Navigation Tools' Effect on Learners' Achievement and Attitude

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(ABSTRACT)

Navigation tools can be used to direct the amount of learner control and interactivity available in a hypermedia hybrid CD-ROM environment. The purpose of this study was to ascertain if varying the amount of learner control and interactivity through the used of navigation tools would influence the achievement and attitude of learners. The design of the study was a quasi-experimental study with random assignment of three ability levels of students to three navigation tool treatment groups. A 3 (navigation tool treatments) by 3 (ability levels) by 2 (achievement and attitude) factorial design was employed to test the hypotheses. A module titled The Poetry Portal was constructed to test 3 navigation tools (linear, menu and search engine) and their effect on achievement and attitude scores. One hundred forty-six eighth grade students were stratified into 3 ability levels (low, middle, high) by Stanford 9 scores. The module content correlated to the English 8 Virginia Standards of Learning. Results of this study based on the data are derived from descriptive statistics, two-way ANOVA, one-way ANOVA and a Tukey/Kramer Post Hoc test. The level of significance was set at .05. Results show a significant gain in achievement for high ability level students using the navigation tool search engine. Significant difference in attitude was found for all ability levels using the navigation tool menu. Suggestions for further research in this area are included.

Dedication

In 1931, a petite Italian woman had lunch with Mussolini to win freedom for her family. The story of her daring and perseverance set an example for her granddaughter. This publication is dedicated to the memory of Maria DalMistro Natali and all the Natali women, past, present, and future.

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Chapter 1

Introduction and Literature Review

Introduction

The purpose of this study was to examine how the use of different navigation tools influence the knowledge acquisition and attitudes of learners of different ability levels. Previous researchers bury navigational elements within their studies of the affects of learner control and interactivity on achievement and attitude. Consequently, the results of the many studies are conflicting. Within the definition of learner control there also exist elements of interactivity and navigation. These terms are not synonymous although the research sometimes treats them as such. Interactivity implies a relationship between the learner and the instructional module with varying degrees of engagement. Navigation is a function of interactivity along with feedback, pacing, inquiry, and elaboration (Schwier, 1992). The presence of interactivity creates an opportunity for navigation.

Navigational tools are part of what determines the amount and quality of information retrieved from a hypermedia source. Little research has been done to see how navigation, as a function that controls and directs the amount of interactivity, may contribute to a perception of learner control and improve achievement or attitude. Methods that access hypermedia are part of an active versus passive array that affects the learner's quality of cognitive and operational knowledge construction (Gordon, 1998). Gordon suggests the balanced use of these dimensions, such as actively responding to a question and locating a specific term, or passively clicking the mouse to move to the next screen, within Computer-Based Instruction (CBI), will enhance the learner's experience. Nonetheless, navigation tools that access interactive dimensions are included in the format of educational software without guidance or discussion to the user or instructor on how different ability learners may be aided or directed.

Recent research on perceived learner control has shown signs of significant difference in achievement for learners who perceive they are in control (Schnackenberg & Hilliard, 1998). It is possible that the higher the level of learner/computer interactivity, the more they perceive control and the greater the level of their achievement. Jonassen, Peck, and Wilson (1999) found "...the more

directly and interactively we experience things, the more knowledge about it we are likely to construct" (p.4). Students' attitudes toward learning may also be affected by their level of interactivity or learner control. Sherman (1999) found students who used a menu navigation tool felt more in control of their learning while those who used the more interactive search engine tool felt less.

Some studies on learner control, interactivity, and navigation show an effect on students of varying ability levels. There are results that show achievement gains for higher ability students when learner control is employed while other results show lower ability students benefit from less learner control and more program control. Studies by Borsook, Higginbotham-Wheat (1991), and Williams (1996) all assert lower ability learners benefit from more program control while high achieving learners benefit from a high degree of learner control. Schnackenbery and Hilliard (1998), found in a review of the literature, measurements used in past studies of the affect of learner control may be invalid and that learners of both high and low ability achieve more using learner control.

Studying the relationship between navigation, interactivity, and learner control is a complicated task. The three may appear to be separate entities that are unconnected, but a closer look reveals an interdependence where none of the variables can exist and complete their function without the others. Past researchers have often regarded the three as one aspect of instructional design. In doing so, important information is compacted, and the unique effect of the individual variable is overlooked. This may be one reason for the conflicting results of experimental research involving navigation, interactivity, and learner control.

Need for study. Instructional material increasingly comes in a hypermedia format. This format by its nature (nodes that are linked in a network) require tools to navigate the network. Navigation tools have different features and dimensions. These features include interactivity and learner control. Researchers of hypermedia have concluded the feeling of "being lost in hyperspace" could have a serious effect on a learner's achievement and attitude and call for greater examination of tools (Bartasis & Palumbo, 1995; Hannafin et al., 1996) and design issues that affect the learner (Myers & Burton, 1994; Unz & Hesse, 1999).

Learner control research findings are contradictory. At first, higher ability learners seemed

to benefit more from greater learner control than low ability students (Bartasis & Palumbo, 1995; Cho, 1995; Gray, 1987; Rogers & Erickson, 1998). Recently, researchers found past studies may be flawed and their evidence indicates all learners benefit from some learner control (Williams, 1991; Schnackenberg & Hilliard, 1998). Research is needed to clarify these findings on learners of different abilities.

Interactivity may allow the computer to act as a collaborative partner. Shute and Psotka (1996) suggest additional research into the effect interactivity has on learning. Some research finds not all learning styles benefit from interactivity in CBI (Reiff & Powell, 1992; Larsen, 1992). Some of the reasons for the contradictory results may be the confusion over differentiating between learner control and interactivity (Borsook & Higginbotham-Wheat, 1991). The lack of guidelines for interactivity in design may be a contributing factor to the confusing results (Hannafin et al., 1996).

The specific role of navigation in the delivery of instruction needs to be understood. Several researchers refer to navigation as an extremely critical design issue in hypermedia (Bateman, 1998; Rogers & Erickson, 1998). Research results on the effect of a navigation tool as a facilitation of interactivity and learner control on learners of different abilities is mixed. Research is needed to either support or eliminate the use of various navigation tools in a hypermedia format. It is imperative more research be conducted to determine the role a navigation tool plays in the delivery of instruction and its effect on learners.

This study focused on the use of three navigational tools and their effect on learner achievement and attitude for three ability levels. Much of the research discussed will overlap aspects of navigation when investigating interactivity or learner control.

Definitions

In order to facilitate a common terminology, the following definitions were constructed from the literature and used throughout this study.

Browsing

Term used to describe random, non-directed travel on the web.

CBI

Computer-Based Instruction covers a broad category of computer delivered instruction that ranges from tutorial through hypermedia Internet environments (Reeves, 1993).

CD-ROM Hybrid

Term used to describe a CD-ROM that interfaces with the Internet (Diaz, 1999).

Hypermedia

Hypermedia is defined by Jonassen (1996) as an extension of hypertext that "integrates graphics, animation, audio, and video with text" (p. 703). Information in hypermedia is presented in nodes, referred to as cards in programs such as HyperCard™, SuperCard™, and HyperStudio™. These nodes are linked to one another in a network that, if visualized, presents a semantic or word map of the knowledge structure. The same functionality of presentation is used on the Internet utilizing HyperText Markup Language (HTML).

Interactivity

According to Schwier (1992) the engagement of the learner with the computer-based instructional module consists of varying degrees of communication that include:

1. Reactive is a response to presented stimuli that includes clicking the mouse on an icon that says "Click Here". This level of interactivity covers linear navigation.

2. Proactive interactivity emphasizes the learner's construction of knowledge. The learner goes beyond selecting or responding to existing structures and begins to generate unique constructions and elaborations beyond designer imposed limits" (p. 5). Using the search engine navigational tool to discover new information is an example of this level.

3. Mutual interactivity occurs when the learner and system are mutually adaptive. They change based on their encounters with each other. An intelligent tutoring system that is able to trace the learner's path and adjust the feedback accordingly shows mutual interactivity.

Schwier (1992) also lists the following descriptions for functions (Hannafin, 1989) of interaction: (a) confirmation: feedback or practice; (b) pacing: time; (c) inquiry: learners ask questions, construct individual pathways; (d) navigation: learner access to instructional routes; (e) elaboration: involves the learner in combining new knowledge, and creating transitions.

Learner Control

"...those design features of CBI that enable learners to choose freely the path, rate, content and nature of feedback in instruction" (Reeves, 1993, p. 40). Learner control appears to be influenced by the learner's perception of his or her control over those design features (Sherman, 1999).

Program Control

"Learner control is typically contrasted with program control, i.e., design features that determine the path, rate, content, and feedback in instruction for learners" (Reeves, 1993, p. 40).

Literature Review

This section reviewed the literature and research on hypermedia, learner control, interactivity, and navigation in a computer-based hypermedia setting. The features, dimensions, and effects of these variables as determined by previous research are included. Finally, in each sub section, research results that involve learners of varying ability levels will be presented.

Hypermedia

Hypermedia is used as an information presentation method in CBI. Learner control, interactivity, and navigation are all features of hypermedia. Hypermedia employs hypertext, defined by *The Free On-Line Dictionary of Computing* (1998) as "a term for a collection of documents containing cross-references or links which, with the aid of an interactive program, allow the reader to move easily from one document to another" (p. 2).

Hypermedia today is defined by Jonassen (1996) as an extension of hypertext that "integrates graphics, animation, audio, and video with text" (p. 703). Information in hypermedia is presented in nodes, referred to as cards in programs such as HyperCard™, SuperCard™, and HyperStudio™. These nodes are linked to one another in a network that, if visualized, presents a semantic or word map of the knowledge structure.

The origination of the idea of hypertext is credited to Vannever Bush who in 1945 published an Atlantic Monthly article, "As We May Think", that proposed the organizational system of the human mind was non-linear and humans had no tools to navigate this structure. Bush (1945) titled his theoretical system *Memex*. Ted Nelson (1998) is credited with carrying on the intellectual

genealogy. Nelson coined the terms hypertext and hypermedia when conceptualizing a software project called *Xanadu*. In this non-linear environment, a learner/user could navigate and explore through pages of information linked together. The present day World Wide Web, written in HyperText Markup Language (HTML), and offering users graphics, animation, audio, and video with text, resembles Nelson's vision.

As the computer became more affordable and capable, audio and visual representations were added and hypertext became hypermedia (Daniels, 1996). With the creation of HyperCard™ by Bill Atkinson in 1987, and his insistence that his program be provided free with all Apple computers, the concept caught on quickly.

Thus, instruction utilizing the linking of nodes in a network, audio, video, graphic animation, and text that make up present day hypermedia and the World Wide Web has become a new format for the delivery of instruction. This format of presenting information access also presents problems for the learner who may not be able to navigate efficiently. Unz and Hesse (1999) contend the hypertext structure in itself can "help or hinder a users interaction with it" (p. 17).

Learner control and interactivity are issues to be addressed when designing instruction in Hypermedia. As Myers and Burton (1994) observed, it is difficult to find a study that uses a hypermedia format that does not also include the term interactivity. Interactivity implies the issue of learner control because giving a learner choices may lead to opportunities for interactivity. In order to facilitate learner control and interactivity, the issue of "interface design" (Myers & Burton, 1994, p. 16), which address navigation, is a particularly important area of research.

Weller, Repman, and Rooze (1994) found field-dependent learners are served negatively by the hypermedia environment and may be disadvantaged by the non-linear structure. These results may predict that the learner with a high external locus of control (LOC) displays less confidence of success and could be more dependent on structure and cues. Weller (1994) found that learners with field-dependent and field-independent cognitive styles may be affected differently by hypermedia-based instruction. For example, a study by Daniels (1996) revealed that the degree of learner control in hypermedia did not benefit field-dependent learners.

Ability levels. Nevertheless, the type of navigational tools used within a hypermedia format may provide the structure needed to benefit learners of differing ability levels. This feeling of being "lost in hyperspace" was an early indication of areas of the new technology that bears further scrutiny and presents critical problems for designers (Bartasis & Palumbo, 1995; Hannafin et al., 1996). Unz and Hesse (1999), in a review of hypermedia studies, suggest the mixed results for learners of varying abilities indicate a need for a set of competencies and student training in this format. "...students need adequate learning and information seeking skills to be successful navigators" (p. 289).

Summary. Hypermedia is the environment of the World Wide Web, a fast growing phenomenon in business and education. Although it has been theorized hypermedia would be an equalizer for the delivery of instruction to learners of different ability levels and learning styles, the theory has not been supported by the data. Research has shown a hypermedia setting may not benefit all learners. Some learners have difficulty navigating in hyperspace. Some learners do not benefit from a high level of learner control in a hypermedia setting. An influencing factor in the disappointing performance of students may be the fact they are not properly trained in the use of hypermedia tools to navigate the hypermedia structure. The placement and type of navigation tools used in a hypermedia format may aid or hinder student achievement. Knowing the influence of navigation tools on learner achievement will be helpful in designing a hypermedia setting that will be beneficial to students of all ability levels.

Learner Control

Learner control has been the subject of many experimental research projects. Learner control appears to be an aspect of design where the instructional designer builds events into the instruction to increase learner involvement. In his critique of learner control research in CBI, Reeves (1993) found that the research was "pseudoscience" due to theoretical, methodological, and analytical problems along with inadequate definitions of this "dimension" of CBI. His definition stated learner control included "those design features of CBI that enable learners to choose freely the path, rate, content, and nature of feedback in instruction" (Reeves, 1993, p. 40). Williams (1996) stated that regardless of the instructional delivery system employed, control relates to occasions when

learners make their own decisions regarding some aspect of path, flow, and events of instruction. Conversely, program control via instructional design controls the path, rate, nature of feedback, content, and events in instruction (Reeves, 1993; Willliams, 1996).

Alessi (1991) segments learner control into four levels. Each level increases the amount of control given the learner, The first level, program, controls the sequence, content, context, and degree of interactivity, but allows some simple learner control such as forward and backward movement. The second level, adaptive, combines program and learner control. The program adapts to the learner's correct performance by giving over more control. The third level, advisement, gives the learner control with the use of help buttons or advisement from the program. In the fourth level, student, the learner is given the highest degree of control without instruction or feedback. The learner explores within CBI without direction or purpose. Designers of instruction have theorized that if learners have the freedom to choose they will be motivated and engaged learners (Williams, 1996).

CBI seems well suited in affording learners the opportunity to exercise their control of the pace, sequence, and content of their instruction. Various learning theories have embraced the idea of control in its diverse adaptations. Designers using behavioral principles employ program control with linear links to implement behavioral principles in an instructional setting where the learner has incremental and structured forward and backward control (Bartasis & Palumbo, 1995). Designers, using cognitive principles, use learner control as a tactic that will encourage the learner to think about his or her choices (Williams, 1996), and give the instructor opportunities to provide cues and scaffolding choices (Bateman & Harvey, 1998). Designers, using constructionist principles, locate the learner in the center of the instructional experience and give the learner control. The learner then makes knowledge out of social and reality-based experiences.

Learning is an active process in which the learner has much control (Grabinger, 1996). Consequently, it is interesting to note the research results on learner control have not always shown significance as positive benefits in achievement scores or attitude. Learners do not always make good decisions when given choices on the computer (Hannafin & Phillips, 1987). Each individual level of

learner control may have a unique influence on learners of different styles.

In 1990, Santiago and Okey found learners with a high internal locus of control (LOC) increased achievement significantly over learners with high external LOC when using CBI with learner control. They suggest learner control will have different effects on learners of different styles.

In a supporting study, Friend and Cole (1990) reviewed the literature on learner control in CBI and found that the different aspects of learner control affected learners based on their preferences or cognitive styles. Further, they recommended that examining the different levels of learner control and their effects would give valuable information in designing individualized instruction. They matched what they called "styles" of learner control to cognitive learning styles and looked at those results. Their working definition of learner control was similar to many of the researchers and included the control of lesson pace, sequence, content, and feedback (Friend & Cole, 1990). These aspects of "learner control", as will be discussed in more detail during the course of this review, are also repeatedly mentioned as functions of both interactivity and navigation.

Gray (1977) found control over sequencing choices resulted in higher achievement but a more negative attitude towards CBI. Gray suggests too much control for the learner may be a distraction causing complex decision making that interferes with the focus of the lesson and learner. This aspect of learner control is revisited by Rogers and Erickson (1998) who found learners suffered when in a hypermedia lesson from cognitive overload when given too much learner control over navigation decisions. This resulted in a "lost in cyberspace" condition (p. 346).

Ability levels. Increased amounts of learner control may not benefit the learner who makes poor choices. Alessi and Trollip (1992) suggest varying the amount of student control based on the "...educational level of the student and lesson complexity" (p. 24). High ability learners usually fare well with learner or program control, but low ability or novice learners suffer from too much learner control (Bartasis & Palumbo, 1995).

In an update of the literature base for learner control studies, Williams (1996) reviewed findings that compared learner control with partial learner control or complete program control in a CBI environment. He reported mixed results, but the affects of learner control were either "as

effective or less effective than treatments under more computer control" (Williams, 1996, p. 960).

Some studies do not find varying the amounts of learner control affects achievement or attitude. In a 1995 qualitative study of twenty students using Hypercard™, Cho found no significant difference in his learners' cognitive processes of information seeking and knowledge acquisition when comparing learner control to program control. Cho triangulated statistical analysis with supporting evidence from the qualitative data. He found low ability students processed less information when given increased learner control.

