 master level and 59 doctoral level students participating. A breakdown by age and gender is found in Table 3.1.

Apparatus:
The instructional material and evaluative instruments were delivered using Windows 3.1 (Microsoft, Inc.) and Authorware 2.0 (Macromedia, Inc.) as the software development application. Twenty 486 DX, 8Mb, 200 MbHD PC compatible computers constituted the hardware requirements. Two laboratories in the College of Education at Virginia Tech provided the experimental setting. The relationship of cognitive aptitude and method of CAI presentation was investigated using graduate students as participants (see Figure 3.1).

Assessment Instruments
Six instruments were used in the study: (1) the demographic instrument used to measure covariate variables (Appendix A); (2) Rotter's Locus of Control (LOC) Scale used to determine levels of LOC (Appendix B); (3) Hidden Pattern Test (Appendix C) was used to determine field
Table 3.1: Breakdown by age and gender of participants

<table>
<thead>
<tr>
<th>Gender</th>
<th>18-22 years of age</th>
<th>23-27 years of age</th>
<th>28-32 years of age</th>
<th>33-37 years of age</th>
<th>38-42 years of age</th>
<th>over 42 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>10</td>
<td>15</td>
<td>6</td>
<td>13</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Male</td>
<td>5</td>
<td>11</td>
<td>6</td>
<td>11</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Program

Introduction of the program to the participants

Demographic questions
  * Gender
  * Age
  * Graduate level
  * Years of experience
  * Number of math classes
  * Last time math class taken
  * Number of statistics classes
  * Last time statistic class taken

Pre-test
  24 questions

Hidden Pattern Test
  2 sections @ 3 minutes each

Treatment/Instruction
  text only (TO)
  text and static graphics (TS)
  text and animated graphics (TA)

Locus of control

Immediate recall test
  24 questions

Delayed recall test
  24 questions

Reasoning

Ethics

Data to be used as independent variables

Covariates

Assessment of previous knowledge

Speed of Perception

Field Independence

Learning environment

External/internal locus of control

Assessment of knowledge after exposure to treatment

Assessment of knowledge retained after a week delay

Figure 3.1: Program design for the exploration of a Brunswik learning environment
dependence/independence (FD/FD); (4) Pre-test (Appendix E); (5) Immediate recall test; and (6) delayed recall test to determine levels of instructional knowledge.

**Demographics**

The computer generated survey (see Appendix A) asked for the following information: gender, age, current student status, computer experiences in number of years, number of statistic classes taken, last time a statistics class was taken, number of math classes that were taken, and last time a math class was taken.

**Locus of Control**

The locus of control instrument is a 29-item test developed by Rotter (1966) and used to measure external or internal orientation. The original form was created as an individually administered paper and pencil test and was adapted for computer use by the researcher. Participants are forced to choose from two possible responses for each question on the test. Six questions of the twenty-nine were created by the original author with the sole purpose of making the test more ambivalent. Scoring is external as only answers matching the external choices are counted. The scale was developed for college age participants. Rotter (1966) reported an internal consistency using Kuder-Richardson of \( r = .70 \). A four week test-retest reliability result of \( r = .73 \) was reported in the same article.

**Field-dependence/Independence**

The Hidden Pattern Test (ETS, 1975) requires participants to search a distracting perceptual field to find a given configuration made from a series of short straight lines. The test was developed to measure the cognitive style know as field-independence (FI). FI is also related to
perceptual speed as it requires the participant to make a visual match while removing the match from a non-relevant background (Carroll, 1974). The original test was adapted for computer use without changing the order of the icons presented in the original paper and pencil test. The first screen reproduces the first page of the paper and pencil version and gives the copyright credits. The original form was taken in two parts with a time limit of three minutes for each section. The computerized version (see Appendix C) was true to the time limits and number of sections. The computer version differed by delivering only one icon at a time versus one-hundred icons per page on the paper and pencil test. An earlier paper and pencil use of this test with 30 graduate students (Packard, Holmes, & Fortune, 1993) averaged 74 responses during the allotted time compared to the computerized version averaging 69 responses.

**Instructional Material:**

The instructional material was developed to teach a section of a statistics course typically required of most doctoral students. *Elementary Survey Sampling* by Scheaffer, Mendenhall, and Ott (1971) served as reference for content. The material was “chunked” or minimized for presentation on the computer screen. There were 21 instructional screens presented to the participants with the same design format. Each screen was designed with four sections: header, right window, left window, and footer (see Appendix D). The header was a simple description of screen content such as “Shapes of distribution” or “Random sampling”, used to help participants organize content. The left window in all twenty-one screens contained textual instructional information. The footer area was used for navigational buttons to allow the participant to move from one screen to another.
All screens had additional “right-hand” window information provided to compliment left hand window. Some of these “right hand” windows presented the opportunity to obtain additional information through the use of hot spots. When these hot spots were clicked using the left mouse button, the screen changed and produced additional information. These hot spots varied from a single word per screen to as many as three words per screen for this program. During the study, three screens (eleven, seventeen, and nineteen) presented instruction in different presentation modes. The content for these screens were as follows: eleven-skewness, seventeen-systematic sampling, nineteen-random sampling.

In this document, these content areas are referred to as subsets. Although the content is the same in each subset, a participant depending on their assignment received information in one of the following modes: text only, text and static graphics, text and animation. For example, screen eleven had two hot spots. In the text mode presentation, (Appendix D), one hot spot described a negatively skewed distribution while the other, when clicked, described a positive distribution. In the text and static graphic mode presentation (Appendix D), one spot showed a graphic representation of a negatively skewed distribution, and the other, a positive distribution. In the text and animation mode (Appendix D), the hot spots presented a spreadsheet of two columns with one labeled X-value and the other Y-frequencies. The directions explained to the participants how they should fill in the frequency for each of the ten X-values with any number from one to ten. Once completed, the computer program would generate a graph representing the values the participant entered in the Y column. Directly under the generated graph, there were two graphic examples of skewed distribution—one negative and
one positive. Similar scenarios were presented during screen seventeen (systematic sampling) and screen nineteen (random sampling). Instructional content was identical throughout the core of the instruction. Only during the branching for additional information did the type of presentation differ. Care was taken to design the instruction and to keep the content consistent while differing the presentation forms.

**Pre-test, Immediate and Delayed Recall Tests:**

The three tests were identical with 24, multiple-choice questions written to test knowledge (Appendix E) of statistics. The reliability of the immediate recall test was 0.4911 Cronbach’s “alpha” and the delayed recall test was 0.4016 Cronbach’s “alpha”. For each of three content areas (random and systematic sampling, and the distribution shaped of skewness), five questions were specifically written in order to gain information about differences in presentation type. These content areas or subsets of the total test are important because the content is taught using three CAI presentations. The remaining questions covered material presented during the instructional delivery.

**Procedure**

An introduction to the research was explained to the individuals who volunteered to participate. The research was explained as being performed to test the possibility of using CAI presentation methods to help students with statistics concepts. It was further explained that it was possible that the program would be expanded to have the capability to suggest to users, based on cognitive skills, which presentation type might be beneficial for each individual. A permission slip was given for each participant to read and sign before beginning the program of instruction (Appendix F).
The computer program was started when participants entered a randomly assigned four digit code given. The program presented the following segments: demographic survey, pre-test of sampling knowledge, two sections of the hidden pattern test, the presentation of information about sampling, locus of control questionnaire, a post-test of sampling knowledge and a questionnaire about the participant's experience. All responses to the computer program questionnaires and measures were recorded on a floppy disk. A paper and pencil recall test was given one week after the computer presentation. Participant identification for the paper and pencil test was accomplished by using the same four digit number assigned earlier.
Chapter IV

RESULTS

Regression analysis was performed for each CAI presentation type (text only, text and static graphics, and text and animated graphics) for both immediate recall and delayed recall measures. Two sets of predictors were included in separate regression equations: (a) total scores of Locus of Control (LOC) and (b) total scores of Field-Dependence and Independence (FD/FI). Throughout the analysis, only a single predictor was used for analysis, with multiple regression demonstrating no greater explanation of variance. Using the recommendation of Cronbach and Snow (1966), the applied procedure was as follows: 1) a test of homogeneity of variance among CAI presentation methods was applied, 2) a test of parallelism of regression. Parallelism was rejected if $F$ exceeded the .05 level of significance. When a significant $F$ test was found, the Johnson-Neyman (1936) technique was applied.

Demographics

Table 4.1 shows the breakdown of the participants of this study by age and degree. The median age group for these participants was 28-32 years of age group. This age median was consistent across the three treatments. The sample participating consisted of forty-two masters and fifty-nine doctoral students. Table 4.2 shows means, standard deviation, and number of participants for each CAI presentation type broken down for content-area questions and the total scores of immediate and delayed recall tests. Results from an One-way ANOVA testing differences between CAI presentation type and scores on the content-area questions and total test questions are also shown. Significant findings for a
content area questions (Skewness p=.0485) and total (Total p=.0356) scores were found in the immediate recall test.

**Homogeneity of Variance**

A test of homogeneity of variance was applied to the immediate recall (see Table 4.4) and delayed recall (see Table 4.5) measure, content-area questions, total scores between CAI presentation methods (text only (TO); text plus static graphics (TS); and text plus animated graphics (TA)) and locus of control. Only the delayed recall total test questions failed to meet the assumption of homogeneity ($F_{2,84} = .029$) (see table 4.5). For this reason it will be left out of any of the following analyses.

**Disordinal and Ordinal Interactions**

Graphs demonstrating any interaction are shown for content area questions and total test scores for both immediate and delayed recall tests. Disordinal interactions are defined by the crossing of any predicted regression line within the range of aptitude scores obtained in this study. It is important to note that since parallelism could not be rejected in all cases, these interactions must not be taken as strong evidence of the expected effect. This decision was made to enable others to see tendencies in the ATI analysis of these cognitive measures when compared with the CAI presentation types.

**Hypothesis One: (Aptitude-Treatment-Interaction)**

There would disordinal interaction between types of CAI presentation methods using scores of immediate and delayed recall as dependent variable and the scores of Locus of control as independent variable.
**Locus of Control Instrument**

Results from the Rotter's Locus of Control instrument show the means and standard deviation of this population to be different from the data collected by Rotter study (1966) (Table 4.5).

**Immediate and Delayed recall content question scores**

There were no significant results for the tests of rejection of parallelism for either immediate or delayed recall test scores. Disordinal interaction was examined to look for trends in the data. It is important to note that since parallelism could not be rejected, these graphic interactions must not be taken as strong evidence of the expected effect. All disordinal interactions shown in Figures 4.1-4.6 and Figure 4.8 are illustrations of tendencies in the data. The regression equations for immediate recall questions (Table 4.6) and delayed recall questions (Table 4.7) are shown using the complete range of LOC scores obtained during this study.