However, Schnackenberg and Hilliard (1998) propose that measurements of learner control used in previous studies are invalid as they are predicted by a pretest and posttest design. In reviewing studies that used standardized test scores to set an initial achievement level, Schnackenberg found significant difference in achievement in learners who used learner control. "...both higher-and lower-ability students using learner control often outperformed students under program control" (Schnackenberg & Hilliard, 1998, p. 354). They recommend revisiting the issue of when and how to include learner control in CBI.

Summary. Learner control has received a great deal of attention from researchers because some of the results suggest the amount of learner control used in instruction can affect achievement and attitude. Some studies show increased learner control results in improved achievement scores. Other studies show different learning styles may respond differently to amounts of learner control. Finally, there are studies that suggest low ability students may suffer from too much learner control while high ability students improve achievement. Too much choice in decision making may negatively affect the attitude of the learners regardless of ability levels.

The research on learner control includes aspects of interactivity and navigation but often overlooks their impact as separate issues of design. A closer look at the impact of interactivity on the achievement and attitude of learners of varying abilities and interactivity's place in the design of CBI instruction is necessary.

Interactivity

In this review of literature the different conceptions of levels and features of interactivity are

explored along with the affect of levels of interactivity on attitude and achievement scores. Lastly, research that indicates interactivity has an effect on learners of different ability levels and cognitive styles will be discussed.

Borsook and Higginbotham-Wheat (1991) assert that it is the potential for interactivity that makes the computer unique. The authors meld the theories of Selnow (1988) and Berlo (1960) to develop measurable guidelines of interactivity for use in the design of instruction. In Selnow's (1988) theory, three levels exist:

1. Communicative Recognition: This communication is specific to the partner. Feedback is based on recognition of the partner. When a learner inputs information into a computer and the computer responds specifically to that input, there is mutual recognition. The menu format allows mutual recognition.

2. Feedback: The responses are based on previous feedback. As the communication continues, the feedback progresses to reflect understanding. When a learner refines a search query and the computer responds with a refined list, message exchange is progressing.

3. Information Flow: There is an opportunity for a two-way flow of information. It is necessary both the learner and the computer have means of exchanging information. The search engine tool allows for learner input via use of the keyboard and the computer responds with written information.

In *The Process of Communication,* Berlo (1960) discusses levels of interdependence that affect interaction. He asserts: "In any communication situation, the source and the receiver are interdependent" (p. 106). His theory of communicative interdependence cites four levels:

1. Definitional Physical: Neither communicator (learner nor computer program) is paying a lot of attention to the other. They are both waiting their turn to encode. The linear form of navigation, where only forward and backward movement is allowed and where high program control is present, is a working example.

2. Action-Reaction Interdependence: At this level, feedback is present. The learner and computer take turns decoding and reacting. Simple computer memory games give immediate feed-

back. There is increased interactivity and some learner control as gaming choices are made. Borsook and Higginbotham-Wheat (1991) contend it is at this level most computer educational software resides. A menu format gives this type of action-reaction interdependence as does a simple search engine.

3. Interdependence of Expectations: At this stage, a kind of empathy is evoked, expectations are formed, and the partners, be it computer or learner, make inferences about the communication based on the action taken. The ability of the latest browsers to predict the URL the user will wish to visit based on past actions is an example. A search engine that allows refining of queries has a level of expectation in that the computer will adapt to the responses of the learner's input, therefore, engaging the learner in a higher degree of interactivity and learner control.

4. Interaction: At this, the ideal communication level in Berlo's (1960) system, the communication partners actually try to see through the other's eyes and take on one another's perceptions of the problem to better predict or react to a response. "The goal of interaction is the merger of self and other, a complete ability to anticipate, predict, and behave in accordance with the joint needs of self and other" (p. 131). Present-day video games appear to mimic this level of communication, luring the player into perceiving he or she is interacting with the computer in an immersible manner. A simulation game that fits this category is SimCity™ (Borsook & Higginbotham-Wheat, 1991).

To provide instructional designers with guidelines based on the interactive theories of Selnow (1998), Berlo (1960), and Borsook and Higginbotham-Wheat (1991) suggest the following as variables of interactivity present within all instructional systems to differing degrees, but specifically in a CBI format: (a) immediacy of response, (b) non-sequential access of information, (c) adaptability, (d) feedback, (e) options, (f) bi-directional communication, and (g) grain-size, the amount of time before the user can initiate further input, or interact.

Studies that find too much learner control in instruction reverses the benefits found by some learner control may not have allowed for interactivity affecting the results. Too much learner control can result in negative results for all but high achieving students (Cho, 1995; Ross & Morrison, 1996). However, interactivity in the learning environment may be responsible for moti-

vating and improving achievement. The following studies address levels of interactivity, either as separate from or functions of learner control, and conclude various results.

Interactivity is a term that shows up in the title of many research articles and studies, but few go on to discuss it as an independent variable. The phrase "interactive computer" is used indiscriminately without any delineation of its characteristics. Shoffner and Dalton (1998) view interactivity as an attribute of computer-based and networked hypermedia instruction where the learner must automatically engage in communication with the system. In reviewing the research, interactivity was found to be frequently used as a function of learner control instead of a separate entity with effects of its own. Hooper, Temeyakarn, and Williams (1998) describes interactivity as a "learner control" method (p. 9). Reeves (1993) contends a popular belief is that interactive instruction allows students to control their own learning and that this control results in greater learner achievement. Bull (1998) points to computer mediated learning (CML) as a learning mechanism for interaction. This interactivity between the learner and the computer may enhance learning. "Learning theorists believe learning takes place or is enhanced by interaction with the environment either socially or individual" (Bull, Kimball, & Stansberry, 1998, p. 217). It is, therefore, difficult to determine if experimental results that refer to interactivity really consider its unique level within the instruction or its effect on learners of varying abilities.

Interactive computer programs developed at Indiana University proved successful in developing learning strategies in a treatment group. This group then transferred their learning to new content material. Mikulecky, Adams, and McIntyre (1988) reported significance in improving the basic reading skills of the 106 college students in this treatment. The computer program used the following interactive strategies: (a) identified key concepts within text; (b) linked summary statements; (c) gave examples and feedback; (d) offered practice opportunities with scaffolding; (e) inserted feedback appropriate to individual student response; (f) assessed student performance and branched users to remediation; (g) provided some learner control; and (h) presented relationships visually. Students in this study were given an advanced organizer to provide a lesson framework. The treatment group showed significantly higher results in achievement, both immediately following

treatment and a week later, on a delayed posttest that presented new material. The learner's gains were transferred to regular class scores where they outperformed the control group on class tests. A five-point Likert scale was used to measure attitude and found the treatment group to be very positive towards the CBI (Mikulecky et al., 1988).

Herr (1994) devised a keypad response program where the instructor selects a question and students individual respond by keying in their answers on a numeric keypad. The instructor's program sends back an individualized reply. Over 200 students participated in the study using the subject of astronomy. The communication interactivity involved: (a) questioning, (b) individual response and feedback, and (c) prompts. There was increased interaction between the students, computer, and professor, but Herr felt it did not justify the amount of time taken away from lecture. The results of this study are anecdotal in nature without any quantitative data presented to support the conclusions that test performance has not improved. "Students appeared to be more attentive in class and better prepared, but the students' test performance has not shown improvement" (p. 5).

Nimchinsky and Camp (1995) designed and tested an interactive computer poetry program that also resulted in no statistical significance in achievement scores. With the goal of aiding students in comprehending and interpreting poetry, several poetry modules were created. Some of the interactive features were: (a) learner input with computer feedback; (b) guided poetry discussions; (c) linked hypertext with additional information; (d) art gallery of images to support content; and (e) a help menu. Although no statistical significance in achievement has been observed there are indications that students who participated in the program have been able to transfer their learning to other poetry content. This program is still being developed as the technology evolves (Nimchinsky & Camp, 1995).

Betz (1995) used the game SimCity 2000™ to demonstrate the interactive communicative power of the computer with freshman engineering students. SimCity 2000™ is a simulation game that offers a high degree of interactive communication opportunities. These opportunities are: (a) input of goals; (b) behaves as a cooperative partner; (c) provides constructive feedback towards the partner's common goals; (d) simulation that encourages visualization, experimentation, and creativity

of play. The students in the treatment group showed significance in their achievement test scores over the control group in a delayed posttest. Betz drew the conclusion that the experimental group tends to learn more.

In a qualitative study, Reiff and Powell (1992) examined the relationship between the learning styles (concrete and active experiential, divergers, and accommodators) of 65 student teachers and interactive computer programs. The student teachers completed five computer-based lessons, but no significant attitude change toward computer usage was found in a pre- and posttest survey that yielded quantitative data. The authors found that learners with "reflective" styles were easily frustrated by CBI instruction as evidenced by attitude scores. The authors urge caution in that "different learning styles may not benefit from interactive CBI unless it accommodates individual differences" (p. 7). In a related study Larsen (1992) also found no significance in achievement or attitude scores by learning style.

Ability level. Researchers hypothesized the motivational aspects of interactivity would benefit learners of different ability levels and cognitive styles. Early experiments found success in combining interactive computer programs with video. Interactive computer-video instructional models have given significant results in several studies. Henderson (1983) found this method was effective when used to deliver mathematics skills and concepts to under-achieving secondary school students. Believing the "interactive powers" of the computer may offset the limitations of the computer-video delivery systems, the authors interfaced them in a mathematical module to convey instruction. Computer interactive communications included: (a) models of behavior in dramatization that matched the target audience; (b) text and graphic messages intended to influence and motivate; (c) feedback and questioning; (d) positive reinforcement; (e) corrective feedback; (f) control of video (program); and (g) exploratory segments (learner control). Significance was found at slightly more than one standard deviation above the norm in the achievement scores of the treatment group. There was no significant difference in attitude or perception of learner control.

The Shute and Glaser (1990) study examined the achievement of students who were stratified according to their learning differences and placed in a discovery type learning environment.

The interactive environment called "Smithtown" provided various levels of learner control and interactivity. Students who exhibited more adventurous behavior fared better in this learning environment. The results showed significant improvement on the posttest for the classroom group and the Instructional Tutoring Systems (ITS) group receiving CBI. The time element was also significant. The CBI group spent half the time on instruction with equal results. Shute and Psotka (1996) reviewed six other studies and saw similar positive outcomes. These studies varied in the amount of interactivity between the students and computers but all students in the treatment groups achieved successfully and efficiently. In examining whether students were more successful learning alone or with the computer as an interactive partner, Shute and Psotka concluded the computer was able to act as a collaborative partner. Based on their review, Shute and Psotka concluded additional research in this area is necessary.

Park (1996) states that adaptive instructional systems, used along with CBI interactively to aid in instructional delivery, appear to be an ideal setting for learners of varying abilities and styles. He asserts that varying the amounts of interactivity and learner control in the delivery of the same content through navigational tools will soon be within reach of the regular classroom teacher. Studies have been conducted in regular classrooms investigating the input and output interactivity between student and teacher during questioning. There is not much information on questioning principles or procedures regarding CBI or ITS. Park calls for an "application of the analysis on the procedure of interactive communication to be implemented in CBI" (p. 657). Adapting CBI to a question and answer format will give teachers a tool for differentiating instruction for learners of varying abilities and styles.

Nevertheless, there have been contradictory outcomes in studies that are trying to determine the effectiveness of interactivity on achievement and attitude. Russin (1995), in a comparison study using 3 ability levels, looked at two groups of grade 6 students who were given a typing tutorial under conditions termed teacher directed and interactive CBI. The interactivity and individual learning opportunities the computer program offered was duplicated when possible by the teacher. The results of this comparison study showed there was no significant difference in the achievement

results. In fact, the posttest typing rates of the two groups were exactly the same. However, the results may have been confounded on two bases:

1. A teacher was present and gave unscripted directions and personalized feedback during CBI instruction.

2. A computer was used in the teacher-directed treatment without measuring the interactivity it added to instruction.

Borsook and Higginbotham-Wheat (1991) maintain the reason for the discrepancy in achievement and attitude results of learner control studies for students of different abilities is due to a lessoning of interactivity. When greater control is given to the learner over pacing and sequencing, the degree of interactivity decreases. "I argue that the reason for the disappointing results is that the learner simply shifts the locus of control from the computer to the learner. As locus of control shifts from one party to another, interactivity is diminished" (p. 112). If this is the case, using a navigation tool that will maintain the level of interactivity with learner control may be more beneficial to learners of all ability levels.

Summary. Interactivity appears to play an important role in the motivation and engagement of the student. Studies show interactive strategies, in some instances, seem to improve the achievement scores and attitudes of students and aid in the transfer of learning. Including interactivity in a lesson may increase the amount of time spent on the lesson. Different learning styles and ability levels may not benefit equally from interactive opportunities, but the fault may lie in the design of instruction and definition. It is sometimes assumed that giving the student the greatest amount of control also gives the greatest amount of interactivity. However, students with total learner control may as well be programming the computer. In this relationship, the give and take of interactivity between the learner and the computer is greatly reduced (Borsook & Higginbotham-Wheat, 1991). Hannafin et al. (1996) assert that interactivity suffers from a lack of a common definition but is a facilitator in lesson navigation and a support in the encoding of specific lesson context. If the amount and quality of interactivity with which the learner becomes engaged affects achievement and attitude, Hannafin et al. are correct in urging further research on interactive meth-

ods.

Finally, many researchers report a lack of guidelines for interactivity in design. Hannafin et al. (1996) report little control or agreement over the design of human-computer interactions and no research on interactive methods to guide instructional designers. One perspective of interactivity is as a facilitator of lesson navigation. According to the Gavora and Hannafin study (as cited in Hannafin et al., 1996), "successful interactions have cognitive as well as physical requirements and are mediated by the quantity and quality of effort" (p. 384).

Navigation

Navigation in a hypermedia format involves the tools learners may use to know where they are, where they are going, and how they will get there. This aspect of instruction in CBI is fairly new and there is a lack of literature on the topic. Researchers use different terminology to describe the features and dimensions of navigation. This section will present the features and dimensions of navigation found in the literature, along with research results.

In hypermedia, Myers and Burton (1994) define navigation as the "...process of moving and retracing through a database" (p. 11). Bateman and Harvey (1998) define navigation as "...the metaphor by which a user selects and interacts with information in hyperspace" (p. 2). de La Passardiere (1992) adds: "... all parts of the interface that are designed to help the user choose the relevant information, whether it helps him to discover the scope of information he wants" (p.19). When referring to CBI, navigation tools assist the learner in knowing where they are, where they have been, where they are going, and how they are going to get there. This aspect of the science of navigation is so new there is still much debate among researchers as to where it belongs.

Some researchers refer to navigation as a function or type of interactivity: (Schwier, 1992; Sherman, 1999; Shoffner, 1988). Others refer to navigation as an element of learner control (Alessi, 1991; Bull, 1998; Friend, 1990; Reeves, 1993; Schnackenberg & Hillard, 1998). Still others refer to navigation as a tool separate from interactivity and learner control (Bartasis, 1995; Bateman, 1998; Chou & Lin, 1998; Davidson, Shivers, Shorter & Jordan, 1999; de La Passadiere, 1992; Evans & Edwards, 1999; Hannafin, 1996; Lawless & Kulikowich, 1998; Rogers & Erickson, 1998; Zeiliger,

1996).

Some authors refer to navigation as the most crucial design issue in hypermedia. When a tool is not properly defined, it is easy for its advantages to be overlooked. The role of navigation as a tool needs to be clarified. Bateman (1998) refers to it as "The most critical issue in the design of large hypermedia databases..." (p. 2). Rogers and Erickson (1998) echo Bateman's (1998) sentiment and also call navigation a "site element" along with content, presentation, links, and nodes. With this in mind, it appears a clear delineation of navigation's attributes and effects would be significant.

de La Passardiere (1992), Rogers and Erickson (1998), and Schwier (1992) have categorized navigation functions according to complexity that reflects increased interactivity between the user and the tool. For example, Schwier's (1992) "Proactive" function allows the user to initiate a search and navigate freely through the hypermedia content. His "Mutual" function (that is, the History map) gives an increased level of interactivity through the anticipation of the user's needs and the provision of advice. Table 1 summarizes the organization of the researchers using their terminology.

Table 1. Navigation Functions

Organization of Navigation

Simple ⟶ Complex

Tools de la Passardiere (1992)	Punctual (Links)	Structural (Menu)		Historical (History trail)
Methods Schwier (1992)		Reactive (Menu)	Proactive (Search engine)	Mutual (History map)
Layers Rogers & Erickson (1998)	Near Linear (Directional)	Guided (Menu)	Self-directed (Search engine)	

Four basic navigation tools are identified from this table: (a) linear, (b) menu, (c) search engine, and (d) history trial. The following literature review investigates the effects of those tools on the achievement and attitude of learners.

Research results in the area of navigation are proving to be as differentiated as the terminology. Different navigation tools, such as linear, menu, search engine, and history trail, appear to affect the achievement and attitude of learners of different abilities in different ways.

Evans and Edwards (1999) examined three types of navigational tools and their use in accessing different structures of information. The tools they examined were sequential, menu, and map. This was part of a design project to determine what tools would be included in a virtual module. Their navigation tools were designed specific to the content and purpose of their virtual module. They included a sequential navigation tool that used a frame format along with next and previous directional buttons. A menu tool was selected that allowed the learner to choose topics using a zoom list menu that gives the learner the ability to ascend and descend the hierarchy but controls his or her interaction with the subtopics until that information section is completed.

Eliasen, McKinstry, Fraser, and Babbitt (1997) found more efficient navigational decisions were made by students accessing a menu version that used screen images. Lawless and Kulikowich (1998) created three navigational profiles of learners and then conducted a study that reinforced these profiles:

1. Knowledge seekers (acquire information in a systematic manner).
2. Feature seekers (spend more time interacting with special effects).
3. Apathetic hypertext users (no logical order, random selections).

In their study, 63 graduate students were given a HyperCard™ stack that offered the following navigation tools of vocabulary: (a) “help” button, (b) hyperlinked “hotwords” , and (b) subtopic buttons. They found evidence to support their profiles. They observed that the learners who were classified as “knowledge seekers” by their analyzed navigational patterns were also the most computer literate. The researchers conclude that the more domain knowledge the learners possess, the more effective use of a hypermedia environment they will make. Notably missing from this study

was a measurement of what the learners learned, regardless of their profiles.

In a qualitative study of the use of search engines, Swan, Bowman, Homes, Schweig, and Vargas (1998-1999) videotaped graduate students as they navigated the World Wide Web. They categorized the World Wide Web expertise of their students from novice to expert users. The students were given a research task. The results were that those with less domain knowledge had difficulty refining their search when using a search engine and evaluating information. Fonts, spacing, colors, screen pictures, cartoons, logos, and other graphical elements affected reading behaviors.

In the following studies historical context maps, concept maps, and navigational maps are used as variables. These various maps aid the learner in visualizing a history trail through the hypermedia. Here the computer will adapt to the responses of the learner's input and engage the learner in a higher degree of interactivity and learner control. Zeiliger (1996) reviewed concept mapping as a navigational tool to aid in instruction. Concept mapping may be used by the designer as an aid in determining navigation. All the main concepts and sub-concepts of instruction within a web of links is determined. Using the application *PHASME* (1999), students who browsed a site were given feedback, depending on their choices, in the form of a concept map. The hypothesis was the learners would construct their own mental map of the content and be able to link the main concepts, resulting in higher posttest scores. No significant differences were found in the students using concept maptools and those who only had hyperlinked words. The author suggests the concept map was underused by the learners who were not used to this function (Zeiliger, 1996).

In their study of navigational maps (textual to physical representations of the hypermedia) Chou and Lin (1998) found there was a profound effect on the students' methods of search efficiency. The cognitive style of field-dependent learners and field-independent learners was used as a variable. The researchers gave 121 college freshman an organizer to guide them through the course material offered in a hypertext environment. Some of the students had the choice of accessing a global map that displayed the entire hierarchical knowledge structure; others had a tracking map that showed the learners where they were in relation to the whole module. The last group had access to a local map that showed the learners where they were in a specific knowledge area within their course.

The results showed no effect on field-dependent learners versus field-independent learners on their search performance but a significant difference on the subjects' cognitive map development. The authors call for continued research into how navigational tools facilitate a learner's progress (Chou & Lin, 1998).

In a related study, Gay, Trumbull, and Mazur (1991) found learning with study skills preparation in an hypermedia format is necessary for successful navigation. Motivation is increased when the anxiety caused by inflexible and ineffective navigation tools is reduced.

Ability levels. There are few studies that examine the effect of navigation tools on the achievement and attitude of different ability learners. Those that do have interesting results. de La Passardiere (1992) used an historical context map, an aid that shows what has been seen and what remains to be investigated, and found exploration increased significantly for learners of all ability levels.

Finally, in a study that tried to compare options, Davidson-Shivers, Shorter, Jordan, and Rasmussen (1999) used only high ability, highly verbal fifth grade students and investigated their navigational decisions in a hypermedia environment. The researchers presented a treatment that allowed three levels of navigation: near linear, associative linked, and menu. The students were given learner control in their selection of items, a menu map on each screen that provides non-linear movement and an associative linked structure. The researchers used a combination of qualitative and quantitative methods to measure their results. Some of the high ability learners attempted to navigate linearly because the researchers hypothesize, " They knew they would be tested" (p. 182). The low scoring group tried out the same number of navigational tools as the high scorers, but used them to a lesser extent and with more error. The authors explain the students' monitoring of their own understanding was flawed. The average group tried out all the navigation tools most frequently while the high scorers, using the same strategic choices as the low scorers, were more frequent in their use of their chosen tools. The strategies used by the high scoring group showed them to be more focused and efficient in their use of navigation tools. The results showed an interesting correlation between low, medium, and high posttest scores of the learners.

Summary. Navigation as a science is fairly old in the celestial realm, but whether it is to be considered a variable in its own right, an element of learner control, or a function of interactivity in hyperspace, is still being debated. Research that treats navigation as a separate entity to be manipulated is fairly recent. The results are engaging. It appears that the amount of learner control and interactivity that a navigation tool delivers might affect achievement and attitude. Studies show learners are less anxious when they are comfortable with the navigation tools. Learners have higher achievement when they utilize the tools efficiently. Concept maps, where a learner can see where they have been and where they are going, seem to improve achievement when the learner chooses to use them. More research is needed to determine how navigation tools affect student achievement and attitude. Instructional designers and software developers would benefit from research information that further elaborates on the benefits and drawbacks of different navigation tools.

Research Questions

Research results have shown learner control, interactivity, and navigation have a definite influence on the achievement and attitude of learners of varying ability levels. Whether the influence is positive or negative is still a question. Learners may not always correctly perceive what type or instructional method offers the highest degree of learner control or interactivity that will benefit their instruction. Moreover, according to the research there is a need for data to guide development of CBI instruction that will serve learners of various ability levels. This review of literature led to the following research questions which frame the present investigation.

1. Will the achievement scores of learners be influenced by treatments that vary the amount of learner control and interactivity through a navigation tool?

2. Will any one ability level have higher achievement scores based on treatment?

3. Will the attitude scores of learners be influenced by treatments that vary the amount of learner control and interactivity through a navigation tool?

4. Will the attitude scores of learners be influenced by ability level?

Indirectly, the following two questions are of interest in this study.

5. Will learners in any one ability group perceive any one treatment as giving them more

control?

6. Will any one treatment be best for the learner in both achievement and attitude?

The following hypotheses were developed and tested from the 6 preceding research questions:

Hypothesis 1

The use of the navigation tool in Treatment 3 (Search engine) will produce higher achievement scores than Treatment 1 (Linear) and Treatment 2 (Menu).

Hypothesis 2

High ability learners' achievement scores will be higher than low ability and middle ability learners' achievement scores.

Hypothesis 3

The use of a navigation tool (Treatment 3, search engine) that delivers more interactivity and learner control will result in higher attitude scores than Treatment 1 (Linear) and Treatment 2 (Menu).

Hypothesis 4

High ability learners' attitude scores will be higher than low ability and middle ability learners' attitude scores.

Chapter 2

Methodology

Introduction

In this study, three navigation tools' affects on achievement and attitude of learners with various ability levels were examined. This chapter describes the instructional program developed by the researcher and the methods, including the design, and participants involved in the study.

Creation of the module

The review of literature, formation of research questions, and hypotheses indicated a need for an experiment that presented navigation tools in levels. These levels would increase in the delivery of interactivity and learner control within the hypermedia format. During the process of creating this instructional module the following steps were followed:

Step 1: Determine the navigation tools to be used. It was determined by the researcher that tools often used in a CD-ROM hypermedia environment were:

1. Linear: a button type tool or arrow that takes the learner to the next screen or node of instruction. The program controls the sequence of content and the learner controls only a mouse click and the pace of content delivery.

2. Menu: a choice of all the nodes of content present in the instructional unit. The learner's level of interactivity is slightly increased in that when a node is selected the computer is responding to that specific request. There is increased learner control in that the learner can choose instruction in any sequence and control the pace and path of delivery.

3. Search engine: here the learner has increased communication or interactivity with the computer. The computer becomes more of a collaborator. When the learner chooses the node of instruction they wish to examine, they must interact with the search engine, inputting the words. The command is then given to the search engine to "search". The response is a list of possibilities. The learner must choose again to gather whatever information is necessary to complete the learner's task.

The researcher decided to construct a module where these three tools would give the learner

access to the same content. The amount of interactivity and learner control involved in instruction would be controlled by the navigation tool.

Step 2: Select population and content. The population selected were grade 8 students at the public middle school where the researcher was employed.

The content of the module was poetry. This content was selected by the researcher as it was pertinent to the target population, eighth grade students in Virginia. These students are tested in their eighth grade year on their comprehension and application of poetic terminology in Standards of Learning tests. With a background in English and fifteen years experience teaching eighth grade, the researcher determined a module delivering the instruction of this content would be of practical value for students and teachers. In examining the breadth and depth of the poetry SOL's grade 8 students are responsible for mastering, three categories emerged: sound effects, figurative language and literary terms with author background. Content material was gathered in these areas. The sound effects content was developed fully to include: refrain, rhythm, rhyme, internal, end, and slant, rhyme scheme, onomatopoeia, alliteration, assonance, meter, 3 stanzas of the poem "The Raven", 2 practice activities with feedback, a practice test, and a review that included researcher developed games and links to other poetry information. The module was carefully prepared to follow the English curriculum of the eighth grade and the Virginia Standards of Learning (SOL's).

Step 3: Design interface. Units were then mapped in three storyboards. Attention was paid to the instructional design. Each unit contained instruction, activities, practice, and assessment on the material. The researcher then focused on the design and interface of the three navigation tools. "The singularly difficult task is building an environment that is truly engaging" (Jones, 1998, p. 205). A 640x480 rectangle with a navigation bar located on the bottom was first explored. The bar contained image buttons that when clicked activated sound, images, animation, or movie. For the navigation tool in treatment 1 (linear) a directional arrow was included; navigation tool treatment 2 (menu) a menu of all content was centered in the rectangle in alphabetical order with the bottom bar; navigation tool treatment 3 (search engine) included a search engine input page. A splash page for all three tools was constructed. The term "phase" was chosen to replace the clinical sounding term

treatment for the eighth grade students. The splash page used a graphic of a porthole with an ocean view beyond and the word "enter". When clicked, a QuickTime™ movie (created in Adobe Premiere™) complete with sound, played and then transferred the learner to a direction screen for their designated phase using one of three navigation tools. Although instruction was developed and material gathered for all three units of poetry only the sound effects unit was completed for the proposal presentation. The module was titled *The Poetry Portal©.* The module was written in *HTML* with *JavaScript* additions using a variety of software tools. A CD-ROM Hybrid (interfaces with the Internet) was created to deliver hypermedia functions with access to web resources. All treatments gave the learner access to all content. The navigation tools determined the pace, sequence, content, nature of feedback and amount of interactivity the learner would use to access the content. *The Poetry Portal* © is copyrighted. For further information contact the author.

Step 4: Edit and revise. Feedback from the committee following the proposal presentation led to a focus on and revision of several items. The navigation bar was simplified to focus on the navigation tool used in the treatment. The menu page was redesigned to allow items to be linked and reflect interactivity. The search engine page was clarified. It had included a side navigation bar that acted as a content map and also reflected the learners progress through the content. This was eliminated and only the search engine entry page was displayed.

A complex advanced organizer had been constructed to keep the learner focused on the lesson and the SOL's. This guide was simplified and homogenized to include only the directions specific to each navigation tool and the identical terms that applied to all phases.

A posttest and attitude survey were constructed by the researcher. The posttest was similar in design to the SOL format used in testing poetry. The attitude survey was constructed by the researcher based in part on a previous study (Sherman, 1999).

Step 5: Pilot study, final revisions. In July 1999, a pilot study was conducted to assess the poetry content, measurements and module, and determine the refinements and changes needed for the dissertation study. Participants included 6 middle school students. They completed the module and attitude survey in 45 minutes and returned 3 days later for a posttest. A number of features of

the treatments were refined based on the pilot test. It was observed that the search engine tool caused frustration among the students in that it offered too many choices. Refinement was made to the web site the engine searched to reduce the number of possible hits. The design of the search engine page was also modified to include the same directions with an index of the terms available to all treatments. Observations determined that the timing in the final experiment needed to be adjusted to fit the current eighth grade schedule. Five minutes of scripted instruction followed by 35 timed minutes of treatment and five minutes for an attitude survey proved to be sufficient. Scripted directions were edited to include directions on how to use the browser *Netscape Navigator*'s™ Go button, so all levels had the ability to retrace content. Finally, the posttest was revised based on feedback from the students in the pilot study and given two days after the treatment to fit the grade 8 schedule.

The final revision of the module focused on fine-tuning the interface of each navigation tool and its facilitations of interactivity and learner control. All learners in all phases had access to the identical content. Special features included: (a) two games designed for the study through the use of *LiveStage*™; (b) a puzzle that gave the definition of poetry when solved, and (c) a matching memory tile game of terms. These were available for all learners as review choices. An interactive rendition of "The Raven" was created where as the learner moved the mouse over a section of the poem the term that it defined would appear to float over the example. This too was included in the review section to which learners in all phases (treatments) had access. An interactive practice test was created using *HotPotatoes*™. This test modeled questions asked on the final posttest with feedback added for each multiple choice answer. This practice test was also available for each phase and written as a final step in the directions on the study guide.

Navigation tools within the interface were refined to deliver increasing levels of interactivity and learner control. The linear tool delivered the content one screen at time. The menu tool gave the learner a choice of items to access but the screen was identical to that of the linear tool minus the uni-directional arrow at the bottom. The search engine required the learner to communicate and choose results, but gave the same screen as the menu tool. All phases included the same sound amplifications. Poetry examples were recorded and read by the researcher along with all directions.

See Table 2 for a view of how the navigation tools influenced learner control and interactivity in this study.

Table 2

Navigation Tools Delivery of Learner Control & Interactivity in The Poetry Portal

Phase	Tool	Learner Control	Interactivity
1	Linear	Pace	Mouse click gives next screen
2	Menu	Pace, sequence, content	Computer responds to learner's choice
3	Search engine	Pace, sequence, content, nature of feedback	Computer responds to inquiry and gives feedback from which learner selects content of choice

Method

Design. The design of the study is quasi-experimental with random assignment of students to treatment groups (three ability levels to three navigation tools). Achievement scores of the three groups were examined with regards to the navigation tool used in their treatment. Attitude scores were also compared to the type of navigation tool used in their treatment. The design is a three (ability levels) by three (treatments) by two (achievement and attitude) factorial. A two-way ANOVA was used first to ascertain if there was a main effect for treatment or levels and any interactions. A one-way ANOVA was to be used when significance was found in level or treatment to determine if the observed differences in ability groups achievement scores and attitude were due to the navigation tool used in treatment. Finally, the Tukey/Kramer Post Hoc test for unequal n(s) would be used to compare the means of the three groups and identify what treatment had significance for what level.

Participants/Setting. The participants were 146 eighth grade English students from an eighth-grade population of 298. Students were stratified into three ability levels, low, middle, high, based on their *Stanford 9 Total Reading Achievement* scores and then randomly assigned to one of the three treatments. Previous research (Bartasis & Palumbo, 1995; Borsook & Higginbotham-Wheat, 1991; Cho, 1995) has shown a disparity in the results obtained from students of differing ability levels when given a task in a CBI format that involved learner control, interactivity, and navigation.

Design features. Audio was used to deliver directions, site element information, and examples of the poetic elements of sound. These techniques mediated content delivery for a variety of learner preferences. Individual headsets were used to control the noise factor in the lab. An interactive practice posttest was designed to give immediate feedback and followed the same format as the final posttest. The posttest required students to apply their understanding of the terms to a new poem and be able to correctly locate, identify, and define those terms. Directions were recorded for every screen of content so the learner could listen as well as read along. The entire module was coded in HTML with *JavaScript* enhancements, so any 4.0 browser could read the files. The first two phases were entirely contained on the CD-Rom except for one page of outside links in the review section. The third phase accessed a server on the Internet in order to make use of a *FrontPage* constructed search engine. The search engine only searched the poetry module web and the outside links to poetry on the review page. The direction pages of all three looked very similar (see Appendix A) with small changes made to specify the type of navigation tool to be used. The pages that followed the direction page revealed the navigation tools (see Appendix B).

The researcher created a module that resembled a world wide web format without the delivery problems of inconsistency of information transfer and long download times associated with the Internet (Diaz, 1999). This technique also afforded the ability to include more multimedia resources such as audio and video. The poetry module focused on the sound elements of poetry. Eight poetry elements were isolated, defined, modeled and practiced in thirty-five minutes. The module proved to be very time efficient with students completing their phases, including a practice test, within the thirty-five minute time period. This supports the research results of Diaz (1999) who found the CD-ROM Hybrid "can reduce the amount of time that students spend interacting with a given technology, and can increase the amount of time they spend learning" (p. 89). Poetry excerpts were taken from the Holt, Rinehart, Winston textbook *Elements of Literature* (1993) used by the students' middle school.

Achievement assessment. The 20-item multiple choice achievement posttest was developed by the researcher with the design based on the SOL test format and SOL content for English 8. The

posttest was further refined based on feedback from the Pilot study. The final format and content of the posttest was reviewed and approved by the Curriculum and Instruction Coordinator for the target school. A Kuder/Richardson21 reliability equation showed a reliability rating of .55 for the instrument (see Appendix C for the posttest and reliability equation results).

Attitude survey. The attitude survey format was adapted from a previous study (Sherman, 1999) and refined with feedback from the pilot study. The survey consisted of 25 items rated on a Likert type scale from 1 to 5 (see Appendix D). This instrument was reviewed and approved by an expert in instructional design at the researcher's educational institute.