**Random sampling content questions**

While parallelism could not be rejected, graphic disordinal interactions were found with regression lines representing the CAI presentation types for both immediate (see Figure 4.1) and delayed (see Figure 4.2) recall tests. Individuals assigned to the TO presentation type performed better on the immediate recall questions if they scored lower on the LOC interaction level of 9. After the interaction of LOC level of 9 the TS individuals scored higher. The results of the delayed recall test were different as the disordinal interaction occurs at LOC level of 6, before which individuals assigned to the TO presentation performed better and, after which, individuals assigned to the TS performed better.
### Table 4.1: CAI participants by program and gender

<table>
<thead>
<tr>
<th>Gender</th>
<th>18-22 years of age</th>
<th>23-27 years of age</th>
<th>28-32 years of age</th>
<th>33-37 years of age</th>
<th>38-42 years of age</th>
<th>Over 42 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>8</td>
<td>10</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>18-22 years of age</th>
<th>23-27 years of age</th>
<th>28-32 years of age</th>
<th>33-37 years of age</th>
<th>38-42 years of age</th>
<th>Over 42 years of age</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>11</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Male</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>4</td>
<td>9</td>
</tr>
</tbody>
</table>

### Table 4.2: Results of one-way ANOVA of CAI method by content areas

<table>
<thead>
<tr>
<th>Questions</th>
<th>Text only (TO)</th>
<th>Text and Static (TS)</th>
<th>Text and Animation (TA)</th>
<th>F results from One Way</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random</td>
<td>m = 1.77</td>
<td>m = 1.65</td>
<td>m = 1.35</td>
<td>F = 1.4066</td>
</tr>
<tr>
<td>5 questions</td>
<td>std. = 1.10</td>
<td>std. = 0.88</td>
<td>std. = 1.13</td>
<td>p = .2498</td>
</tr>
<tr>
<td></td>
<td>n = 34</td>
<td>n = 34</td>
<td>n = 34</td>
<td></td>
</tr>
<tr>
<td>Skewness</td>
<td>m = 2.53</td>
<td>m = 2.06</td>
<td>m = 1.97</td>
<td>F = 3.1215</td>
</tr>
<tr>
<td>5 questions</td>
<td>std. = 0.83</td>
<td>std. = 1.07</td>
<td>std. = 1.06</td>
<td>p = .0485*</td>
</tr>
<tr>
<td></td>
<td>n = 34</td>
<td>n = 34</td>
<td>n = 34</td>
<td></td>
</tr>
<tr>
<td>Systematic</td>
<td>m = 2.77</td>
<td>m = 2.56</td>
<td>m = 2.59</td>
<td>F = .4227</td>
</tr>
<tr>
<td>5 questions</td>
<td>std. = 1.02</td>
<td>std. = 0.96</td>
<td>std. = 1.02</td>
<td>p = .6565</td>
</tr>
<tr>
<td></td>
<td>n = 34</td>
<td>n = 34</td>
<td>n = 34</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>m = 14.46</td>
<td>m = 13.91</td>
<td>m = 12.74</td>
<td>F = 3.4505</td>
</tr>
<tr>
<td>24 questions</td>
<td>std. = 2.54</td>
<td>std. = 3.11</td>
<td>std. = 3.03</td>
<td>p = .0356*</td>
</tr>
<tr>
<td></td>
<td>n = 34</td>
<td>n = 34</td>
<td>n = 34</td>
<td>TO &gt; TA</td>
</tr>
<tr>
<td>Delayed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random</td>
<td>m = 1.39</td>
<td>m = 1.16</td>
<td>m = 1.20</td>
<td>F = .3388</td>
</tr>
<tr>
<td>5 questions</td>
<td>std. = 1.06</td>
<td>std. = 1.16</td>
<td>std. = 0.99</td>
<td>p = .7136</td>
</tr>
<tr>
<td></td>
<td>n = 26</td>
<td>n = 31</td>
<td>n = 30</td>
<td></td>
</tr>
<tr>
<td>Skewness</td>
<td>m = 2.19</td>
<td>m = 1.97</td>
<td>m = 2.43</td>
<td>F = 1.1929</td>
</tr>
<tr>
<td>5 questions</td>
<td>std. = 1.20</td>
<td>std. = 1.28</td>
<td>std. = 1.04</td>
<td>p = .3084</td>
</tr>
<tr>
<td></td>
<td>n = 26</td>
<td>n = 31</td>
<td>n = 30</td>
<td></td>
</tr>
<tr>
<td>Systematic</td>
<td>m = 2.46</td>
<td>m = 2.36</td>
<td>m = 1.93</td>
<td>F = 1.8299</td>
</tr>
<tr>
<td>5 questions</td>
<td>std. = 1.07</td>
<td>std. = 1.17</td>
<td>std. = 1.08</td>
<td>p = .1668</td>
</tr>
<tr>
<td></td>
<td>n = 26</td>
<td>n = 31</td>
<td>n = 30</td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>m = 12.68</td>
<td>m = 12.57</td>
<td>F = .2596</td>
</tr>
<tr>
<td>24 questions</td>
<td>std. = 1.83</td>
<td>std. = 3.38</td>
<td>std. = 2.69</td>
<td>p = .7719</td>
</tr>
<tr>
<td></td>
<td>n = 26</td>
<td>n = 31</td>
<td>n = 30</td>
<td></td>
</tr>
</tbody>
</table>

* Note sig. at p<.05
Table 4.3: ATI Results of Analysis of Immediate Recall Content Area and Total Tests Scores by LOC.

<table>
<thead>
<tr>
<th>Content /CAI presentation</th>
<th>Levene test of Homogeneity</th>
<th>Parallelism</th>
<th>Interaction Location on LOC scale</th>
<th>Johnson-Neyman</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random Sampling</td>
<td>$F_{2,99}=1.1393$</td>
<td>$p=.324$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{3,63}=.20006$</td>
<td>$p=.8960$</td>
<td>Disordinal</td>
<td>9.31277</td>
</tr>
<tr>
<td>to_ta</td>
<td>$F_{3,63}=0.99492$</td>
<td>$p=.4011$</td>
<td>Ordinal</td>
<td></td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3,64}=1.05536$</td>
<td>$p=.3744$</td>
<td>Disordinal</td>
<td>6.1365</td>
</tr>
<tr>
<td>Skewness Distribution</td>
<td>$F_{2,99}=1.0685$</td>
<td>$p=.347$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{3,63}=1.75612$</td>
<td>$p=.1647$</td>
<td>Ordinal</td>
<td></td>
</tr>
<tr>
<td>to_ta</td>
<td>$F_{3,63}=2.44316$</td>
<td>$p=.0723$</td>
<td>Disordinal</td>
<td>21.56596</td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3,64}=0.07595$</td>
<td>$p=.9727$</td>
<td>Ordinal</td>
<td></td>
</tr>
<tr>
<td>Systematic Sampling</td>
<td>$F_{2,99}=0.0099$</td>
<td>$p=.999$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{3,63}=2.27177$</td>
<td>$p=.0888$</td>
<td>Disordinal</td>
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</tr>
<tr>
<td>to_ta</td>
<td>$F_{3,63}=2.11379$</td>
<td>$p=.1073$</td>
<td>Ordinal</td>
<td></td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3,64}=0.62997$</td>
<td>$p=.5983$</td>
<td>Disordinal</td>
<td>12.69</td>
</tr>
<tr>
<td>Total test score</td>
<td>$F_{2,99}=0.8648$</td>
<td>$p=.424$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{3,63}=2.56192$</td>
<td>$p=.0627$</td>
<td>Ordinal</td>
<td></td>
</tr>
<tr>
<td>to_ta</td>
<td>$F_{3,62}=3.34461$</td>
<td>$p=.0246$*</td>
<td>Disordinal outside range</td>
<td>Not Applicable lack of Homogeneity</td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3,64}=2.23769$</td>
<td>$p=.0923$</td>
<td>Disordinal</td>
<td>19.45</td>
</tr>
</tbody>
</table>

* Note sig. at $p<.05$
<table>
<thead>
<tr>
<th>Content /CAI presentation</th>
<th>Levene test of Homogeneity</th>
<th>Parallelism</th>
<th>Interaction Location on LOC scale</th>
<th>Johnson-Neyman</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Random Sampling</strong></td>
<td>F(_{2,84}=1.2784) (p=.284)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to-ts</td>
<td>F(_{3,52}=.77424) (p=.5137)</td>
<td>Disordinal</td>
<td>6.570575</td>
<td></td>
</tr>
<tr>
<td>to-ta</td>
<td>F(_{3,52}=0.31102) (p=.8173)</td>
<td>Disordinal</td>
<td>21.03</td>
<td></td>
</tr>
<tr>
<td>ts-ta</td>
<td>F(_{3,57}=.65029) (p=.5860)</td>
<td>Disordinal</td>
<td>10.02075</td>
<td></td>
</tr>
<tr>
<td><strong>Skewness Distribution</strong></td>
<td>F(_{2,84}=0.7851) (p=.459)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to-ts</td>
<td>F(_{3,52}=0.38229) (p=.7662)</td>
<td>Disordinal</td>
<td>4.000335</td>
<td></td>
</tr>
<tr>
<td>to-ta</td>
<td>F(_{3,52}=0.18797) (p=.9041)</td>
<td>Ordinal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ts-ta</td>
<td>F(_{3,57}=.89517) (p=.4493)</td>
<td>Disordinal</td>
<td>17.01976</td>
<td></td>
</tr>
<tr>
<td><strong>Systematic Sampling</strong></td>
<td>F(_{2,84}=0.4185) (p=.659)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to-ts</td>
<td>F(_{3,52}=1.19322) (p=.3215)</td>
<td>Disordinal</td>
<td>11.14923</td>
<td></td>
</tr>
<tr>
<td>to-ta</td>
<td>F(_{3,51}=.213924) (p=.1067)</td>
<td>Ordinal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ts-ta</td>
<td>F(_{3,57}=.98484) (p=.4064)</td>
<td>Disordinal</td>
<td>18.19869</td>
<td></td>
</tr>
<tr>
<td><strong>Total test score</strong></td>
<td>F(_{2,84}=3.6765) (p=.029)</td>
<td>Disregard</td>
<td>Lack of Homogeneity</td>
<td></td>
</tr>
<tr>
<td>to-ts</td>
<td>F(_{3,52}=3.42795) (p=.0236)</td>
<td>Disordinal</td>
<td>8.98545</td>
<td></td>
</tr>
<tr>
<td>to-ta</td>
<td>F(_{3,51}=2.05201) (p=.1182)</td>
<td>Disordinal</td>
<td>9.546234</td>
<td></td>
</tr>
<tr>
<td>ts-ta</td>
<td>F(_{3,57}=3.68399) (p=.0170)</td>
<td>Disordinal</td>
<td>8.285602</td>
<td></td>
</tr>
</tbody>
</table>

* Note sig. at p<.05
Skewness Questions

No disordinal interaction was found for the immediate recall condition (Figure 4.3). Those individuals assigned to the TO presentation performed better at all levels of LOC. A disordinal interaction occurred between the TO and TS presentation types at a LOC level 11 for the delayed recall test (Figure 4.4). The TO condition enabled those individuals assigned to perform better below 11 on the LOC scale.

Systematic Sampling Content Questions

Disordinal interactions were found for both the immediate (Figure 4.5) and delayed (Figure 4.6) recall tests. For the immediate recall question the interaction occurs at a LOC level 12 before which the TO assigned individuals performed better and, after which, the TA individuals scored higher. The delayed recall results were similar, as the TO assigned individuals performed better than the TS assigned individuals. That is until the LOC level of 12 was observed when the performance switched.