General procedures. In October 1999, permission for the experiment was obtained first from the Virginia Tech departmental IRB representative, second, the student's school board's Director of Testing, and third, the Principal of the middle school. Finally, all 8th grade students and English teachers were given a consent form to read and sign, and parental permission was obtained. (See Appendix E for all permission communications and approvals.) Teachers were also given sample lesson plans with Virginia Standards of Learning correlations that followed the same content of the module. It was arranged with the librarian for the poetry lesson to be conducted in a direct teaching style for students who could not participate in the study. The Stanford 9 Total Reading test data was obtained and the total population of 8th grade students were leveled into three ability levels. From this group, students who returned all permission forms were considered for the study. One hundred forty-six eighth grade middle school students were randomly sampled from the available population of 298 grade 8 students and worked through the CBI poetry module that used three different navigation tools.

The three treatments took place on 2 consecutive days. The students participated during their regular English period. Students who did not participate stayed in their regular English class or were given a similar poetry lesson by the librarian. Students of differing ability levels were involved in different treatments at the same time, and received one of the randomly assigned three treatments. For example, each participating first period English student received 5 minutes of scripted instruction and one of three 35-minute treatments. The students first entered the lab and were randomly

assigned to one of 18 Power Macintosh computers that had been pre-set to present one of the three treatments. Headsets, student instructions, and feedback papers were present at each computer station. When all students were present, scripted instructions were read by the researcher, a timer was set and students were given a go-ahead signal. Students worked through their individual treatment until the timer sounded at the end of 35 minutes. The 25-question attitude survey (see Appendix E) was given to the participants immediately following the treatments. Total time for the treatment and survey was 40 minutes. Two days later, the 20-question multiple choice posttest (see Appendix C) was then given to students on the content of the tutorial and application of that content. Students participated in the treatments during class periods 1st through 7th on Monday and Tuesday and then returned on Wednesday and Thursday for the posttest during the same period they participated in the treatment.

Table 3 addresses the plan of treatment and the variables involved. All treatments accessed the same content that gave instruction, activities, practice, and assessment on eight terms related to the sound effects found in poetry.

Table 3

The Arrangement and Nature of Treatments

Monday	Tuesday	Wednesday	Thursday	Dependent Variables
A	B	A	B	Attitude Survey
Monday's group treatment/ survey	Tuesday's group treatment/ survey	Monday's group posttest	Tuesday's group posttest	Achievement Posttest
n = 60	n = 92	n = 58	n = 88	

Note. Total N = 146 completed treatment and measurement. Six students were absent for the Posttest given on Wednesday and Thursday.

Analysis of Data

Composite *Stanford 9 Total Reading* scores (SRA) were normalized across the total sample population (N=298) to yield a mean of 66.90 with a SD of 26.70. Levels were set at one-half a standard deviation (13.35) above and below the mean with high (100-80.30), Middle (80.20-53.70) and low (53.60-0) for the total population. Only ability level highs provided a large enough sample size when permissions were obtained for randomization of the level. Randomization was performed through the use of a number table (Hinkle, 1998).

Attitude scores were obtained from a 25-question survey with five possible responses using a weight of 5 -1 scale for most positive to least positive. The response choices ranged from "Strongly Agree to Strongly Disagree".

Achievement scores were collected from a 20-item multiple choice assessment of the poetry terms. A score of 1 was given for every correct answer, and a score of 0 was given for an incorrect answer.

Observational data was gathered by the researcher during the treatment phase. Students' start time was noted as well as any delay or problem individual students encountered when working through the modules. Students were encouraged to write down comments, frustrations, and subject notes on their instruction sheets. Instruction sheets were collected and qualitative data gathered and coded. Attempts to track the user's path and pace were prevented by the filter residing on the server used in the school lab and the technicians unavailability to work with the researcher.
Quantitative data from the results of the attitude survey were gathered and an analysis of student comments was conducted. Due to the fact that the data collection for the student comments was not controlled in a rigorous fashion, the findings will be included in the discussion section under areas of further research.

The data entry was conducted by the researcher with verification conducted by an outside reviewer to insure reliability. The content validity for the achievement test and attitude survey were each ascertained by experts.

The level of significance for the statistical analysis of the data in this study was set at .05. The study was designed to test hypotheses regarding the effects on achievement and attitude of learners

stratified into three ability levels using three navigation tools. Statistical software SPSS version 6.1.1 for the Mac was used in the examination.

Chapter 3

Results

Introduction

The experiment was designed to test hypotheses that examined if the use of different navigation tools would affect learner's achievement and if the learner's perception of learner control and interactivity would accurately be reflected by the treatment received. Results of this study are based on the data are derived from descriptive statistics, two-way ANOVA, one-way ANOVA and a Tukey/Kramer Post Hoc test. The level of significance was set at .05. This chapter reports and discusses the results of the present experiment.

Two hundred ninety-one *Stanford 9 Total Reading* achievement scores (SRA) were obtained from the total 8th grade population of 298. The mean of this population was determined to be 66.94 with a standard deviation of 26.70. The mid-range of student ability was set one half a standard deviation above and below the mean. Ninety-two students were determined to be in the low ability range, 82 in the mid-ability range and 117 in the high ability range. Table 4 displays the means and standard deviation for the student population.

Table 4

Statistical Descriptives for Sample Population from Stanford 9 Reading Achievement Scores

SRA Groups	n	M	SD	SE
Level 1 (low)	92	33.54	14.82	1.55
Level 2 (mid)	82	68.82	8.39	.93
Level 3 (high)	117	91.74	5.70	.53

Note Students (N= 291)

One hundred fifty-two of these students returned signed student and parent permission forms. One hundred fifty-two students participated in this study. One hundred forty-six of these completed the study, attitude survey and the posttest which was given two days later. There were 6 students absent and their data were removed.

Achievement

Primary analysis. The analysis of achievement data is reported first followed by attitude data. The analysis of achievement data proceeded as follows: In primary analysis, a two-way ANOVA was used to test for main effects for the three treatments and three ability levels. When a main effect was detected, in secondary analysis, one-way ANOVAs were then used to test for significance within and between the groups. Where significance was found in the one-way ANOVAs, a post hoc Tukey/Kramer analysis for unequal n was used to make all pairwise comparisons and to determine where the significant difference occurred. Secondary hypotheses were created and tested in this post hoc analysis (see Figure 1, p. 37).

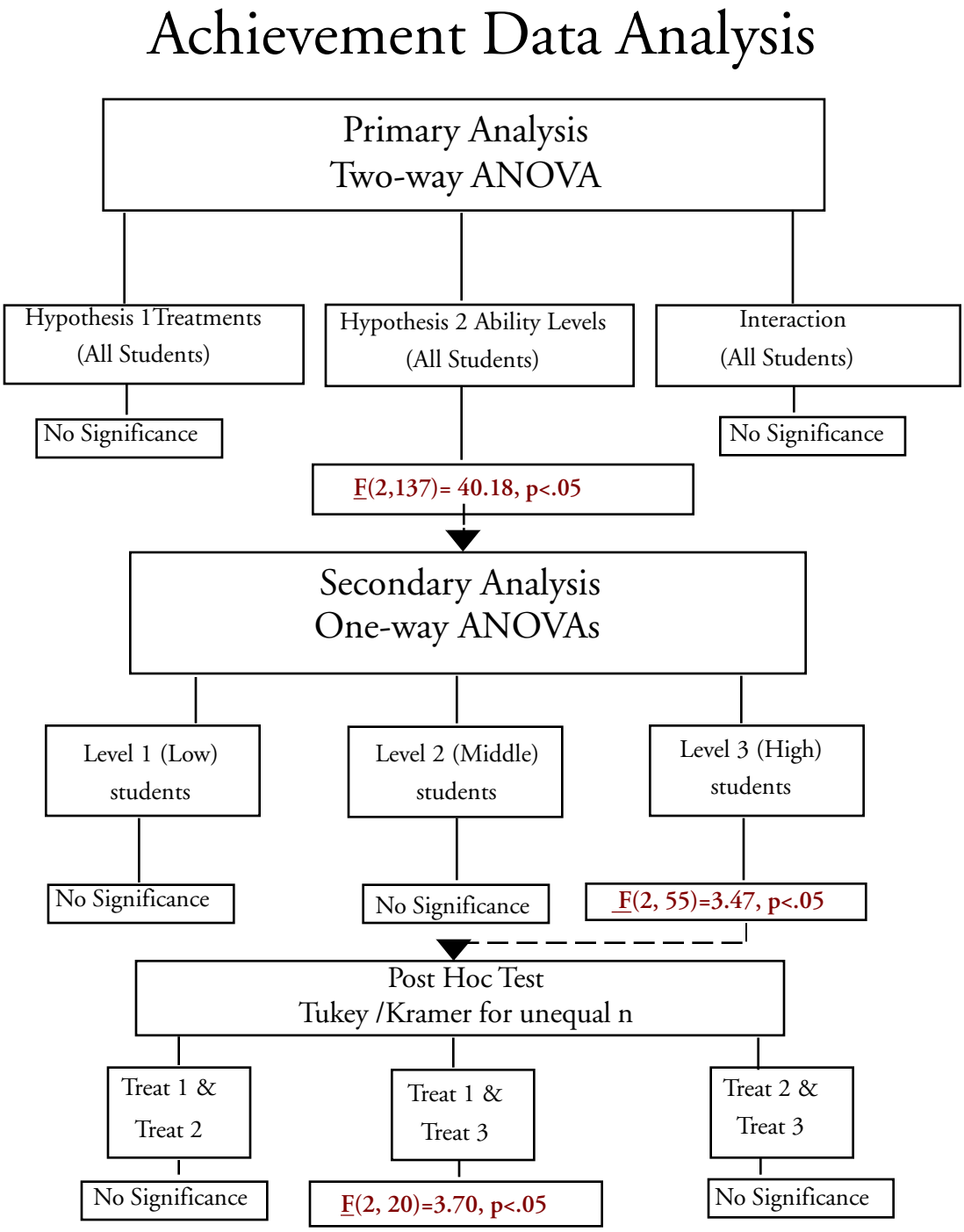

Figure 1. The order of analysis for achievement.

Hypothesis 1. *The use of the navigation tool in Treatment 3 (Search engine) will produce higher achievement scores than Treatment 1 (Linear) and Treatment 2 (Menu).*

In primary analysis, the two-way ANOVA revealed no main effect for the three treatment groups (F (2, 137) = 1.21, p > .05). It was expected that the achievement scores of all ability levels would improve when the navigation tool offered increased learner control and interactivity (see p. 36 for table of means and standard deviation). In primary analysis, the two-way ANOVA found no interaction (F (4, 137)= 1.21, p > .05) for level and treatment. Appendix F displays the results of a two-way ANOVA for Achievement by Treatment by Ability Levels. This hypothesis was not supported by the data. See Appendix F for the ANOVA Table.

Table 5 contains the summary of means and standard deviations for Low Ability, (n = 44), Middle Ability, (n=46) and High Ability, (n = 56) by Treatment Level 1 (Linear), Treatment Level 2 (Menu), and Treatment Level 3 (Search engine).

Table 5

Means of Achievement by Ability Levels and Treatments

		Treatment Methods			
Level		T_1 (Linear)	T_2 (Menu)	T_3 (Search Engine)	Row Total
Low	$\overline{X}$	8.57	8.67	8.07	8.43
	SD	1.91	2.32	2.69	2.3
	n	14	15	15	44
Mid	$\overline{X}$	9.70	10	9.79	9.83
	SD	2.44	3.23	3.17	2.88
	n	17	15	14	46
High	$\overline{X}$	11.85	13.13	13.95	13.00
	SD	3.3	2.16	1.85	2.65
	n	20	16	20	56
Columns Total					
	$\overline{X}$	10.24	10.65	10.96	10.61
	SD	2.98	3.18	3.59	3.25
	n	51	46	49	N=146

Table 6 reports the mean scores for achievement scores by treatment. No one treatment affected scores across ability levels significantly.

Table 6

Means for Achievement by Treatment

Treatment	n	M	SD	SE
Treat 1 (Linear)	51	10.24	2.98	.42
Treat 2 (Menu)	46	10.65	3.18	.47
Treat 3 (Search Engine)	49	10.96	3.59	.51
Total	146	10.61	3.25	.27

Hypothesis 2

High ability learners' achievement scores will be higher than low ability and middle ability learners' achievement scores.

In primary analysis the two-way ANOVA revealed a main effect for the three ability levels ($F(2, 137) = 40.18$ $p < .05$). It was expected that achievement scores would be higher as the ability level increased. This hypothesis was supported by the data. See Appendix F for the ANOVA table.

Secondary Analysis

In secondary analysis, one-way ANOVAs were performed on all ability levels. The one-way ANOVA for Low Ability revealed no significant difference ($F(2, 48) = .59$, $p > .05$) (see Appendix G for the ANOVA table and p. 36 for table of means and standard deviation).

A one-way ANOVA (see Appendix H) performed on Middle Ability also showed no significant difference ($F(2,45) = .04$, $p > .05$) between the mean scores Treatment 1 (Linear) (X = 9.70), Treatment 2 (Menu) (X = 10.), and Treatment 3 (Search engine) (X = 9.79).

The one-way ANOVA performed on High Ability showed a significant difference ($F(2, 55) = 3.47$, $p < .05$) between the mean scores Treatment 1 (Linear) (X = 11.85), Treatment

2 (Menu) (X = 13.12), Treatment 3 (Search Engine) (X = 13.95) . Appendix I shows the results of a one-way ANOVA for High Ability students. Table 7 displays High Ability Mean Achievement Scores by treatments. See Figure 2 for a bar graph of mean scores across levels that illustrates the increasingly higher achievement across all methods by the Ability Level High.

Table 7

High Ability Achievement Scores by Treatments

Summary of Descriptive Statistics for High Ability

Treatment	n	M	SD	SE
Trt 1	20	11.85	3.30	.74
Trt 2	16	13.13	2.16	.54
Trt 3	20	13.95	1.85	.42
Total	56	12.96	2.65	.35

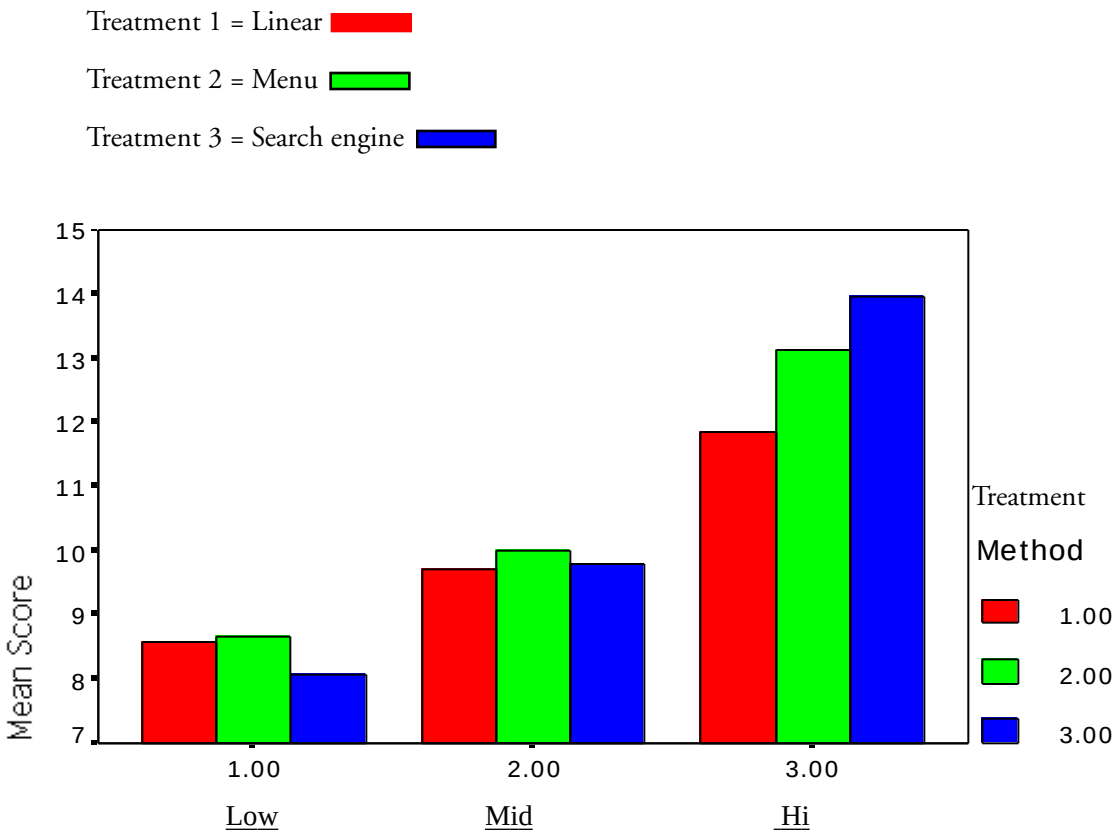

Figure 2. Graph of Three Treatments by Ability Levels

A secondary hypothesis was created and tested in the post hoc analysis (see Figure 1 p. 32):

Secondary Hypothesis . *Treatment 3 (search engine) will have higher achievement results over Treatment 1 (Linear) and Treatment 2 (Menu) for High Ability.*

In order to determine if the significant F ratio found in Ability Level Highs was attributed to a difference between a pair of means, a post hoc test was conducted. According to Hinkle (1998) "... the Tukey or the Newman-Keuls methods are appropriate when the group sizes are equal. However, when the group sizes differ, a modification of the Tukey method is available; it is called the Tukey/Kramer (TK) method" (p. 394). The Tukey/Kramer (TK) Post Hoc test for unequal n was used to identify significance of the difference between achievement means for High Ability based on treatments. The formula for Q in the TK method is: $Q = \frac{\bar{x}_i - \bar{x}_k}{\sqrt{MS_w \left(\frac{1/n_i + 1/n_k}{2} \right)}}$

The one-way ANOVA in Appendix I shows the critical value of F for (2, 53)= 3.47 is significant (f_{cv} 3.17, p <.05). In order to determine which means differ, the means of each Treatment result are subtracted from another until all possible pairs have been calculated. Thus Xi - Xk is equivalent to Treatment 1 minus Treatment 2 divided by the square root of the mean square (6.44) times one divided by the cell number of Treatment 1 and added to one divided by the cell number of Treatment 2 divided by two (the number of cells being compared). The Q distribution is used to control for error.

Significance was found in the achievement scores for High Ability using Treatment 3. The conclusion drawn is that for all High Ability learners in this study, Treatment 3 is significant over Treatment 1. The data for the TK test multiple comparison of the means is found in Table 8.

Table 8

Tukey/Kramer Multiple Comparison of Treatment Means for Unequal n for High Ability Students

Calculation of Q Using the Tukey/Kramer Method

Group	Mean	n	$(X_i - X_k)$	
Trt 1(Linear)	11.85	20		
Trt 2 (Menu)	13.13	16	1.28	
Trt 3 (SE)	13.95	20	2.10	0.83
Trt 1 (Linear)				
Trt 2 (Menu)			2.12	
Trt 3 (SE)			3.70*	1.38

Note. *p< .05 (Qcv =2.83 for df 53).

Based on observed means, Qcv =2.83. The mean difference is significant at the .05 level.

Attitude

Primary Analysis

A two-way ANOVA was used to reveal main effects for the three treatments and the three ability levels and, also, to test for an interaction between the treatments and ability levels on a 25-item attitude survey using a 5-point Likert-type scale. When a main effect was found, secondary analyses using one-way ANOVAs were performed to test for significance within and between the groups. Where significance was found in the one-way ANOVAs, a post hoc Tukey/Kramer analysis was used to make all pairwise comparisons and to determine where the significant differences occurred. Secondary hypothesis were created and tested in this post hoc analysis. Figure 3 depicts the flow of analysis for attitude.

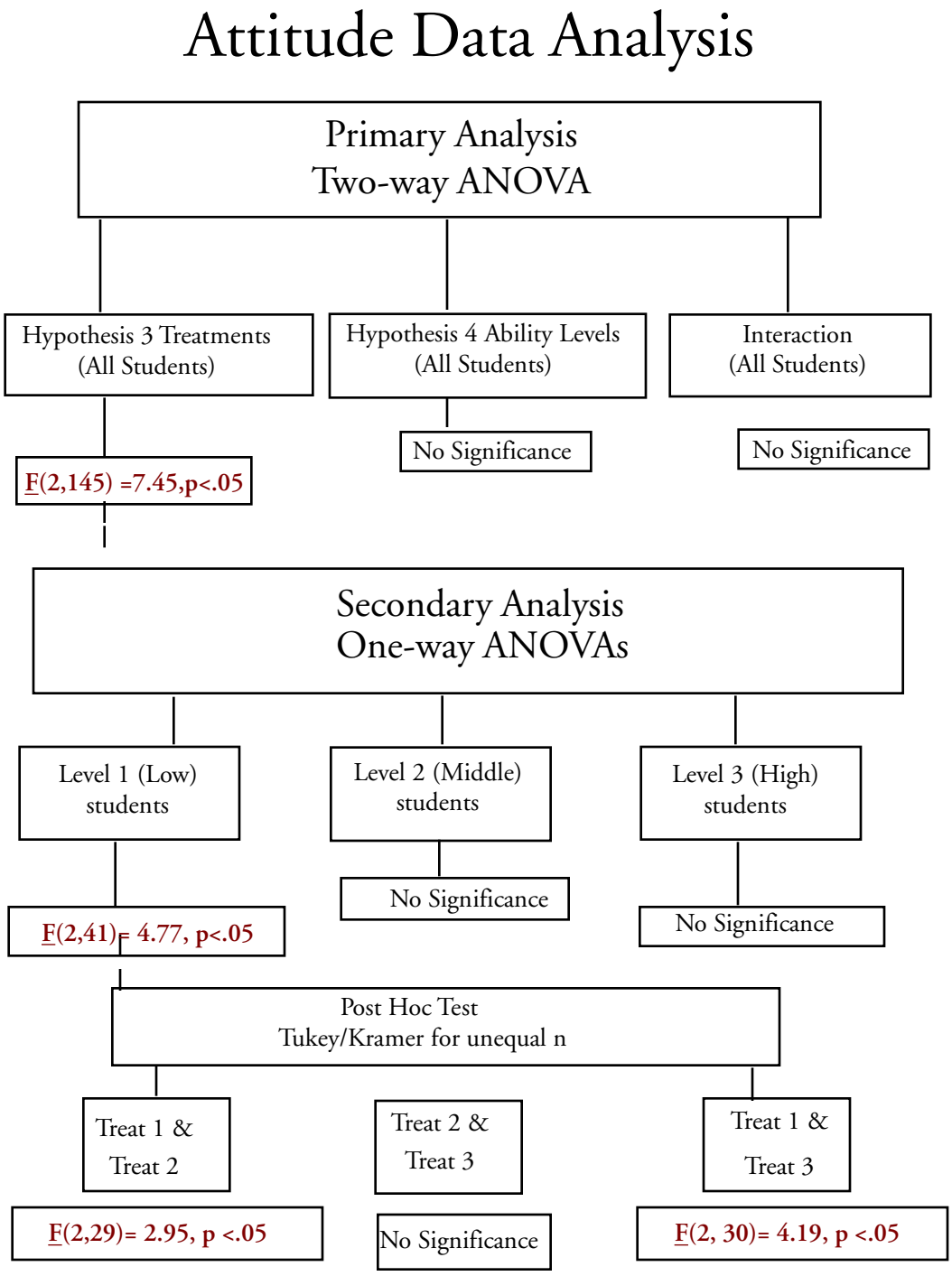

Figure 3. The order of analysis for attitude.

Hypothesis 3. *The use of a navigation tool Treatment 3 (Search engine) that delivers more Interactivity and Learner control will result in higher attitude scores than Treatment 1 (Linear) and Treatment 2 (Menu).*

Table 9 contains the summary of means and standard deviations for Treatment 1 (Linear), Treatment 2 (Menu), and Treatment 3 (Search engine). The two-way ANOVA for attitude by treatment showed significance in treatment ($F(2, 145) = 7.45$, $p > .05$) (see Figure 3, p. 46 and Appendix J). This hypothesis was supported.

Table 9

Means of Attitude by Ability Levels and Treatments

		Treatment Methods			
Level		T_1 (Linear)	T_2 (Menu)	T_3 (Search Engine)	Row Total
Low	$\bar{X}$	96.5	104.67	93.07	98.08
	SD	10.63	8.79	12.00	10.47
	n	14	15	15	44
Mid	$\bar{X}$	99.70	104.40	97.21	100.20
	SD	12.18	8.99	10.81	10.66
	n	17	15	14	46
High	$\bar{X}$	98.90	101.50	95.80	98.73
	SD	10.81	8.77	9.08	9.55
	n	20	16	20	56
Columns Total					
	$\bar{X}$	98.27	103.48	95.37	98.94
	SD	11.07	8.77	10.44	10.6
	n	51	46	49	146

Table 10 summarizes the means for attitude by treatment. Following a two-way ANOVA, a main effect for Treatment was found to occur across all three ability levels of students (see Appendix J) (F (2, 145) = 7.45, p < .05).

Table 10

Means for Attitude by Treatment for all Ability Levels

Treatment	n	M	SD	SE
Treat 1	51	98.27	11.07	1.57
Treat 2	46	103.48	8.77	1.29
Treat 3	49	95.37	10.44	1.49
Total	146	98.94	10.64	.84

Hypothesis 4. *High ability learners' attitude scores will be higher than low ability and middle ability learners' attitude scores.*

Primary analysis in the two-way ANOVA revealed no main effect for ability levels (F (2, 145) = .47, p > .05) (see Appendix J for two -way ANOVA table). Primary analysis in the two-way ANOVA revealed no interaction between Treatment and Level (F (2, 145) = .44, p > .05) (see Appendix J for two -way ANOVA table). This hypothesis was not supported by the data.

Secondary Analysis (Research Questions 5 & 6)

In secondary analysis, one -way ANOVAs were performed on each of the three treatments to determine whether the significant F ratio was due to differences between pairs of means within levels by treatments or another combination of means. No significant differences were found in Middle Ability (F (2, 45) = 1.77, p > .05) (see Appendix K) and High Ability (F (2, 55) = 1.57, p > .05) for attitude (see Appendix L).

There was significant difference in Low Ability (F (2, 41) = 4.77, p < .05) (see Appendix M). A Tukey/Kramer post hoc test was performed to determine what pair of means in Low Ability had significance. Table 11 contains the data for the multiple comparison TK test.

Table 11

Tukey/Kramer Multiple Comparison of Attitude Means for Unequal n in Ability Low

Calculation of Q Using the Tukey/Kramer Method				
Group	Mean	n	$(X_i - X_k)$	
Trt 3 (SE)	93.07	15		
Trt 1 (Linear)	96.50	14	8.17	
Trt 2 (Menu)	104.67	15	11.6	7.50
Trt 3 (SE)				
Trt 1 (Linear)			1.24	
Trt 2 (Menu)			4.19*	

$p < .05$ ($Q_{cv} = 2.86$ for $df = 43$).

Results Summary. Based on observed means, Qcv =2.86, the mean difference is significant at the .05 level. Low Ability showed a significant difference in their mean attitude scores for Treatment 2 (Menu) over both Treatment 1 (Linear) and Treatment 3 (Search engine). Figure 4 illustrates this difference with a graph of the attitude means by three treatments.

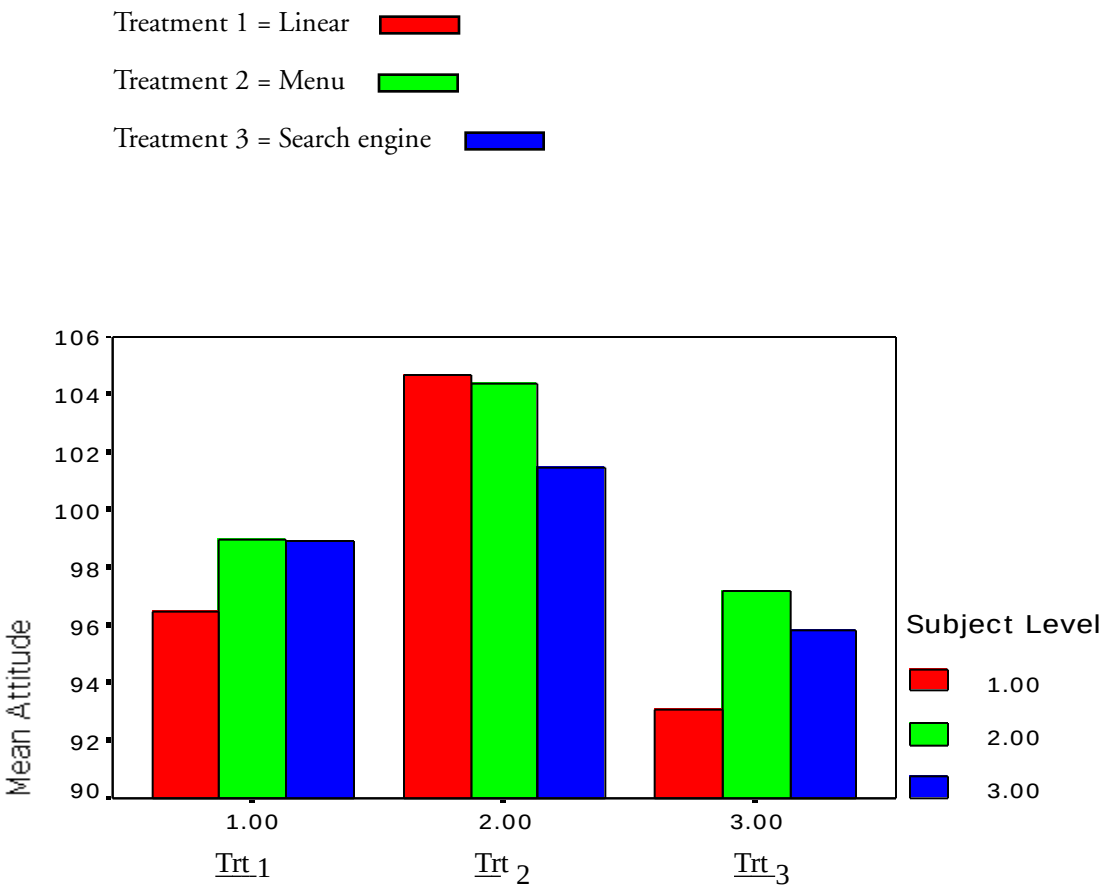

Figure 4

Attitude graph by three treatments by method

Interestingly, the treatment that delivered the most Learner Control and highest level of Interactivity, Treatment 3 (Search engine), was not selected as such by any ability level groups. All ability levels perceived Treatment 3 (Search engine) overall as offering the least amount of Interactivity, Navigation, and Learner Control. Table 12 gives the means by treatment group and ability level for the collection of attitude items related to Learner Control (7 items), Interactivity(4 items), and Navigation (4 items). Appendix N shows the attitude statements that related to Learner Control, Interactivity and Navigation with means by treatments. Attitude items were grouped according to

Table 12

Grouped Attitude Questions and their Means by Treatment and Ability Level

	Learner Control Questions		
Treatment	Low Ability	Middle Ability	High Ability
Linear	3.45	4,10	4.06
Menu	4.41	4.34	4.30
Search	4.02	4.13	4.09
	Navigation Questions		
Linear	3.27	3.72	3.95
Menu	3.92	3.72	3.61
Search	3.11	3.52	3.38
	Interactivity Questions		
Linear	3.93	3.99	3.95
Menu	4.19	4.18	4.03
Search	3.83	3.96	3.74

N= 146 The scale for these items was: 5= strongly agree, 4 = Agree, 3 = Uncertain, 2 = Disagree, 1 = Strongly Disagree.

the categories: (a) Learner Control, (b) Navigation, and (c) Interactivity. Two-way ANOVA's were performed on each grouping (see Appendix O-Q). A main effect for treatment occurred across all three ability levels for treatment. The seven learner control questions showed ($F(2, 145) = 5.38$, $p < .05$) where Treatment 2 (Menu) was perceived to give more learner control than either Treatment 1 (Linear) or Treatment 3 (Search engine). The Navigation questions showed a main effect for treatment ($F(2, 145) = 4.14$, $p < .05$) and treatment 2 (Menu) was perceived as having more navigation functions than Treatment 3 (search engine). The interactivity questions showed a main effect for treatment ($F(2, 145) = 3.68$, $p < .05$). Treatment 2 (Menu) was again perceived by all ability levels to offer more interactivity than Treatment 3 (Search engine). When the questions that dealt with Learner control, Interactivity, and Navigation were separated from the general survey questions relating to attitude towards the subject and the computer environment, learners showed a clear preference for Treatment 2 (Menu).

Chapter 4

Discussion and Conclusion

Introduction

The review of literature in this study indicated little research had been conducted on the effectiveness of various navigation tools in the design of instructional software. Research results on Learner Control and levels of Interactivity indicated navigation tools that offer degrees of these variables in learning offered mixed results in terms of influences on achievement and attitude. Further, research results have been ambiguous as to how students of different ability levels may be affected by instruction that offers a little, some, or a lot of Learner Control and Interactivity (Bartasis & Palumbo, 1995; Hannafin et al., 1996; Schnackenberg & Hilliard, 1998; Unz & Hesse, 1999).

This study examined the achievement and attitude results of 146 eighth grade participants who completed a poetry module using three randomly assigned navigation tools. The research questions under investigation for this study were:

1. Will the achievement scores of learners be influenced by treatments that vary the amount of Learner Control and Interactivity through a navigation tool?

2. Will any one ability level have higher achievement scores based on treatment?

3. Will the attitude scores of learners be influenced by treatments that vary the amount of Learner Control and Interactivity through a navigation tool?

4. Will the attitude scores of learners be influenced by ability level?

5. Will learners in any one ability group perceive any one treatment as giving them more control?

6. Will any one treatment be best for the learner in both achievement and attitude?

The module that was developed for this study offered three navigation tools that afforded students three methods of instruction. The treatments were as follows:

Treatment 1 (Linear): The linear navigation tool; this tool most resembled direct instruction with minimal Learner Control and Interactivity. Results show students of all ability levels have

the lowest achievement scores when using this tool.

Treatment 2 (Menu): The navigation menu tool allowed moderate Learner Control and an increased level of Interactivity. This tool did not increase achievement significantly. Attitude survey results showed students significantly thought they had the most Learner Control and Interactivity with this method.

Treatment 3 (Search engine): The navigation search engine tool gave the most Learner Control and highest level of Interactivity. High ability students had significant achievement using this tool over the other two, menu and linear. Students of all ability levels indicated on their attitude survey they did not think this tool delivered the most Learner Control or Interactivity.

The two-way ANOVA of Hypotheses 1 (treatment affect on levels) showed no significant difference in achievement scores due to treatments between all ability levels. Based on these findings, increased Learner Control and Interactivity neither increased nor decreased student achievement across ability levels with significant difference. Significant difference was found for levels (Secondary Hypothesis). Since levels were stratified according to ability, some difference was to be expected. However, the continued trend of increasing achievement scores as the amount of Learner Control and Interactivity increased via the navigation tool necessitated further analysis. The results showed that high ability students benefited from the search engine tool significantly over the use of the linear tool. The answer to Research Question 1 is the increase of Learner Control and Interactivity will do no harm to the achievement of students of different ability levels. The decrease of Learner Control and Interactivity will negatively affect high ability students.