Total Score Of Immediate Recall Questions

One disordinal interaction occurred between the TS and TA presentation methods (see Figure 4.7). A significant finding was found for the TO and TA regression lines and the test of parallelism ($F_{3,63} = 3.344, p = .0246$). The intersection of the two regression lines occurred at the score of 19 on the LOC scale that was located outside the range of recorded scores for this sample. A Johnson-Neyman technique was performed to determine the region of non-significance and was found between 0 and 19 on the LOC axis. A significant difference was also found for the TO presentation method for levels of LOC ($F_{1,32} = 4.38284$;
\(p = 0.0443\). No results were reported due to the failure of the homogeneity of variance of the delayed recall total test questions. (Figure 4.8).
Table 4.5: Means and Standard Deviation of Rotter’s Locus of Control for several populations

<table>
<thead>
<tr>
<th>Gender</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia Tech males</td>
<td>49</td>
<td>9.92</td>
<td>4.58</td>
</tr>
<tr>
<td>Virginia Tech females</td>
<td>53</td>
<td>10.47</td>
<td>4.96</td>
</tr>
<tr>
<td>Ohio State Univ. males</td>
<td>575</td>
<td>8.15</td>
<td>3.88</td>
</tr>
<tr>
<td>Ohio State Univ. females</td>
<td>605</td>
<td>8.42</td>
<td>4.06</td>
</tr>
</tbody>
</table>

Table 4.6: Regression equations for immediate recall questions for each CAI presentation method using LOC as independent

<table>
<thead>
<tr>
<th>Regressed Variable</th>
<th>TO</th>
<th>TS</th>
<th>TA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate recall questions</td>
<td>a</td>
<td>bx</td>
<td>a</td>
</tr>
<tr>
<td>Random</td>
<td>2.1515</td>
<td>- .0409</td>
<td>1.4058</td>
</tr>
<tr>
<td>Skewness</td>
<td>2.1713</td>
<td>.0379</td>
<td>2.0135</td>
</tr>
<tr>
<td>Systematic</td>
<td>3.4852</td>
<td>-.0763</td>
<td>2.9282</td>
</tr>
<tr>
<td>Total</td>
<td>16.255</td>
<td>-.1797</td>
<td>16.166</td>
</tr>
</tbody>
</table>

Table 4.7: Regression equations for delayed recall questions for each CAI presentation method using LOC as independent

<table>
<thead>
<tr>
<th>Regressed Variable</th>
<th>TO</th>
<th>TS</th>
<th>TA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delayed recall questions</td>
<td>a</td>
<td>bx</td>
<td>a</td>
</tr>
<tr>
<td>Random</td>
<td>1.3663</td>
<td>.0019</td>
<td>1.7712</td>
</tr>
<tr>
<td>Skewness</td>
<td>2.0294</td>
<td>.0175</td>
<td>2.1845</td>
</tr>
<tr>
<td>Systematic</td>
<td>3.1637</td>
<td>-.0757</td>
<td>2.7503</td>
</tr>
<tr>
<td>Total</td>
<td>13.867</td>
<td>-.0852</td>
<td>16.171</td>
</tr>
</tbody>
</table>

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Figure 4.1: Immediate recall Random sampling content (5) questions by CAI presentation type by level of LOC

Figure 4.2: Delayed recall Random sampling content (5) questions by CAI presentation type by level of LOC
Figure 4.3: Immediate recall Skewness content (5) questions by CAI presentation type by level of LOC

Figure 4.4: Delayed recall Skewness content (5) questions by CAI presentation type by level of LOC
Figure 4.5: Immediate recall Systematic content (5) sampling questions by CAI presentation type by level of LOC

Figure 4.6: Delayed recall Systematic content sampling (5) questions by CAI presentation type by level of LOC
Figure 4.7: Immediate recall Total (24) test questions by CAI presentation type by level of LOC

Figure 4.8: Delayed recall Total (24) test questions by CAI presentation type by level of LOC
**Hypothesis Two (Aptitude-Treatment-Interaction)**

There would be disordinal interactions between types of CAI presentation methods using scores of immediate and delayed recall as dependent variable and the scores of Field-dependence/field-independence as independent variable.

**Homogeneity of Variance**

A test of homogeneity of variance was applied to the immediate recall (see Table 4.8) and delayed recall (see Table 4.9) measure, content-area questions and total scores between CAI presentation methods (text only; text and static graphics; and text and animated graphics) and FD/FI.

**Immediate and Delayed recall content question scores**

There were significant results for the tests of rejection of parallelism for three scores: immediate recall random sampling, delayed recall random sampling and immediate recall total test questions. In all three measures, a Johnson-Neyman (1936) test of non-significance determined that the scores which would separate type of presentation did not exist within the range of FD/FI measured with this sample population. There were three significant rejections of parallelism (Figures 4.9, Figure 4.10 and Figure 4.15). It is important to note that all other interactions shown must not be taken as strong evidence of the expected effect. All disordinal interactions shown in Figures 4.11-4.14 and Figure 4.16 are illustrations of tendencies in the data. The regression equations for immediate recall questions (Table 4.10) and delayed recall questions (Table 4.11) are shown using the complete range of LOC scores obtained during this study.
Random sampling content questions

In both the immediate recall (see Figure 14) and delayed recall (see Figure 15) conditions, disordinal interactions were found. In the test of parallelism, only the comparison of slopes between TS and TA of the immediate recall condition was found to be significant ($F_{3,64} = 3.14573; p = .0311$). The intersections of pairs occurred at various points in the immediate recall test condition. Field-dependent individuals (under 103 on FD/FI scale) who represented approximately 27% of sample population fared better when assigned to the TS presentation. Field-independent individuals scoring above 166 on the F_ D/I scale fared better when assigned to the TA presentation. The majority of individuals (66% of sample) fared better when assigned to the TO presentation methods. There was a significant difference ($F_{1,32} = 5.28076; p = .0282$) for those assigned to the TA presentation where those individuals scoring higher (field-independent) on the F_ D/I scale performed better on this test. A similar pattern occurred in the analysis of the delayed recall condition. Field-independent individuals (below 90) assigned to TS performed better than those field-dependent individuals on the other two CAI presentations. TO assignees performed better on delayed recall questions on random sampling if they had scores ranging between 90 and 144 on the FD/FI measurement. Individuals assigned to TA performed at the higher level if they measured above 144 on the FD/FI measurement scale.

Skewness content questions

Disordinal interactions were found in both immediate recall (see Figure 4.11) and delayed recall tests (see Figure 4.12). Ninety-eight percent of the individuals assigned to the TO presentation method
### Table 4.8: ATI Results of Analysis of Immediate Recall Content Area and Total Tests Scores by FD/FI.

<table>
<thead>
<tr>
<th>Content /CAI presentation</th>
<th>Levene test of Homogeneity</th>
<th>Parallelism</th>
<th>Interaction Location on FD/FI scale</th>
<th>Johnson-Neyman</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Random Sampling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{2.90} = 1.1393$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$p = .324$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ta</td>
<td>$F_{3.64} = 2.05893$</td>
<td></td>
<td>Disordinal</td>
<td>166.975</td>
</tr>
<tr>
<td></td>
<td>$p = .0666$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{2.64} = 3.14573$</td>
<td></td>
<td>Disordinal</td>
<td>136.1591</td>
</tr>
<tr>
<td></td>
<td>$p = .0311$</td>
<td></td>
<td></td>
<td>non-sig. range</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>92-170</td>
</tr>
<tr>
<td><strong>Skewness Distribution</strong></td>
<td>$F_{2.90} = 1.1393$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$p = .324$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{3.64} = 1.82374$</td>
<td></td>
<td>Disordinal</td>
<td>186.5269</td>
</tr>
<tr>
<td></td>
<td>$p = .1517$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ta</td>
<td>$F_{3.64} = 2.05983$</td>
<td></td>
<td>Ordinal</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$p = .1143$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3.64} = 0.37394$</td>
<td></td>
<td>Disordinal</td>
<td>103.1605</td>
</tr>
<tr>
<td></td>
<td>$p = .7721$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Systematic Sampling</strong></td>
<td>$F_{2.90} = 1.1393$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$p = .324$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{3.64} = 1.09886$</td>
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<td>Disordinal</td>
<td>141.8037</td>
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<tr>
<td></td>
<td>$p = .3562$</td>
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<td></td>
</tr>
<tr>
<td>to_ta</td>
<td>$F_{3.64} = 1.17424$</td>
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<td>Disordinal</td>
<td>136.1912</td>
</tr>
<tr>
<td></td>
<td>$p = .3266$</td>
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<td></td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3.64} = 0.60935$</td>
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<td>Disordinal</td>
<td>50.7508</td>
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<tr>
<td></td>
<td>$p = .6114$</td>
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<tr>
<td><strong>Total test score</strong></td>
<td>$F_{2.90} = 1.1393$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$p = .324$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{3.64} = 0.84341$</td>
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<td>Disordinal</td>
<td>177.0277</td>
</tr>
<tr>
<td></td>
<td>$p = .4752$</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>to_ta</td>
<td>$F_{3.64} = 4.05281$</td>
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<td>Disordinal</td>
<td>290.3967</td>
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<tr>
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<td>$p = .0106$</td>
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<td>Out of Range</td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3.64} = 2.56992$</td>
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<td>Disordinal</td>
<td>219.191</td>
</tr>
<tr>
<td></td>
<td>$p = .0619$</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4.9: ATI Results of Analysis of Delayed Recall Content Area and Total Tests Scores by FD/FI.

<table>
<thead>
<tr>
<th>Content /CAI presentation</th>
<th>Levene test of Homogeneity</th>
<th>Parallelism</th>
<th>Interaction Location on FD/FI scale</th>
<th>Johnson-Neyman</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Random Sampling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{2,84} = 1.1393$</td>
<td>$\text{p} = .324$</td>
<td>Disordinal</td>
<td></td>
</tr>
<tr>
<td>to_ta</td>
<td>$F_{3,53} = 0.51032$</td>
<td>$\text{p} = .6769$</td>
<td>Disordinal</td>
<td>90.93844</td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3,52} = 1.27173$</td>
<td>$\text{p} = .2937$</td>
<td>Disordinal</td>
<td>110.0595</td>
</tr>
<tr>
<td><strong>Skewness Distribution</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{3,53} = 0.92626$</td>
<td>$\text{p} = .4345$</td>
<td>Disordinal</td>
<td>138.4674</td>
</tr>
<tr>
<td>to_ta</td>
<td>$F_{3,52} = 0.92458$</td>
<td>$\text{p} = .4355$</td>
<td>Disordinal</td>
<td>258.6469</td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3,57} = 1.06429$</td>
<td>$\text{p} = .3715$</td>
<td>Disordinal</td>
<td>95.67844</td>
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<tr>
<td><strong>Systematic Sampling</strong></td>
<td>$F_{2,84} = 1.1393$</td>
<td>$\text{p} = .324$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>to_ts</td>
<td>$F_{3,53} = 0.09183$</td>
<td>$\text{p} = .9642$</td>
<td>Disordinal</td>
<td>161.6961</td>
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<td>to_ta</td>
<td>$F_{3,52} = 1.35657$</td>
<td>$\text{p} = .2663$</td>
<td>Disordinal</td>
<td>245.4597</td>
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<td>$F_{3,57} = 0.88255$</td>
<td>$\text{p} = .4557$</td>
<td>Disordinal</td>
<td>206.2657</td>
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<tr>
<td><strong>Total test score</strong></td>
<td>$F_{2,84} = 1.1393$</td>
<td>$\text{p} = .324$</td>
<td></td>
<td></td>
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<td>$F_{3,53} = 2.24543$</td>
<td>$\text{p} = .0937$</td>
<td>Disordinal</td>
<td>169.8196</td>
</tr>
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<td>$F_{3,52} = 3.48764$</td>
<td>$\text{p} = .0221$</td>
<td>Disordinal</td>
<td>183.9089</td>
</tr>
<tr>
<td>ts_ta</td>
<td>$F_{3,57} = 2.45056$</td>
<td>$\text{p} = .0727$</td>
<td>Disordinal</td>
<td>154.2985</td>
</tr>
</tbody>
</table>
performed better in the immediate recall condition. For the delayed recall condition only seventeen percent of those assigned to the TO method performed better. At the FD/FI score of 95, individuals assigned to the TA method performed better.