The secondary analysis of Hypothesis 2 (achievement across levels) showed an expected significant increase in achievement of favoring students of higher ability levels as the amount of Learner Control and level of Interactivity increased via the navigation tool. Post hoc analysis revealed High Ability learners benefitted from Treatment 3 (Search engine) significantly over Treatment 1 (Linear). Treatment 3 (Search engine) offered an increase in Learner Control and Interactivity over Treatment 1 (Linear). The findings of Cho (1995), Borsook, and Higginbotham-Wheat (1991) hypothesized students of lower ability benefit from more structure in instruction. This

study does not support those findings as there was no significant difference in achievement scores for low ability or middle ability students when treatments with more structure (Treatment 1, Linear) were applied.

The findings of Schnackenbery and Hillard (1998) in a review of the literature claim all students benefit from some amount of Learner Control and Interactivity and the discrepancy in past results is due to flawed measurements. The data from this present study of navigation tools supports those findings. Students of all ability levels benefitted from an amount of Learner Control that offers a learner choice and Interactivity in a CD-ROM Hybrid delivery of instruction. Students of higher ability levels improve achievement significantly from instruction that does offer Learner Control and Interactivity. The significant increase in high ability students' scores best reflects the relationship between the amount of Interactivity, Learner Control and knowledge construction and supports the findings that direct interactive experience enhances the construction of knowledge (Jonassen, Peck, & Wilson 1999). This is especially important in a hypermedia format: "This interactivity promotes cognitive engagement and contributes to the effectiveness of hypermedia" (Bartasis & Palumbo, 1995, p. 4). Research Question 2, that explored whether any one ability level would have higher achievement scores based on treatment was "yes" for high ability students.

The search engine tool was the least familiar to all students. Researcher observation indicated it took longer for students in Treatment 3 (Search engine) to access their first content page than students in Treatments 1 (Linear) and 2 (Menu). Students were observed sitting and staring at the computer screen while those in other treatments were proceeding through the modules. Observational notes taken during treatment sessions revealed students using the search engine delayed their entry into the instructional material longer than those using other navigation tools. Williams (1996) reported that more Learner Control in instruction encourages the learner to think about his or her choices. For students in higher ability levels, the time spent thinking of how to proceed and the time spent considering the term they wished to research may have resulted in greater recall over two days length of time.

An analysis of the data for Hypothesis 3 (treatment effect on attitude) indicated that Low

Ability students had a more positive attitude towards the navigation menu tool in Treatment 2 (Menu) and perceived this treatment as delivering the most Learner Control and highest level of Interactivity. The finding is this study was limited to the Low Ability students who significantly perceived Treatment 2 (Menu) as offering more Learner Control and Interactivity then both Treatment 1 (Linear) and Treatment 3 (Search engine) when responding to the general attitude survey. Upon secondary analysis where an aggregation of attitude survey responses into Learner Control, Navigation, and Interactivity groups was performed, the popularity of Treatment 2 (Menu) was more pronounced. All ability levels showed a significant difference in their preference for the Menu over the Search engine. All ability levels perceived Treatment 2 (Menu) to offer the most Learner Control, Interactivity and Navigation functions. The attitude survey results of this study complemented the work of Sherman (1999) who found students using a menu believed themselves more in control than those who used a search engine.

The interesting aspect of this result is that the students' perceptions did not match the researcher's expectations. The navigation search engine tool in Treatment 3 (Search engine) delivers the highest amount of Learner Control and level of Interactivity. This was not evident to the students in any level to the point of significance. Perhaps the unfamiliarity of the search engine left the students unsure of whether or not they had control. Treatment 3 (Search engine) produced significantly higher achievement scores for High Ability students. In the attitude survey, it was expected these students would recognize the greater amount of Learner Control and Interactivity. They did not. Student responses that addressed seven learner control questions such as 1) I had control over accessing the poetry information in this website and 2) I had control over what I learned about poetry in the Poetry Portal computer program (website) had a mean of 4.09 and High Ability learners who received Treatment 3 (Search engine). The same ability level students who received Treatment 2 (Menu) showed a mean of 4.30 on the same seven questions. This indicated students felt more in control of their learning when using the menu format in Treatment 2 (Menu) where choice was limited to a set menu, then when actually making a decision about what information to access as when using the search engine in Treatment 3. Schnackenberg and Hilliard (1998) found that stu-

dents' perception of their control might possibly affect their achievement. The results of this study do not support that finding since High ability students had significant achievement using Treatment 3 (Search engine) and did not perceive that tool as giving them more control. The High Ability students found that Treatment 1 (Linear) gave them almost as much Learner Control with a mean of 4.06 as Treatment 3 (Search engine) with a mean of 4.09.

Four questions that measured Interactivity were aggregated and analyzed. High Ability students who received Treatment 3 (Search engine) indicated they perceived Treatment 2 (Menu) to offer the most Interactivity. On statements such as: 1) I interacted with this website a lot to learn about poetry, and 2) When I make an error or get something right, the computer lets me know the mean for High ability students using the (Search engine) was 3.74 and 4.05, while a mean of 4.03 and 4.25 reflected Treatment 2 (Menu). Low Ability students had a mean of 3.83 for the Search engine and 4.19 for the Menu on the same grouped questions for Interactivity. Middle ability students also indicated a mean of 3.96 for Treatment 3 (Search engine) and preferred Treatment 2 (Menu) with a mean of 4.18. All ability levels of students thought Treatment 2 (Menu) offered the most Interactivity.

Analysis showed Low and Middle Ability students receiving Treatment 2 (Menu) had the highest means (4.33 and 4.26) when responding to the statement: (a) I knew how to use all the tools that were available on this site. All ability levels receiving Treatment 3 (Search engine) had the lowest means for the same statement (Low = 3.33, Mid = 3.57, High = 3.85). This may indicate a lack of confidence in using the search engine tool in Treatment 3 (Search engine) contributed to lower posttest achievement scores for students of low and middle ability levels. Research Question 3 was answered "yes". Student attitude was influenced by treatments that vary the amount of learner control and interactivity, but not as expected. Research Question 4 was answered "no". Attitude scores of learners were not influenced by ability level. Research Question 5 was answered "yes" learners in all ability groups perceived one treatment as giving them more control. All learners indicated a preference for Treatment 2 (Menu) as offering the most Learner Control.

The results of this study seem to indicate that Treatment 2 (Menu) offered the best blend of

achievement and attitude preference for all learners. The higher level of Interactivity and Learner Control in the search engine tool did not improve attitude scores for any ability level. The lack of Interactivity and Learner Control in Treatment 1 (Linear) decreased the achievement of High ability learners. Varying the degrees of Interactivity and Learner Control is as Park (1996) predicted within the reach of the regular classroom teacher. Results that indicate what levels of Interactivity and Learner Control will best support the learning process for learners of various ability levels is important for designers of instruction. The answer to Research Question 6 is "yes", the Menu format is best for learners of all abilities when considering both achievement and attitude.

Qualitative data gathered during this study consisted of the study sheet and copy of a poem each student was given during the treatment. The opportunity to gather information from the computers regarding path, pace, and sequence of the learners did not exist due to the filter software in place on the lab computers and server. The study sheets were collected from each student and the notes were coded according to type and quantity. Note taking strategies varied in several ways. Students wrote: 1) definitions, 2) examples, 3) practice activities, and 4) circled and underlined items on their copy of the poem "The Raven". There were many combinations and amounts of notes. Table 13 presents the results of the coding of amounts of note-taking data.

Table 13

Note-taking Data Across Treatments

Quantity	Treat1(Linear)	Treat 2 (Menu)	Treat3 (Search engine)
Students with notes	44	43	31
Students with 8 or more	3	8	7
Students with 4-7 notes	17	8	9
Students with 1-3 notes	24	27	15
Students without notes	8	7	19
Total Students	52	50	50

N=152 (Students who completed the first part of the study). Notes were considered as chunks of information. For example, 6 definitions = 6 notes, 6 definitions and one example = 7 notes.

The results indicated the learners using the search engine tool took fewer notes than learners in other the other two treatments, Menu and Linear. Perhaps they were preoccupied with the Search engine tool.

Conclusions. The implications for design of instruction using a CD-ROM Hybrid with Internet access seems to indicate a need for a choice of navigation tools that offer at least moderate Learner Control and level of Interactivity. Higher achieving students will have their best performance when given a higher amount of Learner Control with a higher level of Interactivity. Linear navigation tool should not be offered as the only tool for High Ability students.

Nevertheless, the purpose of this study was to examine the effects different navigation tools, used in a Hybrid CD-ROM computer lab setting, might have on the achievement of students of varying ability levels. In the existing literature, the inclusion of navigation tools in instructional software design based on their ability to alter the delivery of instruction has not been considered in depth. This study demonstrates the amount of Learner Control and Interactivity level the navigation tool presents does impact the achievement of Higher A bility students. The linear instructional method, or drill and practice format, found in educational software used in computer labs may have a negative effect on these students. Student attitudes across all achievement levels demonstrates a need for instructional software that offers a navigation tool that delivers more Learner Control and a moderate level of Interactivity. To increase the effectiveness of instructional software it is suggested at least two types of navigation tools (Menu, Search engine) should be available to the learner and instructor. This study has shown that the Search engine has a significant effect on High Ability level students' achievement and the Menu format does not have a negative effect. This will afford the instructor a means of diversifying instruction to learners of varying ability levels in the same computer lab setting at the same time. Instructional design of educational software must consider a balance of Learner Control and level of Interactivity to best individualize and optimize instruction.

Grade 8 students were involved in this study. It would not be appropriate to generalize the results beyond the middle school age group. These subjects are a sample group from a predominately white middle socio-economic population. This population generally scores above average on stan-

dardized tests and there should be care taken in attempting to generalize to the general student population. Conclusions drawn from the three navigation tools within the treatments to the achievement and attitude scores of the subjects should be limited to the three ability levels as pre-determined by Language Arts standardized test scores. A simple set of directions that include the specific poetry elements to be learned was used to insure that the focus for all treatments would remain on the grade 8 English SOL.

Suggestion for Future Research

The findings of this study suggest three areas for further research. The areas and reasons for their consideraton will be discussed.

1. Future research into the design and use of various navigation tools to augment software instructional delivery for students of different ability levels is recommended. The linear tool had a negative effect on the achievement of high ability learners. The menu tool was preferred by all ability levels. Information that benefits instructional designers of software will be of practical value in the design of a differentiated learning environment.

2. It is recommended that in replicating this study, an instructional session to familiarize students with the navigation tools, be conducted prior to the experiment. This is because the Search engine tool in Treatment 3 was not as familiar to students as the Treatment 2 (Menu) tool and Treatment 1 (Linear) tool. In their atttitude survey, students indicated they did not feel this tool allowed them as much Learner Control or Interactivity as the Menu tool.

3. A careful collection and analysis of qualitative data of student's comments and behaviors including the path, sequence, and pacing while using different navigation tools may yield answers to exactly how much time students spend with each tool, what navigation path they follow and when difficulties occur, how they are resolved.

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Appendix A

Scripted Directions & Screen Directions

Appendix A

Scripted Directions & Screen Directions

Revised Scripted Instructions. Hello. I am Mrs. Farrell and as you may know I am working on a Doctorate degree at Virginia Tech in Instructional Technology. I am reading off this paper to make sure I tell everyone who participates in this project the exact same thing.

You are about to participate in a study on navigational tools. I am studying how different ways of navigation affect your learning. You will be using the browser Netscape Navigator. The three different tools are the button, menu and search engine. The material is poetry. You will learn about the sound effects in poetry. This is an important part of your 8th grade English curriculum. Your job will be to complete the short tutorial following the directions on the sheet I give you. Once we start, I will not be able to answer any questions concerning the content of this module or the navigational tools, so if you have any questions try to ask them now.

Pause for questions.

The directions and content you need to learn is on the study paper I have given you. The directions are also in the module. The important terms you need to learn and understand are listed on your handouts. Do you have any questions on the directions? I can help you with any technological problems we may have with the machines.

Are you familiar with Netscape Navigator?

Do you know how to use the Go item in the menu to return to a page?

The search engine will return more hits than you need. There are duplicates. Don't waste time. If the name is the same, the page is the same. In most instances the best pages for your terms are first.

Pause for any questions.

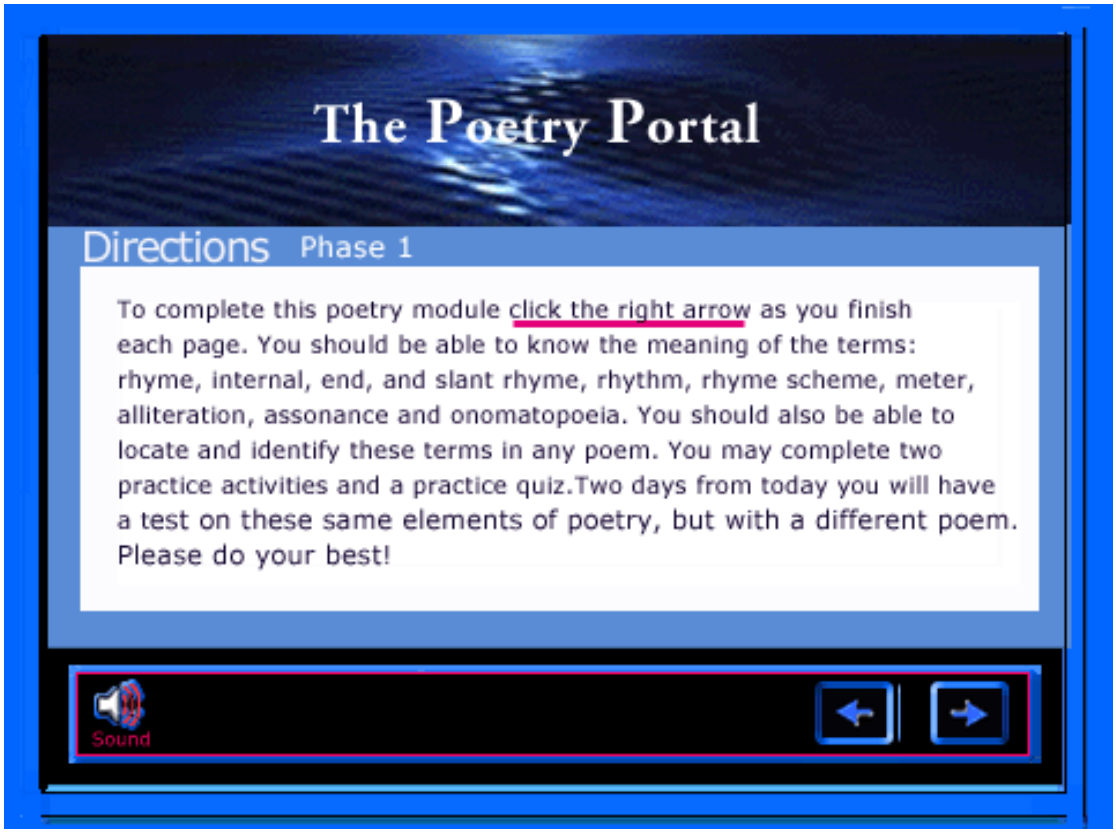
Are you comfortable with the scroll bar?

There are practice activities in the module. Do as many as you can but be aware that you have only forty-five minutes to finish the module and take the practice test.

I have noticed that for the sound to work in this lab you must wait a few seconds for the page to load and then scroll to the bottom of the page. Every page but the Practice test has sound.

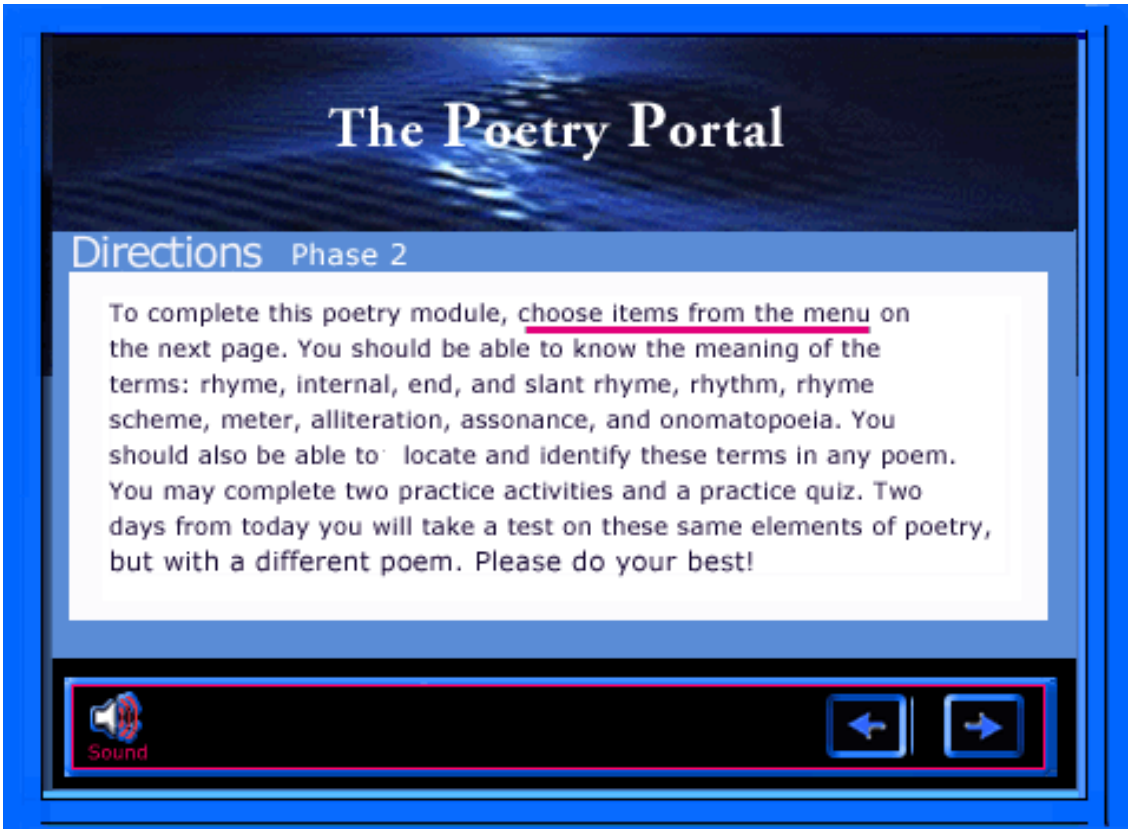
Please. It will be an enormous help to me if you write down on your paper any questions or problems you may have as you work through the tutorial. Any thing that comes to your mind is important information for me. I am trying to make this module as good as I can and you can help. Please remember to wear the headsets so your machine sound does not disturb others. You will have thirty-five minutes to go through the module. I will set this timer when we begin. As you work I will be observing and taking notes to help me improve this lesson. When the timer sounds I will ask you to complete the attitude survey included with your handouts. In two days I will give you a posttest on the material you have learned but a different poem will be used. Thank you so much for helping me.

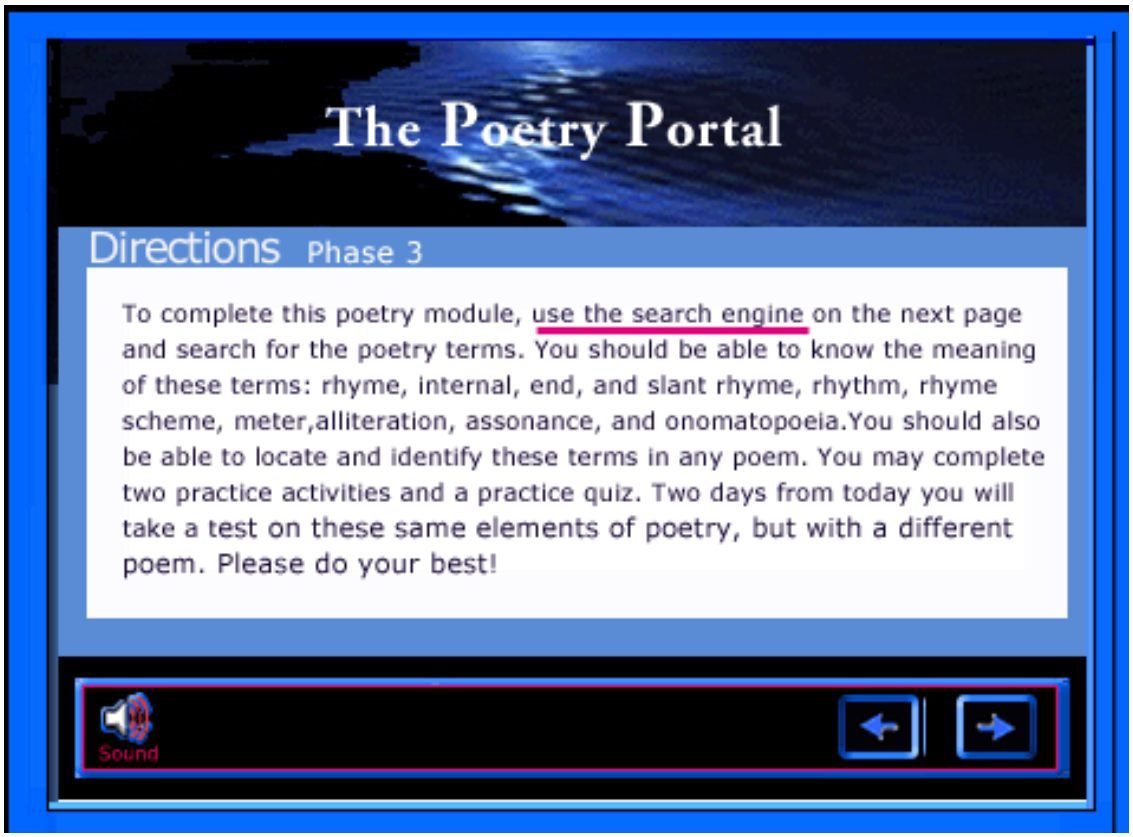
Directions for Phase 1, Phase2 and Phase3



Directions for Phase 1, Phase2 and Phase3

STUDY NOTES


The Poetry Portal
Directions Phase 2
To complete this poetry module, choose items from the menu on the next page. You should be able to know the meaning of the terms: rhyme, internal, end, and slant rhyme, rhythm, rhyme scheme, meter, alliteration, assonance, and onomatopoeia. You should also be able to locate and identify these terms in any poem. You may complete two practice activities and a practice quiz. Two days from today you will take a test on these same elements of poetry, but with a different poem. Please do your best!
Sound


The Poetry Portal
Directions Phase 3
To complete this poetry module, use the search engine on the next page and search for the poetry terms. You should be able to know the meaning of these terms: rhyme, internal, end, and slant rhyme, rhythm, rhyme scheme, meter,alliteration, assonance, and onomatopoeia.You should also be able to locate and identify these terms in any poem. You may complete two practice activities and a practice quiz. Two days from today you will take a test on these same elements of poetry, but with a different poem. Please do your best!
Sound

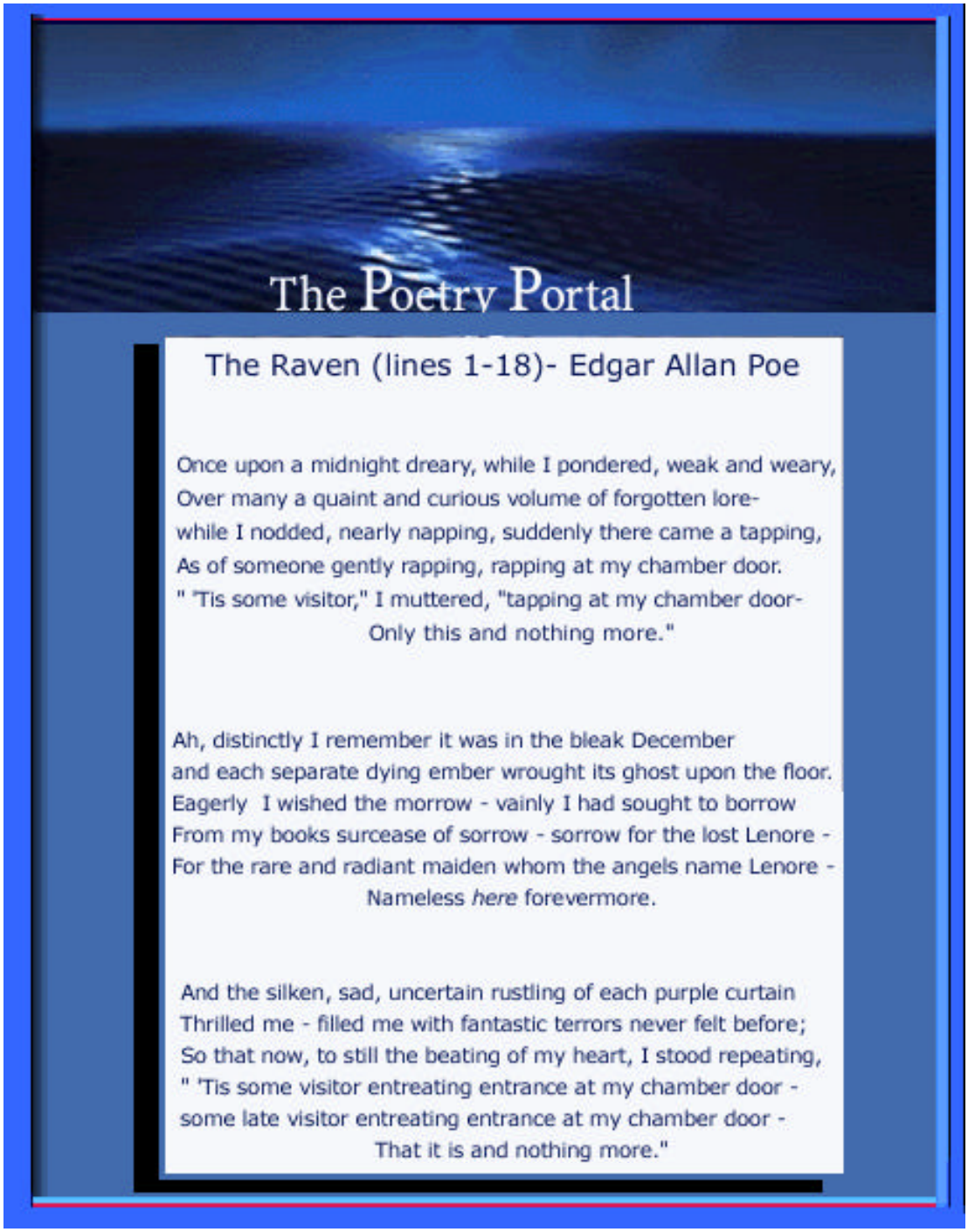
Opening Screen for all treatments

Appendix B

Navigation Tools Opening Screens

Appendix B.

Navigation Tools Opening Screens




Netscape: Memu_Phase2
Back
Forward
Reload
Home
Search
Netscape
Images
Print
Security
Stop
Go To:
£££££333<<<<<<<>>>>>ñññññññññ<<<<<33333333333
What's Related
WebMail
Contact
People
Yellow Pages
Download
Find Sites
The Poetry Portal
Menu
Poetic Devices
Alliteration
Assonance
Meter
Onomatopoeia
Refrain
Rhyme
Rhyme Scheme
Rhythm
Types of Rhyme
Poem
The Raven
Practice Material
Practice 1 - How Did I Do?
Practice 2 - How Did I Do?
Practice Test
Review

Search Engine

Use the form below to search for information in this web containing specific poetry terms. the terms you will be searching for are on your directions handout. They are: rhyme, internal, end and slant rhyme, rhyme scheme, rhythm, meter, alliteration, assonance and onomatopoeia. The text search engine will display a weighted list of matching documents, with **better matches shown first.** Each list item is a link to a matching document. You may find there are duplicates of items. If this occurs, move quickly to the next item you need. Once you find the information about the poetry terms that help you understand them you can take a practice test. You can also review the information with some interactive activities if you finish early. A brief explanation of the query language is available, along with examples.

Search for: Start Search Clear

Query Language

The text search engine allows queries to be formed from arbitrary Boolean expressions containing the keywords AND, OR and NOT, and grouped with parentheses. For example:

rhyme scheme
finds documents containing 'rhyme' or 'scheme'

rhyme or **scheme**
same as above

Appendix C

Measurements Posttest

Appendix C

Measurements Posttest

Achievement Test

Name Date

Age

Achievement Test "Sound Effects"

Using "Paul Revere's Ride (lines 1-30) –Henry Wadsworth Longfellow

Listen my children, and you shall hear
Of the midnight ride of Paul Revere,
On the eighteenth of April, in Seventy-five;
Hardly a man is now alive
Who remembers that famous day and year.

He said to his friend, "If the British march
By land or sea from the town tonight,
Hang a lantern aloft in the belfry arch
Of the North Church tower as a signal light-
One, if by land, and two, if by sea;
And I on the opposite shore will be,
Ready to ride and spread the alarm
Through every Middlesex village and farm,
For the country folk to be up and to arm."

Then he said, "good night!" and with muffled oar
Silently rowed to the Charlestown shore,
Just as the moon rose over the bay.
Where swinging wide at her moorings lay
The Somerset, British man-of-war;
A phantom ship, with each mast and spar
Across the moon like a prison bar,
And a huge black hulk, that was magnified
By its own reflection in the tide.

Meanwhile, his friend, through alley and street,
Wanders and watches with eager ears.
Till in the silence around him he hears
The muster of men at the barrack door,
The sound of arms, and the tramp of feet,

And the measured tread of the grenadiers.

30 Marching down to their boats on the shore.

Circle the letter that represents the best answer.

1. Rhythm can be defined as

   a. musical quality produced by the repetition of stressed and unstressed syllables and other sound patterns

   b. a noise created by background sounds

   c. lack of regular meter or rhyme scheme

   d. words that appeal to the sense of sound

2. Rhythm is produced in "Paul Revere's Ride" by all of the following except

   a. the use of a refrain

   b. end rhyme

   c. slant rhyme

   d. alliteration

3. The poem has a meter that gives the poem a galloping sound. Almost every line has

   a. seven beats

   b. four beats

   c. five beats

   d. nine beats

4. Rhyme can be defined as

   a. the repetition of the same word several times in the same line

   b. repeating accented vowel sounds and all sounds following them

   c. words whose sounds imitate there meanings

d. repeating stressed and unstressed syllables in a line

5. The most common form of rhyme used in "Paul Revere's Ride" is

   a. slant rhyme

   b. end rhyme

   c. approximate rhyme

   d. internal rhyme

6. The pattern of rhyme in a poem is called

   a. rhythm

   b. end rhyme

   c. rhyme scheme

   d. slant rhyme

7. End rhymes appear

   a. in the middle of lines

   b. at the end of lines

   c. at the end of a sentence

   d. at the end of the poem

8. Internal rhyme refers to rhymes that are found

   a. within one poem

   b. within lines

   c. at the end of lines

   d. within the same word

9. The rhyme scheme of "Paul Revere's Ride" changes in each of the first four stanzas. The rhyme scheme of the third stanza (lines 15-23) is

a. ababccddd

b. aabbaaacc

c. abbcabccc

d. aabbaaacc

10. Alliteration can be defined as the repetition of

a.words that imitate sounds

b. the repetition of a line or phrase in a poem

c. the combination of end rhyme and near rhyme in a poem

d. the repetition of similar sounds

11. Examples of alliteration from "Paul Revere's Ride" include all of the following except

a."By land or sea from the town tonight"

b."For the country folk to be up and to arm."

c."Ready to ride and spread the alarm"

d. "On the eighteenth of April, in Seventy-five;

12. Assonance can be defined as

a. sounds that imitate human or animal noises

b. repetition of a rhythmic pattern of stressed and unstressed syllables

c. the repetition of consonant sounds

d. the repetition of similar vowel sounds in several closely aligned words

13. An example of slant rhyme in "Paul Revere's Ride" is all of the following except

a.march, arch

b. war, spar

Kuder-Richardson 21 (KR21) performed on Achievement Posttest for reliability

The following formula was applied to the data:

Appendix D

Attitude Surveyk (Numberof test items) =20

X (Mean of scores) = 10.61

σ^2 = 10.37

Using the above formula and data an alpha (α = .547) was calculated for the achievement posttest. Nunnally (1978) (as cited inPedhazur and Schmelkin, 1991) states: "In the early stages of research on predictor tests or hypothesized measures of construct, one saves time and energy by working with instruments that have only modest reliability, for which purpose reliabilities of .60 or .50 will sufice"(p 109).

Appendix D

Attitude Survey

Attitude Assessment

Directions: Indicate the extent to which you agree or disagree with each statement by circling the appropriate letter to the right of each statement.

Name

Phase#

Date

	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. This web site helped me understand poetry better.	SA	A	U	D	SD
2. I usually get lost on the Internet (web).	SA	A	U	D	SD
3. I was able to choose what I wanted to learn about poetry.	SA	A	U	D	SD
4. Learning about poetry can be interesting.	SA	A	U	D	SD
5. When I work on a computer I like to be in control.	SA	A	U	D	SD
6. Learning with a computer is more interesting than sitting in class.	SA	A	U	D	SD
7. I tried hard to learn about poetry.	SA	A	U	D	SD
8. I always knew where I was supposed to go in the Poetry Portal module.	SA	A	U	D	SD
9. I had control over accessing the poetry information in this website.	SA	A	U	D	SD
10. I believe I will do well on my poetry test.	SA	A	U	D	SD
11. I interacted with this website a lot to learn about poetry.	SA	A	U	D	SD
12. I could tell where I had been in this Poetry Portal module.	SA	A	U	D	SD
13. I would like to learn more about poetry.	SA	A	U	D	SD
14. Listening to the poetry was helpful.	SA	A	U	D	SD
15. I like choosing how I learn about poetry.	SA	A	U	D	SD
16. I would like to visit other poetry sites on the Internet.	SA	A	U	D	SD
17. I never felt lost in my Poetry Portal site.	SA	A	U	D	SD
18. I was motivated to explore all the information about poetry on this website.	SA	A	U	D	SD
19. I had control over what I learned about poetry in the Poetry Portal computer program (website)	SA	A	U	D	SD
20. I was able to control how I wanted to learn about poetry.	SA	A	U	D	SD

21. I like to be able to choose the order in which I learn about poetry.	SA	A	U	D	SD
22. When I make an error or get something right, the computer lets me know.	SA	A	U	D	SD
23. I have a better understanding of poetry after this activity.	SA	A	U	D	SD
24. I knew how to use all the tools that where available on this site.	SA	A	U	D	SD
25. I interacted with the website to complete my study guide.	SA	A	U	D	SD

Appendix E

Permission Forms and Communications

Appendix E

Permission Forms

VIRGINIA POLITECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Participants of Dissertaion Projects

Title of Project Navigation Tools' Effect on Learners' Achievement and Attitude

Investigator **Inez Farrell,**

I. The purpose of this Research/Project

The purpose of the study is to examine how navigation as a tool that controls and directs the amount of interactivity may contribute to a perception of learner control that improves achievement and attitude.