**Systematic Sampling content questions**

Disordinal interactions were found in both immediate recall (see Figure 4.13) and delayed recall (see Figure 4.14) systematic questions. Only the TO and the TA suggested instructional changes. The disordinal interaction occurred at the FD/FI score of 136. Those scoring below 136 performed better when given the TO presentation method whereas those scoring above were better served with the TA presentation method. The delayed recall test had only one interaction between TO and TS at the FD/FI level of 161. The TO presentation method was better for those who scored less than 161 on the FD/FI scale than those individuals who scored over 161 on the FD/FI measure. Also the TA presentation method gave the best results for this population.

**Total test question scores**

There is a disordinal interaction between the regression lines of TO and TS (see Figure 4.15). A lack of parallelism was found between TO and TA ($F_{3,64} = 4.05281; p = .0106$). The intersection between TO and TA occurs outside of the range of the FD/FI scale scores from this sample of graduate students. No analysis was performed for the total delayed recall question due to the lack of homogeneity (Figure 4.16).
Table 4.10: Regression equations for each immediate recall questions for CAI presentation method using FD/FI as the independent

<table>
<thead>
<tr>
<th>Regressed Variable</th>
<th>TO</th>
<th></th>
<th>TS</th>
<th></th>
<th>TA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>bx</td>
<td></td>
<td>a</td>
<td>bx</td>
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<tr>
<td>Immediate recall</td>
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<td>questions</td>
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</tr>
<tr>
<td>Random</td>
<td>1.5548</td>
<td>.0017</td>
<td>2.3056</td>
<td>-.0055</td>
<td>0.2782</td>
<td>.0094</td>
</tr>
<tr>
<td>Skewness</td>
<td>2.8357</td>
<td>-.0025</td>
<td>1.5106</td>
<td>.0046</td>
<td>2.1321</td>
<td>-.0014</td>
</tr>
<tr>
<td>Systematic</td>
<td>3.5896</td>
<td>-.0067</td>
<td>2.1412</td>
<td>.0035</td>
<td>2.1072</td>
<td>.0042</td>
</tr>
<tr>
<td>Total</td>
<td>13.919</td>
<td>.0052</td>
<td>12.019</td>
<td>.0159</td>
<td>10.174</td>
<td>.0222</td>
</tr>
</tbody>
</table>

Table 4.11: Regression equations for delayed recall questions for each CAI presentation method using FD/FI as the independent

<table>
<thead>
<tr>
<th>Regressed Variable</th>
<th>TO</th>
<th></th>
<th>TS</th>
<th></th>
<th>TA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>a</td>
<td>bx</td>
<td></td>
<td>a</td>
<td>bx</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delayed recall</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>questions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Random</td>
<td>1.0019</td>
<td>.0031</td>
<td>1.6858</td>
<td>-.0043</td>
<td>0.4024</td>
<td>.0072</td>
</tr>
<tr>
<td>Skewness</td>
<td>3.2014</td>
<td>-.0082</td>
<td>1.3988</td>
<td>.0047</td>
<td>2.2828</td>
<td>.0013</td>
</tr>
<tr>
<td>Systematic</td>
<td>2.7379</td>
<td>-.0022</td>
<td>2.3005</td>
<td>.0004</td>
<td>1.5455</td>
<td>.0035</td>
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<tr>
<td>Total</td>
<td>10.647</td>
<td>.0198</td>
<td>9.5233</td>
<td>.0264</td>
<td>10.009</td>
<td>.0233</td>
</tr>
</tbody>
</table>
Figure 4.9: Immediate recall Random sampling content (5) questions by CAI presentation type by level of FD/FI.

Figure 4.10: Delayed recall Random sampling content (5) questions by CAI presentation type by level of FD/FI.
Figure 4.11: Immediate recall Skewness content (5) questions by CAI presentation type by level of FD/F1.

Figure 4.12: Delayed recall Skewness content (5) questions by CAI presentation type by level of FD/F1.
Figure 4.13: Immediate recall Systematic content sampling (5) questions by CAI presentation type by level of FD/FI.

Figure 4.14: Delayed recall Systematic content sampling (5) questions by CAI presentation type by level of FD/FI.
Figure 4.15: Immediate recall Total (24) test questions by CAI presentation type by level of FD/FI.

Figure 4.16: Delayed recall Total (24) test questions by CAI presentation type by level of FD/FI.
**Hypothesis Three (ANCOVA)**

Research question three was created to determine if the participant scores on the three immediate and delayed content recall questions and total test scores were significantly different when compared to the type of CAI presentation. The pre-test scores and level of statistic classes taken were used as covariates. The hypothesis used to test research question three was:

There would be differences in the three types of presentation and the scores of total immediate and delayed recall tests.

To test this hypothesis an analysis of covariance was performed using the pre-test score and number of statistic classes previously taken as the covariates. All F’s were evaluated at a probability of .05. The covariate pre-test was always matched with the dependent immediate recall test variable (for example, dependent pre-test for random questions would be the covariate for immediate recall test for random questions).

**Immediate recall content questions**

Hypothesis 3 was not supported for the content area questions: random immediate recall questions \(F_{2,99}=1.838, p=.165\); skewness immediate recall questions \(F_{2,99}=2.786, p=.067\) and systematic immediate recall questions \(F_{2,99}=163, p=.850\) with no significant differences at \(p>.05\).

The hypothesis was supported for the total immediate recall questions \(F_{2,99}=5.366, p=.006\) with significant differences at \(p<.05\). A summary of the results of this analysis of covariance is presented in Table 4.12. A one-way analysis of variance was run using total immediate recall question score as the dependent variable and the CAI
presentation type as the independent variable with a significant result $(F_{2,99} = 3.4505, \, \mu = 0.0356)$. The participants assigned to the text only CAI type ($m = 14.5588, \, \text{std.} = 2.5369, \, n = 34$) scored significantly higher than participants assigned to the text and animation CAI type ($M = 12.7353, \, \text{std.} = 3.0282, \, n = 34$) according to the results of Student-Newman-Keuls test at $\alpha = 0.05$. A summary of the one-way analysis is presented in Table 4.13.

**Delayed recall content questions**

Hypothesis 3 was not supported for all three content area questions and the total test score: random delayed recall questions $(F_{2,99} = 0.208, \, p = 0.813)$; skewness delayed recall questions $(F_{2,99} = 0.464, \, p = 0.631)$; systematic delayed recall questions $(F_{2,99} = 2.049, \, p = 0.136)$; and total delayed recall questions $(F_{2,99} = 0.503, \, p = 0.607)$ with no significant differences $p > 0.05$.

**Secondary Analysis A (ANCOVA)**

There would be differences in the three levels of Locus of Control and scores of total immediate and delayed recall tests.

To test this hypothesis an analysis of covariance was performed using the pre-test score and number of statistics classes previously taken as the covariate. The levels of the cognitive measures were formed by using the mean and the standard. The lower level is found by subtracting one-half of the standard deviation from the mean. The upper level is a half a standard deviation above the mean leaving the non-distinctive region the width of a standard deviation around the mean.
Table 4.12: Test scores for immediate recall test by CAI presentation type

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>2</td>
<td>227.650</td>
<td>113.825</td>
<td>18.905</td>
<td>.000</td>
</tr>
<tr>
<td>Pre-Test Stat. Classes</td>
<td>1</td>
<td>174.311</td>
<td>174.311</td>
<td>28.952</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>18.199</td>
<td>18.199</td>
<td>3.023</td>
<td>.085</td>
</tr>
<tr>
<td>Main Effects</td>
<td>2</td>
<td>64.619</td>
<td>32.310</td>
<td>5.366</td>
<td>.006</td>
</tr>
<tr>
<td>CAI presentation</td>
<td>2</td>
<td>64.619</td>
<td>32.310</td>
<td>5.366</td>
<td>.006</td>
</tr>
<tr>
<td>Explained</td>
<td>4</td>
<td>292.269</td>
<td>73.067</td>
<td>12.136</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>95</td>
<td>571.971</td>
<td>6.021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>99</td>
<td>864.240</td>
<td>8.730</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.13: One-way Total Immediate recall questions by CAI presentation type

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>58.1176</td>
<td>29.0588</td>
<td>3.4505</td>
<td>.0356</td>
</tr>
<tr>
<td>Within Groups</td>
<td>99</td>
<td>833.7353</td>
<td>8.4216</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>101</td>
<td>891.8529</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Text/ Text/ Text/
only Static Animation

mean 14.5588 13.9118 12.7353
Standard dev. number 2.5369 3.1078 3.0282 34 34 34

Student-Newman-Kuels test with significance level .050

Text Only presentation > Text and Animation presentation
**Immediate recall questions**

The hypothesis was not supported for two of the three content/subset immediate recall measures and total score: random immediate recall questions ($F_{2,99}=.970, p=.383$); skewness immediate recall questions ($F_{2,99}=.692, p=.503$) and total immediate recall questions ($F_{2,99}=2.268, p=.109$) with no significant differences $p>.05$.

The hypothesis was supported for the systematic content questions ($F_{2,99}=5.105, p=.008$) (see Table 4.14) with significant differences $p<.05$. A significant result ($F_{2,99}=4.7906, p=.0103$) was obtained when a one-way analysis of variance was run using systematic immediate recall question score as the dependent variable and level of Locus of Control as the independent variable. A Levene Test for Homogeneity of Variance was performed showing no differences in homogeneity (2-tail Sig. = .970). Internal ($m = 2.848$, std. = $1.0038$, $n = 33$) and non-distinct ($m = 2.815$, std. = $0.9545$, $n = 38$) participants performed significantly better than external ($m = 2.193$, std. = $0.9099$, $n = 31$) participants.

**Delayed recall questions**

The secondary analysis was not found significant for the three content area questions for delayed recall scores: random delayed recall question ($F_{2,84}=1.492, p=.231$); skewness delayed recall questions ($F_{2,84}=.638, p=.531$); and systematic delayed recall questions ($F_{2,84}=1.964, p=.147$) with no significant differences $p>.05$.

The secondary analysis was found significant (see Table 4.15) for the total delayed recall questions ($F_{2,84}=3.939, p=.023$) with significant difference $p<.05$. A one-way ANOVA was performed with significant results ($F_{2,84} = 4.989, p = .009$). Student-Newman-Keuls test (.05) indicated significant difference between both internal ($m = 13.629$, std. =...
2.002, n = 27) and non-distinctive (m = 13.09, std = 2.897, n = 33) and external (m = 11.481, std = 2.778, n = 27).

**Secondary Analysis B (ANCOVA)**

There would be significant difference in the three levels of Field-dependence/Independence and scores of total immediate and delayed recall tests.

To test this hypothesis an analysis of covariance was performed using the pre-test score and number of statistic classes previously taken as the covariates. The levels of the cognitive measures were formed by using the mean and the standard. The lower level is found by subtracting one-half of the standard deviation from the mean. The upper level is a half a standard deviation above the mean leaving the non-distinctive region the width of a standard deviation around the mean.

**Immediate recall questions**

The secondary analysis for FD/FI was not supported for all the three content/subsets and the total measure: random immediate recall questions (F_{2.99}=.154, p=.858); skewness immediate recall questions (F_{2.99}=.780, p=.461); systematic immediate recall questions (F_{2.99}= 1.469, p=.235) and the total immediate recall questions (F_{2.99}=1.477, p=.234) with no significant differences p>.05.
Table 4.14: Immediate recall test systematic by three levels of LOC

<table>
<thead>
<tr>
<th>Source of Variation</th>
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<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>2</td>
<td>8.208</td>
<td>4.104</td>
<td>4.877</td>
<td>.010*</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>6.865</td>
<td>6.865</td>
<td>8.157</td>
<td>.005*</td>
</tr>
<tr>
<td>Stat class</td>
<td>1</td>
<td>.124</td>
<td>.124</td>
<td>.147</td>
<td>.702</td>
</tr>
<tr>
<td>Main Effects</td>
<td>2</td>
<td>8.593</td>
<td>4.297</td>
<td>5.105</td>
<td>.008*</td>
</tr>
<tr>
<td>LOC levels</td>
<td>2</td>
<td>8.593</td>
<td>4.297</td>
<td>5.105</td>
<td>.008*</td>
</tr>
<tr>
<td>Explained</td>
<td>4</td>
<td>16.801</td>
<td>4.400</td>
<td>4.991</td>
<td>.001*</td>
</tr>
<tr>
<td>Residual</td>
<td>95</td>
<td>79.949</td>
<td>.842</td>
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<tr>
<td>Total</td>
<td>99</td>
<td>96.750</td>
<td>.977</td>
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</table>

* Note sig. at p<.05

Non-distinctive

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<th>Source</th>
<th>Internal</th>
<th>distinctive</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>2.848</td>
<td>2.815</td>
<td>2.193</td>
</tr>
<tr>
<td>Standard dev.</td>
<td>1.003</td>
<td>.9545</td>
<td>.9099</td>
</tr>
<tr>
<td>number</td>
<td>33</td>
<td>38</td>
<td>31</td>
</tr>
</tbody>
</table>

Internal participants and non-distinctive > External Participants

Table 4.15: Total Delayed Recall Test Questions by three levels of LOC

<table>
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<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>2</td>
<td>190.573</td>
<td>95.286</td>
<td>18.744</td>
<td>.000</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>133.048</td>
<td>133.048</td>
<td>26.173</td>
<td>.000</td>
</tr>
<tr>
<td>Stat class</td>
<td>1</td>
<td>17.293</td>
<td>17.293</td>
<td>3.402</td>
<td>.069</td>
</tr>
<tr>
<td>Main Effects</td>
<td>2</td>
<td>40.043</td>
<td>20.021</td>
<td>3.939</td>
<td>.023</td>
</tr>
<tr>
<td>LOC levels</td>
<td>2</td>
<td>40.043</td>
<td>20.021</td>
<td>3.939</td>
<td>.023</td>
</tr>
<tr>
<td>Explained</td>
<td>4</td>
<td>230.615</td>
<td>57.654</td>
<td>11.341</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>80</td>
<td>406.679</td>
<td>5.083</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>637.294</td>
<td>7.587</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Note sig. at p<.05

Non-distinctive

<table>
<thead>
<tr>
<th>Source</th>
<th>Internal</th>
<th>distinctive</th>
<th>External</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>13.6296</td>
<td>13.0909</td>
<td>11.4815</td>
</tr>
<tr>
<td>Standard dev.</td>
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<td>2.8979</td>
<td>2.7786</td>
</tr>
<tr>
<td>number</td>
<td>27</td>
<td>33</td>
<td>27</td>
</tr>
</tbody>
</table>

Internal participants and non-distinctive > External Participants

57
**Delayed recall questions**

The secondary analysis for FD/FI was not supported for all of the three content area questions delayed recall measures: random delayed recall question ($F_{2,84} = 0.60$, $p = .941$); skewness delayed recall questions ($F_{2,84} = 0.573$, $p = .566$); systematic delayed recall questions ($F_{2,84} = 0.279$, $p = .758$) with no significant difference $p > .05$.

The secondary analysis for FD/FI was supported for the Total delayed recall questions ($F_{2,84} = 5.672$, $p = .005$). A one-way ANOVA was performed with significant results ($F_{2,84} = 5.5159$, $p = .0056$). Student-Newman-Keuls test (.05) indicated significant differences between field-independent ($m = 14.12$, std = 2.8036, $n = 25$) and both field-dependent ($m = 11.6818$, std. = 2.8517, $n = 22$) and non-distinctive ($m = 12.50$, std = 2.309, $n = 40$).

**Other variables**

Caution must be used when looking at the results of these other variables as the cell size can alter the real significance. These are included only to show tendencies in some of the demographic variables.

**Age**

Although analysis of covariance showed no significant difference for the immediate recall skewness questions for three levels of Locus of Control, a significant difference was found when age was considered. When age by itself was compared to Locus of Control no significant difference was found ($F_{2,99} = 1.4142$, $p = .248$). When ages were set to level some significant findings were found. At Age Level 18-22, there is a significance ($F_{2,14} = 5.04$, $p = .038$) yet no significant CAI presentation method was found during one-way analysis. Age Level 33 and above ($F_{2,48} = 3.867$, $p = .029$) skewness results demonstrated
Table 4.16: Total Delayed Recall Test Questions by three levels of FD/FI

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Covariates</td>
<td>2</td>
<td>190.573</td>
<td>95.286</td>
<td>19.484</td>
<td>.000</td>
</tr>
<tr>
<td>Pre-Test</td>
<td>1</td>
<td>133.048</td>
<td>133.048</td>
<td>27.205</td>
<td>.000</td>
</tr>
<tr>
<td>Stat class</td>
<td>1</td>
<td>17.293</td>
<td>17.293</td>
<td>3.536</td>
<td>.064</td>
</tr>
<tr>
<td>Main Effects</td>
<td>2</td>
<td>55.478</td>
<td>27.739</td>
<td>5.672</td>
<td>.005</td>
</tr>
<tr>
<td>FD/1 levels</td>
<td>2</td>
<td>55.478</td>
<td>27.729</td>
<td>5.672</td>
<td>.005</td>
</tr>
<tr>
<td>Explained</td>
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<td>246.051</td>
<td>61.513</td>
<td>12.578</td>
<td>.000</td>
</tr>
<tr>
<td>Residual</td>
<td>80</td>
<td>391.243</td>
<td>4.891</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>637.294</td>
<td>7.587</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note p<.05

<table>
<thead>
<tr>
<th></th>
<th>Dependent</th>
<th>Non-distinctive</th>
<th>Independent</th>
</tr>
</thead>
<tbody>
<tr>
<td>mean</td>
<td>11.6818</td>
<td>12.500</td>
<td>14.120</td>
</tr>
<tr>
<td>Standard dev.</td>
<td>2.8517</td>
<td>2.3094</td>
<td>2.8036</td>
</tr>
<tr>
<td>number</td>
<td>22</td>
<td>40</td>
<td>25</td>
</tr>
</tbody>
</table>

Independent > Non-distinctive and Dependent Participants
Student-Newman-Keuls *post hoc* comparison at $\alpha = .05$ significant differences between TA ($m = 3.0$, std = .894, n = 11) and both TO ($m = 1.94$, std = .873, n = 18) and TS ($m = 1.88$, std = .22, n = 11) presentation methods.

Post systematic questions also demonstrated significant differences using Locus of Control and Age Levels 23-32 ($F_{2,37} = 6.846$, p = .003) with Student-Newman-Keuls *post hoc* comparison at $\alpha = .05$ significant difference with TO ($m = 3.25$, std = .754, n = 12) and TS ($m = 3.0$, std = .913, n = 13) presentation methods to be superior than TA ($m = 1.92$, std = .954, n = 13). Post test total scores using 23-32 Age Level and Locus of Control were also found significantly different ($F_{2,37} = 3.691$, p = .036) with Student-Newman-Keuls *post hoc* comparison at “alpha” = .05 significant findings TO ($m = 14.67$, std = 3.2, n = 12) and TS ($m = 14.62$, std = .43, n = 13) being superior to TA ($m = 11.77$, std = .74, n = 13).

**Experience**

At the level of one previous statistics class, significant differences were found for immediate test total scores and immediate systematic sampling scores. Post total test scores were significantly ($F_{2,35} = 3.647$, p = .037) different between CAI presentation types at one statistic class experience level. A one-way ANOVA demonstrated differences between levels of Locus of Control ($F_{2,35} = 6.43$, p = .0044) with Student-Newman-Keuls *post hoc* comparison at $\alpha = .05$ demonstrating TO ($m = 15.5$, std = 2.0, n = 8) superior to TA ($m = 11.64$, std = 2.37, n = 14). Post systematic sampling test scores were also found significantly ($F_{2,35} = 3.55$, p = .040) different at levels of Locus of Control with one statistics class experience. A one-way ANOVA demonstrated difference between levels of Locus of Control ($F_{2,35} = 4.03$, p = .0272) with Student-Newman-Keuls *post hoc*
comparison n at a = .05 demonstrating TO (m=3.25, std = .886, n =8) superior to TA (m =2.14, std = .949. n =14).

**Tracking Time**

**Tracking skewness questions with FD/FI**

Analysis of tracking time was done with the time spent on the Skewness instructional material using ANOVA 3 x 3. The three CAI presentation methods and three levels of FD/FI comparison found a main effect of CAI presentation type ($F_{2,93} = 56.598, p = .000$) and a significant 2-way interaction ($F_{2,93} = 2.903, p = .026$). A one-way ANOVA was run with FD/FI for each CAI presentation type where significance difference was found only in the TO presentation ($F_{2,30}= 6.9936, p=.0034$). Student-Newman-Keuls post-hoc comparison at $\alpha = .05$ showed significant differences for field-dependence (m =37.4, std=13.975, n = 5) and field-independent (m =37.4167, std = 15.3176, n = 12) when compared to non-distinctive (m = 20.5, std=8.9163, n = 14).

**Tracking Systematic questions with FD/FI**

No main effects were found for ANOVA 3 X 3 but there was a significant 2-way interaction between treatment and FD/FI ($F_{2,93} = 4.123, p = .004$). For participants who were found to be field-dependent or independent, there were no significant differences. However, significant differences existed for those individuals measuring non-distinctive there was a significant difference ($F_{2,42} = 5.5244, p = .0076$) in tracking time. Student-Newman-Keuls post-hoc comparison at $\alpha = .05$ demonstrated that those individuals assigned to TA presentation (m = 89.7333, std = 32.6135, n = 15) took significantly longer time than those assigned to TO (m = 62.3571, std = 22.49. n = 14) or TS (m = 62.2143, std = 19.9391, n = 14).
Participants qualitative question results

Twelve qualitative questions were part of the data collected and answered by all the participants (Table 4.17). These questions were designed to look at the participants evaluation of the presentation forms. A chi-square analysis was performed to determine if there were any differences between the answers and the type of treatment. The only significant finding ($\chi^2 = 11.58666, \text{df} = 4, p = .02070$) was found with question ten (Table 4.18).
### Table 4.17: Twelve qualitative question results

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree/Somewhat agree in percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I like this computer program as it would help me learn this or other courses.</td>
<td>79%</td>
</tr>
<tr>
<td>2. I would like to see this expanded to support an entire course.</td>
<td>78%</td>
</tr>
<tr>
<td>3. I would like to be able to do this work at home.</td>
<td>88%</td>
</tr>
<tr>
<td>4. I would like to be able to do this at anytime which was convenient for me.</td>
<td>89%</td>
</tr>
<tr>
<td>5. I would use this to help me (study for exams, to support lectures, while preparing for my Dissertation or Thesis.</td>
<td>85%</td>
</tr>
<tr>
<td>6. I would like to be able to see more examples for each concept.</td>
<td>82%</td>
</tr>
<tr>
<td>7. I think I could learn more from the textual presented material.</td>
<td>53%</td>
</tr>
<tr>
<td>8. I think I could learn more if the material was presented in text and static graphics.</td>
<td>76%</td>
</tr>
<tr>
<td>9. I think I could learn more if the material was presented in text and animated graphics.</td>
<td>76%</td>
</tr>
<tr>
<td>10. I think I am capable of choosing what is the best way for me to learn material I am responsible for.</td>
<td>95%</td>
</tr>
<tr>
<td>11. I would be willing to allow the machine to suggest the best way for me to learn material I am responsible.</td>
<td>64%</td>
</tr>
<tr>
<td>12. I would need more practice using computers to feel comfortable with this manner of instruction.</td>
<td>68%</td>
</tr>
</tbody>
</table>

### Table 4.18: Crosstab table of Question 10.

<table>
<thead>
<tr>
<th>Count total Pct.</th>
<th>Text/Only</th>
<th>Text/Static</th>
<th>Text/Animation</th>
<th>Row %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>29</td>
<td>16</td>
<td>21</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>28.7%</td>
<td>15.8%</td>
<td>20.8%</td>
<td>65.3%</td>
</tr>
<tr>
<td>Agree with reservation</td>
<td>4</td>
<td>15</td>
<td>11</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>4.0%</td>
<td>14.9%</td>
<td>10.9%</td>
<td>29.7%</td>
</tr>
<tr>
<td>Disagree with reservation</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>1.0%</td>
<td>3.0%</td>
<td>1.0%</td>
<td>5.0%</td>
</tr>
<tr>
<td>Column %</td>
<td>34</td>
<td>34</td>
<td>33</td>
<td>101</td>
</tr>
<tr>
<td></td>
<td>33.7%</td>
<td>33.7%</td>
<td>32.7%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Chapter V

Introduction

The original problem statement looked at computer-assisted learning environments while questioning their theoretical base as well as their utility for delivering instruction. A focus of this study was to investigate learning outcomes associated with the development and implementation of a CAI model based on Brunswik’s theory. Three presentation formats were delivered in a multimedia environment aimed at accommodating individual cognitive traits. By placing emphasis on a theoretical model the researcher was able to address some of the criticisms of CAI more objectively. Aptitude-treatment-interaction (ATI) analysis was used to investigate the possible relationship between presentation methods and cognitive styles.

Appropriateness of cognitive measures

It was expected that cognitive styles would interact with CAI presentation types to produce differences in participants recall results. This was based on Brunswik’s notion that cognitive differences in the perception of cues may also account for different levels of learning.

Locus of Control

Based on the pilot study (Packard, et al., 1995), it was expected that LOC would be an effective predictive measure. The results of this study did not support the predictive capability of LOC as strongly as in the earlier study. Immediate recall scores demonstrated differences, although not significant, between internal (using the text only (TO)) and external participants (using graphic text plus static graphics (TS) or text plus animated graphics (TA)).
The effectiveness of presentation methods was found to be significantly different for delayed recall test questions. Those individuals with an internal LOC were aided by the addition of animation to the text. This was unlike the external LOC individuals who performed better on the delayed recall questions, but with the aid of the TO presentation method.

The interactions formed by the results of this study indicated there are occasions when the Locus of Control measure by Rotter (1966) could be used as a predictor of the better instruction presentation method choice for individuals. It has been suggested (Daniel & Stevens, 1976; Parent, Forward, Cantor, & Mohling, 1975) that externally controlled students excel in highly structured settings while internally controlled students do better in lowly structured environments. During this study the structure of the environment was high because individuals had to attend to every possible piece of information. This may have aided the externally controlled students while frustrating the internally controlled students.

Using the results of this study, it is questionable that Rotter's Locus of Control can be used to predict which CAI presentation is best for an individual learner. Other factors such as age may also influence the discriminating ability of locus of control.

**Age and Locus of control**

As previously demonstrated with undergraduates (Packard et al., 1995), Rotter's measure of Locus of Control may be a good predictor of the better CAI presentation method to use with younger college students. This study supported that finding although the sample size diminishes the significant difference of 18-22 year old participants between LOC and type of treatment. An unexpected significant outcome was at the age
group of 33 years and older, where individuals who were assigned to the TA presentation method performed better than their peers who were assigned to other presentation methods.

Field-dependence/Independence

Individuals who measured as field-dependent, performed better on the subset of random sampling questions when given static graphics in addition to the textual information. Otherwise, field-dependent individuals for the remaining content questions (skewness and systematic) and the total test questions performed best when assigned to the text only presentation. This held true whether it was a immediate or delayed recall test. Individuals who measured as field-independent performed best on all subset questions and the total test score when they were assigned to the text and animation presentation method. These results are the same for both immediate and delayed result tests. It is possible that the participants needed to examine the animation more thoroughly to draw out the information required to answer the question favoring the field-independent individuals.

Researchers who recently looked at the relationship of presentation methods and field-dependence/independence have found different results. Wey and Waugh (1993) found that field-dependent individuals performed better when graphics were added to the textual instruction. They also implied that field-independent individuals would perform better than field-dependent individuals when assigned to a text only presentation. Kini (1994) found no difference between field-dependence/independence individuals when performing on any of the three presentation methods (text only, text and static graphics, and text and animation).
Whether F D/I can predict or discriminate between the best CAI presentation method are questions that were unanswered by the results of this study. The results show tendencies but these are far from conclusive and require testing with a larger sample.

**Functions of presentation methods**

The computer program was designed from a theoretical base and it can be said to have the capacity to deliver instruction in a variety of methods. Improvement of scores from the pre-test to the immediate recall test suggest some learning; however, the reason was not defined by this study. Only with the immediate recall, total question score, did CAI presentation make a significant difference in knowledge gains. Individuals assigned to the text only presentation performed significantly better than their counterparts assigned to the text and animation presentation method. There are two possible explanations for this result. Exposure to the subject matter was very brief in this study. It is possible that exposure to the clear concise textual information was sufficient for short term recall for this group of individuals. It is also possible that students at postsecondary level are not as heavily dependent upon graphics as has been suggested by others (King, 1975; Rieber, 1989). King (1975) studied Naval training students taking calculus and found no difference in TO, TS. and TA. He suggested that older students had already refined many personal learning strategies and were not dependent on external imagery. A more recent study by Rieber (1989) on adult learners stated that college aged students probably do not benefit from instruction which contains additional visual elaboration since they are able to form mental images without additional lesson support.
Text with Static graphics

Individuals with internal LOC had better scores on delayed recall, random sampling questions, and delayed recall total test scores when assigned to the TS presentation. For these questions the graphic presentation may have added to long term memory, as suggested by the work done by Rieber and Kini (1991). This was not true of external LOC participants whose scores were lower than the internal LOC individuals. External individuals assigned to the TO presentation outscored all other external LOC individuals using either of the graphic presentation modes. It would appear that internal LOC individuals were capable of taking advantage of the alternative graphic information to encode the knowledge.

Dwyer's (1987) meta-analysis of the studies on learning environments and the results of the addition of graphics to textual information suggest graphics facilitate learning. This seemed true with the internal LOC participants answering delayed recall questions. Field-dependent participants' results in this study support earlier studies about the positive nature of adding graphics. Since these individuals had higher scores for the remaining questions while using the TO presentation method, a uniqueness for instructional material content appears to influence whether or not graphics add to information recalled.

Text with Animated Graphics

The internal locus of control individual's recall was better when instructed using the text and animation presentation for the delayed recall skewness questions. Internally controlled individuals are more capable of investigating a complex presentation using it more efficiently than externally controlled individuals (Wesley, Krockover, & Hicks, 1985). This may be the reason that there was no tendency for externally
controlled individuals to performing better in any of the question subsets or the total set of questions when using text plus animation.

The results from this study would suggest that field-independent individuals learn better when animations are added to text-based instruction. It is possible that field-dependent individuals did not understand how to attend the relevant cues or details provided by the animated segments. This would add support to a study by Baek and Layne (1988) which found success in animation over static and text because the student’s attention was focused on information contained in animation.

**Experience**

Experience has been suggested as an important variable in the acquisition of knowledge (Osman & Hannafin, 1992). However, this was supported with only one content subset of questions used in this study. Learning is more efficient when previously learned material is tied to new instructional content (Severin, 1987). The exposure to information is only one important aspect of instruction. Material relevant to the learner makes an important contribution to the outcome of the instructional design. Instruction of several sampling methods at one time may have interfered with previous knowledge. In this study, scores of the random sampling continue to drop from the pre-test scores through both recall tests. This observation might be explained by Severin’s (1967) suggestion that unrelated or opposing information creates a problem with the recall of information.

**Tracking time**

As different instructional delivery modes used in this study took different time to view, time on task might have created a learning
environment causing individuals subjects corresponding time on task might have created a learning environment which inadvertently, yet unfairly altered the results. For the subset of skewness, significant differences in tracking time between treatment and level of FD/FI were found. However, the small sample sizes question the strength of these findings and results. The results should be regarded as tendencies rather than true significant findings. For the text-only presentation field-dependent and non-distinctive groups spent significantly longer times completing the instruction than did the field-independent group. This finding is consistent with an earlier study done by Avolio, Alexander, Barret and Stern (1979) who suggested that field-independent individuals when compared to other levels of F D/I were able to extract salient information more quickly from background information. The individuals assigned to the TS presentation method took the same amount of time spent regardless of the level of FD/FI. Text and animation presentation showed subjects’ tendencies similar to the TO presentation group, yet without a significant difference. However, there was a tendency for the field-independent individuals to be capable of extracting information more quickly than their counterparts.

A significant finding also apparent while the tracking time students took to complete the systematic sampling instruction. A two-way interaction was found between the treatment type and the level of FD/FI. Unlike the skewness instruction, the group found to be significantly different in instruction time was the non-distinctive FD/FI. The animated instruction took longer for this group than either the text only or the text and static graphics.
Qualitative Questions

The twelve qualitative questions offer insight into learner's motivation for using the delivery methods. Results from these questions would suggest that the program was enjoyable to use and would be used if it were available. More individuals suggested that they would prefer presentation methods which included graphics. However results pointed toward the TO presentation as enabling more learners to perform better on the recall scores. This observation is supported by several researchers studying learner control (Burwell, 1991; Carrier, 1990). In the current study, the one significant finding pertained to question 10 which addressed learner choice. Ninety-five percent of the respondents believed that they could choose the appropriate instructional delivery rather than having the machine choose for them (sixty-four percent). This feeling would support the findings of a study by Schwier (1993) suggesting that individuals experience more ownership in the educational process when allowed to make decisions about the method of delivery for their own instruction.

Future studies

The sole purpose of this study was not to test the differences between CAI presentation methods but was aimed at examining possible interactions between cognitive traits and instructional methods. Although there are few statistically significant results supporting the original hypotheses, interactions were present. A larger population needs to be studied as in many cases significant findings are negated because of a small sample size. Efforts should be made to include a more homogeneous sample along such dimensions as statistical experience, levels of post-secondary education and computer experience. A control group receiving no instruction could be used to confirm
instruction delivery was effective. This would enable the researcher to more accurately identify which item did the instructing. Different educational levels might also address questions that can only be hinted toward from this study. Relevance of subject matter could have influenced the ability for this program to instruction participants. To create a complete Brunswikian learning environment several steps need to be taken. The availability of a database to provide more cues that could deliver material relevant to an individual’s major is needed. Other types of instructional delivery are also needed, including audio and an interactive workspace. Freedom of navigation that was not allowed during this exploratory study could be left up to the individual user. A major component in this study was the use of feedback. Feedback suggesting options to the user based on his/her cognitive abilities would be useful. Also, knowledge of response type feedback at particular points in the instructional delivery is needed to better enable the participant to monitor their own progress and resolve conflicts which may be adding to confusion. Other cognitive measures could be more discriminating and, therefore, be of better assistance to the individual learner.

What conclusion and theoretical implications can be drawn

The capacity for this instructional medium to deliver instruction has been seen and answers to the twelve qualitative questions suggest that it would be motivational to the learner. The measure of locus of control appears to have some discriminatory ability with undergraduates as well as for older students.

Brunswik’s theoretical basis for designing an instructional environment is sound. The probabilistic functioning of instructional software can be aided with the increasing cues for the learner. The program used in this study enabled individuals to proceed at their own

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pace while receiving instruction. However the capabilities for individuals to use different methods to understand concepts was not addressed. That is, participants were directed through only one method by the very nature of their random assignment. Neither was the amount time to receive instruction adjustable - a factor surely to be identified as a constraint within the Brunswik theory or model for learning.
References


Rieber, L. P. (1989). The effects of computer animated lesson presentations and cognitive practice on young children's application learning in physical science. *Proceedings of Selected Research Papers of the Association for Educational Communications and Technology, Dallas, TX.*


Appendix A

Demographic Questions

Consent Form
Please Read before proceeding

We are research the possibility of presenting instructional material in a manner which would allow individualistic presentation of instruction. If you agree to participate in this study, it is important that you pause at each screen and read all material. Some of this material will guide you in navigation and some will deliver instruction. An identification number will be assigned to you and you are to write it on the line below. Once you have started you program detach the bottom portion of this slip and have it stapled to a paper and pencil test which we will ask you to answer after a week has pasted. When the time comes for the recall test, you may remove the name portion of the slip from the recall test so your identity will remain anonymous.

Should I have any questions about this research or its results, I should contact:

Abbot L. Packard 1-(703)-231-9716
Jimmie C. Fortune 1-(703)-231-9731

____________________ Please detach here ________________

Subject permission

I have read the information about the condition of this computer program and give my voluntary consent for participation in this project.

Name ____________________________________________ (please sign)
____________________ Please detach here ________________

Student Name ____________________________________________ (Please Print)
Identification Number ________________________________
Demographics
1. Gender
   a) Female
   b) Male

e) to 5 years ago
f) More than 5 years ago
g) Does Not Apply

1. Age
   a) years of age
   b) years of age
   c) years of age
   d) years of age
   e) years of age

6. Number of Math Classes taken
   a) 0
   b) 1
   c) 2
   d) 3
   e) 4
   f) more than 5

2. over 42 years of age
   a) Current Student Status
   b) Undergraduate
   c) Master
   d) Graduate

7. When was the last Math Class completed?
   a) Last semester
   b) Two semesters ago
   c) year ago
   d) years ago
   e) to 5 years ago
   f) More than 5 years ago
   g) Does Not Apply

3. Number of years of Computer experience
   a) 0
   b) 1
   c) 2
   d) 3
   e) 4
   f) more than 5

4. Number of Statistics Classes taken
   a) 0
   b) 1
   c) 2
   d) 3
   e) 4
   f) more than 5

5. When was the last Statistics Class completed?
   a) Last semester
   b) Two semesters ago
   c) year ago
   d) years ago
Appendix B

Locus of Control
Rotter’s Locus of Control Scale

Choose one statement from each pair of statements which you agree with most

1. a) Children get into trouble because their parents punish them too much.
   b) The trouble with most children nowadays is that their parents are too easy with them.

2. a) Many of the unhappy things in people’s lives are partly due to bad luck.
   b) People’s misfortunes result from the mistakes they make.

3. a) One of the major reasons why we have wars is because people don’t take enough interest in politics.
   b) There will always be wars, no matter how hard people try to prevent them.

4. a) In the long run people get the respect they deserve in this world.
   b) Unfortunately, an individual’s worth often passes unrecognized no matter how hard he tries.

5. a) The idea that teachers are unfair to students is nonsense.
   b) Most students don’t realize the extent to which their grades are influenced by accidental happenings.

6. a) Without the right breaks one cannot be an effective leader.
   b) Capable people who fail to become leaders have not taken advantage of their opportunities.

7. a) No matter how hard you try some people just don’t like you.
   b) People who can’t get others to like them don’t understand how to get along with others.

8. a) Heredity plays the major role in determining one’s personality.
   b) It is a person’s experiences in life which determine what they’re like.

9. a) I have often found what is going to happen will happen.
   b) Trusting to fate has never turned out as well for me as making a decision to take a definite course of action.
10. 
   a) In the case of the well prepared student there is rarely if ever such 
   a thing as an unfair test.
   b) Many times exam questions tend to be so unrelated to course 
   work that studying is really useless.

11. 
   a) Becoming a success is a matter of hard work; luck has little or 
   nothing to do with it.
   b) Getting a good job depends mainly on being in the right place at 
   the right time.

12. 
   a) The average citizen can have an influence in government 
   decisions.
   b) This world is run by the few people in power, and there is not 
   much the little guy can do about it.

13. 
   a) When I make plans, I am almost certain that I can make them 
   work.
   b) It is not always wise to plan too far ahead because many things 
   turn out to be a matter of good or bad fortune anyhow.

14. 
   a) There are certain people who are just no good.
   b) There is some good in everybody.

15. 
   a) In my case getting what I want has little or nothing to do with 
   luck.
   b) Many times we might just as well decide what to do by flipping a 
   coin.

16. 
   a) Who gets to be the boss often depends on who was lucky enough 
   to be in the right place first.
   b) Getting people to do the right thing depends upon ability; luck 
   has little or nothing to do with it.

17. 
   a) As far as world affairs are concerned, most of us are the victims of 
   forces we can neither understand, nor control.
   b) By taking an active part in political and social affairs the people 
   can control world events.

18. 
   a) Most people don't realize the extent to which their lives are 
   controlled by accidental happenings.
   b) There really is no such thing as "luck".

19. 
   a) One should always be willing to admit mistakes.
   b) It is usually best to cover up one's mistakes.
20. a) It is hard to know whether or not a person really likes you.
b) How many friends you have depends upon how nice a person you are.

21. a) In the long run, the bad things that happen to us are balanced by the good ones.
b) Most misfortunes are the result of lack of ability, ignorance, laziness, or all three.

22. a) With enough effort, we can wipe out poverty.
b) It is difficult for people to have much control over the things politicians do in office.

23. a) Sometimes, I can't understand how teachers arrive at the grades they give.
b) There is a direct connection between how hard I study and the grades I get.

24. a) A good leader expects people to decide for themselves what they should do.
b) A good leader makes it clear to everybody what their jobs are.

25. a) Many times I feel that I have little influence over the things that happen to me.
b) It is impossible for me to believe that chance or luck plays an important role in my life.

26. a) People are lonely because they don't try to be friendly.
b) There's not much use in trying too hard to please people; if they like you, they like you.

27. a) There is too much emphasis on athletics in high school.
b) Team sports are an excellent way to build character.

28. a) What happens to me is my own doing.
b) Sometimes I feel that I don't have enough control over the direction my life is taking.

29. a) Most of the time, I can't understand why politicians behave the way they do.
b) In the long run, the people are responsible for bad government on a national as well as on a local level.
Appendix C

Field-independence Measure

Hidden Patterns Tests
Hidden Patterns Tests

Copyright 1962 and 1975 by Educational Testing Services

How quickly can you recognize a figure that is hidden among other lines? This test contains many examples of patterns. In each pattern you are to look for the model shown below:

The model must always be in this position, not on its side or upside down. In the next row, when the model appears, it is shown by heavy lines:

You will be given three choices each time a model is presented: Yes, No, and Skip.
You can use the mouse to click on answer or use the first letter of the answer.

Your score on this test will be the number marked correctly minus the number marked incorrectly. Work as quickly as you can without sacrificing accuracy. If you are unsure of a model press skip and there will be no score given for that model. You will have 3 minutes for to complete this segment and the computer will keep track of the time and will inform you that time is up. You will then have another 3 minute segment.
Appendix D

Examples of CAI Presentation Screens

Opening Screen for Skewness

Text Only Screen for Skewness

Text and Static for Skewness

Text and Animation for Skewness
  First Screen
  Second Screen
A skewed distribution is not have a normal distribution shape.

Skewed distribution has the mean pulled away from the median due to the extreme scores at one end of the distribution.

Click one of the above words and/or phrases for more information.
Shapes of distribution

A Skewed distribution is not have a normal distribution shape.

Skewed distribution has the

If the mean is pulled to the right the skewed distribution is called positive

Negatively Skewed

One of the above words and/or phrases for more information.
Shapes of distribution

A skewed distribution is not

Negatively Skewed Distribution

Positively Skewed

Click Here to Close

Previous Page

Next Page
This exercise will help increase your understanding of "skewedness." The objective is to determine if you can generate a table of values that will result in a positively or negatively skewed curve. Please enter 10 values (ranging from 1-10) in the table that follows such that a "negatively" or "positively" skewed graph will result. You may repeat the drill as often as you like. Click the button below to continue.
<table>
<thead>
<tr>
<th>X-Axis</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
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<td>5</td>
<td>7</td>
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<td>8</td>
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<td>7</td>
<td>9</td>
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<tr>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>

Please enter frequencies (between 1 and 10) in the spaces to the left for each of the X-axis values which you believe will plot either a positively or negatively "skewed" curve. When done, press the button to try another or end.
Appendix E

Assessment Exam

used for all three

Pre-test, Immediate, and Delayed Recall test
1. In a negatively skewed distribution of exam scores, Tom scored at the mean, Mary scored at the median, and Jane scored at the mode. Who had the highest score?
   a) Tom
   b) Mary
   c) Jane
   d) cannot be determined from information given

2. A systematic sample is obtained by separating the population into two nonoverlapping groups and then selecting a sample from each group.
   a) True
   b) False

3. Random sampling is the process that the researcher uses to assign individuals to each treatment in a random fashion.
   a) True
   b) False

4. It is easier to select a sample by using a one-in-k systematic sampling technique, because that technique can be used anywhere to gather a sample of those who pass by.
   a) True
   b) False

5. An extreme score on the left of the distribution would create a negatively skewed distribution
   a) True
   b) False

6. A random sample is frequently used because it is best at representing the population.
   a) True
   b) False

7. Which term describes a distribution which has an extended tail?
   a) Kurtosis
   b) Skewness

8. A simple random sample will proportionally represent the distribution of the population and therefore is the best to use
   a) True
   b) False

9. In order to develop a stratified sample, one must have measurements on the variable used to create
   a) list of subjects
   b) the subgroups
   c) random selection
   d) population parameters

10. Looking at the following data, can you describe the distribution:
    2,2,2,3,4,4,5,5,5,6,6,7,16
    a) Negatively skewed
    b) Positively skewed
11. Cluster samples are based on
   a) equal intervals
   b) ordered pairs
   c) natural groups
   d) list of subjects

12. Which sampling model allows you to choose intact government units (i.e., county, state, city, etc.)?
   a) cluster
   b) simple random
   c) stratified
   d) systematic

13. Which would you use for a study of a new instructional design, but you are unsure of how it effects students from different ethnic backgrounds who posses different levels of test scores.
   a) Cluster Sampling
   b) Random Sampling
   c) Stratified Sampling
   d) Systematic Sampling

14. Which sampling method would you use to give every member in the population an equal opportunity to participate in the study?
   a) Cluster Sampling
   b) Random Sampling
   c) Stratified Sampling
   d) Systematic Sampling

15. Which term describes a distribution with many scores located at the lower (value) end of the distribution and progressively fewer scores toward the upper (value) end of the distribution would be
   a) Leptokurtic Distribution
   b) Positively Skewed Distribution
   c) Platykurtic Distribution
   d) Negatively Skewed Distribution

16. Systematic sampling can be easier to perform and easier to implement than a simple random sample.
   a) True
   b) False

17. A random sample is always the best to select the sample allowing the researcher to infer the results to the entire population?
   a) True
   b) False
18. The larger the sample size becomes when selected from the same population the more cost efficient the sample will be
   a) True
   b) False

19. A peaked curve is described by the term "Leptokurtic"
   a) True
   b) False

20. Which sampling technique would you use, if you had no list of the population, to get the ideas of the students in your school if you know that they all come to lunch at noon?
   a) Cluster Sampling
   b) Random Sampling
   c) Stratified Sampling
   d) Systematic Sampling

21. The proper sample size helps to assure the assumption of a normal distribution in accordance with of the Central Limit Theorem.
   a) True
   b) False

22. The frame describes the population from which the sample is to be drawn.
   a) True
   b) False

23. Using a random starting point of 3 and a interval of 7, the third sample taken would be the
   a) 21
   b) 30
   c) 24
   d) 17

24. A population is the same as the sample when they equal variances.
   a) True
   b) False
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Education
Doctor of Philosophy in Education-Research and Evaluation;
Virginia Polytechnic Institute and State University, Blacksburg, VA
Graduation May 1996
Master of Education -Curriculum & Instruction;
Keene State College Keene, NH- May 1990
Bachelor of Arts - Psychology;
Keene State College Keene, NH- September 1988

Funded Grants
Giles County, VA 1995
Family Preservation and Family Support Services Program ($58,381)
Bland County, VA 1995
Family Preservation and Family Support Services Program ($58,381)

Funded Contracts/Evaluation
New River Valley Prevention Coalition 1995
Evaluation of Youth Prevention Needs Program
City of Hampton, Virginia -School System - 1994-95
Evaluation of the Gifted Program
Montgomery County School District - 1994
Analysis of School Department Annual Survey
Mississippi Band of Choctaw Indians - 1994
Evaluation of Alcohol Program
Mississippi Band of Choctaw Indians - 1993
Evaluation Of Substance Abuse Survey Done By And Outside Agent.
Mississippi Band of Choctaw Indians - 1993
Evaluation of the Special Alternative Instruction Program
North Carolina Rural Initiative Study of Secondary Schools- 1992
Evaluation Of The Funding Effects On Depth Of The Curriculum
City of Flavanna, Virginia - School System -1992
Evaluation of Curriculum Program
Seminole Point Hospital, Sunapee NH -1990-1992
Development Of Patient Quality Control Using Statistical Analysis.
**Professional Experience - Teaching**

Virginia Tech-AES - Educational Research and Evaluations -
Graduate Assistant - Fall 1991-Fall 1994
- Basic Statistical Skills - computer literacy course for beginning
  graduate students: statistical analysis on the PCs for
  introductory statistical course
- Basic Research Skills - computer literacy course for beginning
  graduate students: databases, word-processing
- Advanced Statistical Skills - statistical analysis using
  mainframe as well as PC packages
- Advanced Research Skills - textual analysis, advanced word
  processing, preparation for the writing of dissertation and
  thesis

Keene State College - Psychology Department - Adjunct professor
- Undergraduate Basic Statistics - 1991
- Undergraduate Research Methods - 1991

Keene State College - Education Department - Adjunct professor -

Keene State College - Psychology Department
Graduate Assistance - Psychology Lab - 1988-1990
- Work Study - Tutoring statistics

Keene State College - Computer Department - 1986-1989
- Work Study - Workshops for - Microsoft word, Microsoft Excel,
  Lotus 123, Appleworks

**Professional Experience - Non-teaching**

Virginia Tech-AES - Educational Research and Evaluations -
Graduate Assistant - Spring 1995
- Faculty computer coordinator - aided faculty to become
  computer-literate, coordinated the acquisition of computer
  hardware and software

Virginia Tech-AES - Educational Research and Evaluations -
Graduate Assistant - Fall 1991-Fall 1994
- Coordinator of the teaching computer-laboratory for the
  Educational Research and Evaluation department. - scheduled
  classes and graduate assistants teaching assignments,
  coordinated the acquisition of computer hardware and
  software, developing instructional content for the lab classes

Keene State College - Academic Advising - 1988-1989
- Graduate Assistant - support services providing equal opportunities
  for academic success of students with handicaps

High Mowing School - Wilton NH 03086
- Physical Education Department 1984-1988
- Basketball coach - boys and girls teams.
Other Experience - Non-Teaching
Edward Stevens
  Auctioneer - Fall 1982 - Fall 1987
  Auction Manager - Responsibilities: Hiring, scheduling, and sale management.
Abbot L. Packard
  Independent Contractor - Spring 1980 - 1985
  Carpentry and Plumbing - Residential Housing
Abbot L. Packard
  Manufacture Representative - Fall 1964 - Fall 1979
  Commission Sales for the Furniture and Gift Trade

Professional Organizations
American Educational Research Association,
  Student member 1992-present
  Conference Proposals 1995
Association for the Advancement of Computing in Education,
  Student member 1994 - present
Eastern Educational Research Association,
  Student member 1992 - present
  SIG, Chair 1992-Teaching (Teaching Research Methods and Statistics)
International Visual Literacy Association,
  Student member 1993 - present
Mid-South Educational Research Association,
  Student member 1992 - present
Mid-Western Educational Research Association,
  Student member 1993 - present
  Conference Proposal, 1993

Publications - Reviews
  Burros Mental Measurements Yearbook, Eleventh Edition, Nebraska, September, 1993

Publications Refereed journals
Publications Refereed ERIC


Packard, Abbot L. & Holmes, Glen A., A Comparison Of Three Presentation Methods Of Teaching Statistics. Mid-Western Educational Research Association Meeting, Chicago, IL, October 1993


Publication Refereed proceeding


Publication Refereed proceeding-continued
Packard, Abbot L., and Fortune, Jimmie C., Introduction to the Philosophy of
the Computer Laboratory. Mid-South Educational Research Association
Proceedings for Twenty-First Annual Meeting, Knoxville, TN, November
1992 ERIC 1992

Conference Presentations
Packard, Abbot L., Holmes, Glen A. & Fortune, Jimmie C., Exploration of a
Brunswick Learning Environment for Instruction of Basic Sampling
Boston, MA February 21-24, 1996
Duncan, S.S., Packard, Abbot L., and Fortune, J.C., Using Software to Conduct
Meta-Analyses of Mental Health Outcome Studies. Paper presented at
Eastern Educational Research Association, Boston, MA February 21-
24, 1996
Packard, Abbot L., Fortune, Jim C. and Reynolds, Mary Ruth. Investigative
Focus Groups: Research As Creative Conflict Resolution For A Sensitive
Topic. Paper presented at Mid-South Educational Research Association
conference, Biloxi, MS, November 8-11, 1995
Packard, Abbot L., Holmes, Glen A. & Fortune, Jimmie C., Using Brunswick
Concept of Environment In Building A Distance Learning Unit. Paper
presented at Distance Educational Conference and AECT Professional
Development Seminar at Ames IA, July 6-9, 1995
Packard, Abbot L., Holmes, Glen A. & Fortune, Jimmie C., Evolution Of An
Instructional Design. Paper presented at the Annual Conference of the
American Educational Research Association, San Francisco April 18-22,
1995
Packard, Abbot L., Holmes, Glen A. & Fortune, Jimmie C., The Effect Of Static
And Animation Graphics When Presenting Principles Of ANOVA
Interactions. Paper presented at the Annual Meeting of the Eastern
Packard, Abbot L., Holmes, Glen A. & Fortune, Jimmie C., The Effect Of
Animation On The Instruction Of The Principles Of ANOVA. Annual Meeting
of the Mid-South Educational Research Association, Nashville, TN,
November 1994
Money Has Been Shown To Make A Difference In School Achievement.
Annual Meeting of the Mid-South Educational Research Association,
Nashville, TN November 1994
Packard, Abbot L., Fortune, Jim C. & Holmes, Glen A., The Yellow Brick Road
To Research Instruction Through Computerized Distance Education.
Annual Meeting of the Eastern Educational Research Association, Sarasota,
FL, February 1994
Conference Presentations—continued


Work in progress

Aptitude-Treatment Interaction Analysis of Computer-Assisted Instructional delivery of basic statistical concepts using text, static graphics and animated graphics.

Computerized tutorials for basic statistical and research concepts to be placed on-line across campus and the network

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**Professional Institutional Service**
Virginia Tech - College of Education - 1994-present
  Steering Committee
Virginia Tech - College of Education - 1994-present
  Task force for restructuring - Collaboration Committee
Virginia Tech - College of Education - 1994-present
  Student Committee for restructuring

**Computer Literacy**

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References
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