II. Procedures

A poetry module titled Poetry Portal has been constructed to deliver poetry instruction with three different navigation tools, varying the degree of learner control and simulating a web environment.

III. Risks

The instructional experience is not designed to cause any risks or discomforts. If at any point you begin to feel uncomfortable you may leave the study and return to regular English class.

IV. Benefits of this Project

I cannot promise you any personal benefits, but you will be studying the curriculum you need to master in eighth grade English and the achievement tests do follow the SOL format of questioning. All the material is geared to the SOL's you are responsible for in poetry by the end of the eighth grade. The results of your achievement tests may provide insight into the type of instructional delivery from which you most benefit.

V. Extent of Anonymity and Confidentiality

I will refer to you in notes and transcripts as a number within a group number. Nothing I might write based on this data will attribute scores or statements to you or any of

the other participants by name. After the completion of our instructional experiences, I will store the data in a secure location where no one but myself will have access, and I will erase or destroy all data when the project ends. You should be aware, however, that my use of a number does not necessarily guarantee you anonymity.

VI. Compensation

Other than my sincere appreciation, and any learning or computer skills you may accrue, there is no compensation for participation in this project.

VII. Freedom to withdraw

You can stop your participation in this study at any time by telling me that you don't want to continue. If you have any questions about the conduct of the research you may contact any of the individuals listed at the end of this form.

VIII. Approval of Research

This research project has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University, by the Department of Teaching and Learning.

IX. Your Permission

I have read and understand the Informed Consent and condition of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project. I have been offered a copy of this form to keep.

If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project.

Signature Date

Should I have any questions about this research or its conduct, I may contact:

Inez Farrell 389-6034

Investigator Phone

Mike Moore, 231-5587

Sue Magliaro, 231-8338,

H. T. Hurd 231-5281

VIRGINIA POLITECHNIC INSTITUTE AND STATE UNIVERSITY

Informed Consent for Parents of Students to be Involved in Dissertation Projects

Title of Project Navigation Tools' Effect on Learners' Achievement and Attitude

Investigator **Inez Farrell**

I. The purpose of this Research/Project

The purpose of the study is to examine how navigation as a tool that controls and directs the amount of interactivity may contribute to a perception of learner control that improves achievement and attitude.

II. Procedures

We would like your permission to ask your child to participate in a study that will engage him or her in one of three different instructional experiences involving the English curriculum requirements for poetry. The instruction will take place in the computer lab on two separate occasions and will be based on the poetry SOL's from 6th-8th grade. An achievement assessment will be given along with an attitude questionnaire for the purpose of determining what navigational functions increase achievement and improve attitude.

III. Risks

The study will deal with varying the navigation tool within computer based instruction. None of the scores or other data collected will be reported back to the teachers or administrators of the school your child attends in a way that would identify your child.

IV. Benefits of this Project

I cannot promise you any personal benefits, but the findings of this study may provide insight into the ways the use of the computer to aid in the delivery of instruction may be improved for the benefit of the individual learner.

V. Extent of Anonymity and Confidentiality

I will refer to your child in notes and other written reports with a group number. Nothing I might write based on this data will attribute quotations or statements to your child or any of the other participants by name. After I complete my study I will store the data in a secure location where no one but myself will have access.

VI. Compensation

Other than my sincere appreciation, there is no compensation for participation in this project, although the content covered is required material for eighth grade students on their SOL English test.

VII. Freedom to withdraw

Your agreement does not commit your child to participate. It merely allows me to ask them if they would like to be a part of the study. You child can refuse to participate without penalty. If your child does agree to participate he or she can stop participating at any time by telling me that he or she doesn't want to continue. Your child may then return to his or her regular English class in session. I will make it clear to your child that the results of his or her achievement tests has no impact on a class grade. If you or your child have any questions about the conduct of the research you may contact any of the individuals listed at the end of this form.

VIII. Approval of Research

This research project has been approved, as required, by the Institutional Review Board for Research Involving Human Subjects at Virginia Polytechnic Institute and State University, by the Department of Teaching and Learning.

IX. Permission

I have read and understand the Informed Consent and condition of this project. I have had all my questions answered. I hereby acknowledge the above and give my voluntary consent for participation in this project.

If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project.

Signature Date

Should I have any questions about this research or its conduct, I may contact:

Investigator	Phone
Inez Farrell	389-6034

Inez Farrell
430 Moses Lane
Salem, VA 24153
November 9, 1999

Permissions Department
Penguin Putnam
375 Hudson St
Ny, NY 10014

To Whom It May Concern:

I am writing in regards to gaining copyright permission where needed for material used in the development of my dissertation project. I am a middle school teacher in Salem, Virginia currently on leave to obtain my doctorate in Instructional Technology. My project involves the different tools of navigation and their impact on student achievement and attitude in a hypermedia/web environment. I have created a poetry module to test the navigation tools and at the same time give the students the content they are required to master for the state SOL tests at the end of their eighth grade year. I am using The Elements of Literature, Annotated Teacher's Edition, Second Course, ISBN 0-03-075934-X, as a general resource since this is the text used by the school system in which I teach and where I will conduct my study.

Within this text is the poem "Crossing" by Philip Booth with the following copyright credit: Viking Penguin, a division of Penguin Books USA Inc.: "Crossing": from *Letter from a Distant Land* by Philip Booth. Copyright 1953 by Philip Booth. I would like permission to specifically quote in less than 150 words "Crossing" by Phillip Booth (p.378 within this text) in both written and audio format. This poem is used as an example of the sound effects of poetry with the focus on the rhythm and rhyme.

This project involves the creation of a hybrid CD-ROM that can access information both on the CD and off the Internet. This work is to be used for no other purpose than to test my dissertation hypotheses, but when I return to the classroom I would like permission to use the CD as a tutorial with my students. There is to be no monetary gain from the use of these poems. May I have your permission?
Sincerely,

Inez H. Farrell
Doctoral Candidate
Virginia Polytechnic Institute & State University

September 23, 1999

HRWS REF: FARRELL/

Ms. Inez H. Farrell
430 Moses Lane
Salem VA 24153

Dear Ms. Farrell:

In response to your 08/30/1999 letter, we are willing to grant permission for the reprinting of "The Raven" (except page 348) and "Paul Revere's Ride" from ELEMENTS OF LITERATURE, Annotated Teacher's Edition, Second Course by Robert Anderson, John M. Brinnin and John Leggett (Request ID Num: 123253) in your forthcoming dissertation, provided it includes the title page and copyright page of our work (or equivalent information which includes: title, author(s) and/or editor(s), copyright (C) year and claimant(s), reprinted by permission of the publisher).

We are also willing to grant permission for your thesis to be reproduced and distributed in 50 copies only, by University Microfilms, provided you give complete credit to the source. If your dissertation is committed for publication, we ask that you reapply.

Our permission does not cover electronic use, including scanning, unless otherwise noted herein. "Crossing" (pages 378-379) and page 348 are reproduced in our volume by permission of other sources. Please apply directly to the acknowledged sources.

Sincerely,

Rachel McGee
Paralegal II
Holt, Rinehart and Winston
Permissions Dept., 6th Floor
Orlando, FL 32887-6777
(407) 345-3980

Date: Thu, 30 Sep 1999 09:13:46 -0400

From: Jan Nespor <nespor@vt.edu>

Subject: Re: Permissions-both for study and Website

X-Sender: nespor@mail.vt.edu

To: Inez Farrell <ifarrell@vt.edu>

Inez,

I'm sorry, but for the IRB I'll also need a copy of the School Board/School Administration letter giving you permission to do the study (I hope they gave you something in writing, if not, I need a letter from you explaining who agreed and what they agreed to). This shouldn't hold you up for Tuesday, but do get it to me asap.

jan

Date: Wed, 29 Sep 1999 11:09:48 -0500

From: Lew Romano <lromano@salem.k12.va.us>

Subject: Re: Project Proposal

To: Inez Farrell <ifarrell@vt.edu>

Cc: wtripp@salem.k12.va.us, jcampbell@salem.k12.va.us

Organization: Salem City Schools

Inez, I have reviewed your proposal and you may proceed as proposed. I have discussed the design and it's implementation with Mr. Campbell and it does not appear to be time intensive nor a burden upon instructional time in that it is SOL related. Please provide a copy of your results and findings to my attention in addition to ensuring the confidentiality of our students during the implementation of this study. Lewis Romano

Date: Mon, 04 Oct 1999 10:01:17 -0400
From: Jan Nespor <nespor@vt.edu>
Subject: Re: Permissions-both for study and Website
X-Sender: nespor@mail.vt.edu
To: Inez Farrell <ifarrell@vt.edu>

Sorry Inez, I thought I responded -- I've sent along the email from Romano, so your materials are moving through channels now and should be approved with no problem.

Could you show me the exact wording you would use on these postcards?

Jan

Hello Dr. Nespor,

Here is the postcard info: I have read the "Informed Consent for Parents of Students in Dissertation Projects" from the Virginia Politechnic Institute and State University regarding the dissertation project to be conducted by Inez Farrell and give my signed permission for my child to participate if he or she so wishes. I understand that my child may withdraw from the project at any time without penalty. I also understand that my child must also agree to be a part of the study and my agreement does not commit my child to participate.

_____ _____

Parent Signature Date

Anything else you think I should add? I also noticed I had left some of the consent info from Qualitative class on the consent form (Informed Consent for Parents of Students to be Interviewed) and I have changed it to read " Informed Consent for Parents of Students in Dissertation Projects".

Hi Dr. Nespor,

Thank you. As it turns out after my meeting today with the English teachers (they would make a formidable dissertation committee) I will not need the postcards. They said they would rather be in charge of sending home the permission forms and getting them back. They think they will have better luck in getting it done faster and more efficiently. I am on my way now to get the 600 copies (two per parent, so they have one to keep).

Inez

Appendixes F -M

Tables for Two-way ANOVAs and One-way ANOVAs

Appendix F.

Two- way ANOVA of Achievement by Treatment for Ability Levels

Between Levels - Treatment Effects

Source	Sum of Squares	df	Mean Square	F	Sig.
Main Effects	562.72	4	140.68	20.57	.000
Treatment	15.31	2	7.65	1.12	.330
Level	549.50	2	274.75	40.18	.000
2-Way Interactions	33.19	4	8.30	1.21	.308
Explained	595.92	8	74.49	10.89	.000
Residual	936.83	137	6.84		
Total	1532.75	145	10.57		

Appendix G,

One-Way ANOVA for Ability Level Low Achievement by Treatment

Between Levels - Treatment Effects

Source	Sum of Squares	df	Mean	F	Sig.
Between Groups	3.10	2	1.55	.28	.75
Within Groups	223.70	41	5.46		
Total	226.80	43			

Appendix H.

One-Way ANOVA for Ability Level Middle Achievement by Treatment

Between Levels - Treatment Effects

Source	Sum of Squares	df	Mean	F	Sig.
Between Groups	.722	2	.36	.04	.95
Within Groups	371.89	43	8.65		
Total	372.61	45			

Appendix I.

One-Way ANOVA on Level High 3 by Treatment

Between Treatment Groups - Treatment Effect

Source	Sum of Squares	df	MS	F	Sig
Between Groups	44.680	2	22.33	3.47	.038
Within Groups	341.250	53	6.450		
Total	385.930	55			

Appendix J.

Two - way ANOVA of Attitude by Treatment for all Ability Levels

Main Effects - Attitude by Treatment

Source	Sum of Squares	df	Mean Square	F	Sig.
Main Effects	1695.590	4	423.897	3.995	.004
Treatment	1581.331	2	790.666	7.452	.001
Level	100.168	2	50.084	.472	.625
	188.131	4	47.033	.443	.777
Explained	18883.721	8	235.465	2.219	.030
Total	16420.445	145	113.244		

Note. N = 146

Appendix K .

One-Way ANOVA for Ability Level Middle Attitude by Treatment

Between Levels - Treatment Effects

Source	Sum of Squares	df	Mean	F	Sig.
Between Groups	413.87	2	206.93	1.77	.182
Within Groups	5025.96	43	116.88		
Total	5439.83	45			

Appendix L.

One-Way ANOVA for Ability Level High Attitude by Treatment

Between Levels - Treatment Effects

Source	Sum of Squares	df	Mean	F	Sig.
Between Groups	292.93	2	146.46	1.57	.218
Within Groups	4943.	53	93.26		
Total	5235.93	55			

Appendix M.

One-Way ANOVA for Ability Level Low Attitude by Treatment

Between Levels - Treatment Effects

Source	Sum of Squares	df	Mean	F	Sig.
Between Groups	1062.67	2	531.33	4.77	.014
Within Groups	4567.77	41	111.41		
Total	5630.43	43			

Appendix N

Descriptive Statistics for Attitude Statement Ordered by Treatment by Levels

Appendix N

Attitude Statement Related to Learner Control with Means by Treatments

Question	Level	M	SD	Treatment
3. I was able to choose what I	Low	4.27	.80	3
wanted to learn about poetry	Mid	4.07	1.07	3
	High	4	.86	3
	Low	4.33	.72	2
	Mid	4.2	.68	2
	High	4.38	.50	2
	Low	3.79	.89	1
	Mid	3.59	.94	1
	High	3.7	.86	1
5. When I work on a computer	Low	4.27	.88	3
I like to be in control.	Mid	4.64	.63	3
	High	4.45	.60	3
	Low	4.87	.35	2
	Mid	4.8	.41	2
	High	4.25	.68	2
	Low	4.21	1.05	1
	Mid	4.65	.61	1
	High	4.7	.73	1
9. I had control over accessing	Low	3.87	1.06	3
the poetry information in this	Mid	3.79	.97	3
website.	High	3.85	.88	3
	Low	4	.93	2
	Mid	4.07	.59	2
	High	4.13	.50	2

Question	Level	M	SD	Treatment
9. iI had control over accessomg	Low	4	.65	1
the poetry information in this	Mid	3.71	.92	1
website.	High	4	.92	1
15. I like choosing how	Low	3.6	.83	3
I learn about poetry.	Mid	4.43	.65	3
	High	4.25	.79	3
	Low	4.6	.51	2
	Mid	4.33	.72	2
	High	4.63	.50	2
	Low	4.07	.92	1
	Mid	4.35	.79	1
	High	4.1	.85	1
19. I had control over what	Low	3.93	.96	3
I learned about poetry in the	Mid	3.92	.82	3
Poetry Portal computer program	High	3.9	.55	3
(website).	Low	4.4	.74	2
	Mid	4.13	.64	2
	High	4.19	.75	2
	Low	3.86	.86	1
	Mid	3.94	1.03	1
	High	3.95	1.00	1
20. I was able to control how	Low	3.93	1.03	3
I wanted to learn about poetry	Mid	4	.68	3
	High	3.95	.69	3
	Low	4.27	.70	2
	Mid	4.33	.62	2
	High	4.19	.75	2

Question	Level	M	SD	Treatment
20. I was able to control how	Low	4.14	.77	1
I wanted to learn about poetry	Mid	4.12	.93	1
	High	3.8	.77	1
21. I like to be able to choose	Low	4.27	.70	3
the order in which I learn	Mid	4.07	.62	3
about poetry.	High	4.2	.70	3
	Low	4.4	.74	2
	Mid	4.53	.52	2
	High	4.31	.48	2
	Low	3.57	.94	1
	Mid	4.35	.93	1
	High	4.2	.62	1

Attitude Statements Related to Navigation Grouped by Treatment

Question	Level	M	SD	Treatment
2. I usually get lost on the	Low	3.3	1.40	3
Internet (web)(Negative	Mid	3.36	1.34	3
item).	High	3.95	1.05	3
	Low	4.13	1.06	2
	Mid	3.87	1.25	2
	High	3.88	.89	2
	Low	3.07	1.33	1
	Mid	3.41	1.06	1
	High	4	1.12	1
8. I always knew where I	Low	3	1.06	3
was supposed to go in the	Mid	3.21	1.31	3
Poetry Portal moduel.	High	2.8	.89	3

Attitude Statements Related to Navigation Grouped by Treatment

Question	Level	M	SD	Treatment
8. I always knew where I	Low	3.53	.99	2
was supposed to go in the	Mid	3.27	.80	2
Poetry Portal moduel.	High	3	1.32	2
	Low	3.07	1.14	1
	Mid	3.47	.87	1
	High	4.1	.91	1
12. I could tell where I had	Low	3.06	1.22	3
been in this Poetry Portal	Mid	4	.67	3
module.	High	3.58	1.12	3
	Low	4.2	.56	2
	Mid	3.93	.80	2
	High	4.18	.81	2
	Low	3.71	.61	1
	Mid	4	.79	1
	High	4.1	.85	1
17. I never felt lost in	Low	3.06	1.33	3
my Poetry Portal module.	Mid	3.5	1.28	3
	High	3.2	1.28	3
	Low	3.8	1.21	2
	Mid	3.8	.86	2
	High	3.38	.96	2
	Low	3.21	1.05	1
	Mid	4	1.12	1
	High	3.6	1.31	1

Attitude Statements Related to Interactivy Grouped by Treatment

11. I interacted with this	Low	3.73	1.03	3
website a lot to learn about	Mid	3.78	.42	3
poetry.	High	3.7	.86	3
	Low	4	.93	2
	Mid	4	.85	2
	High	3.88	.81	2
	Low	3.71	.99	1
	Mid	3.88	.60	1
	High	3.95	.60	1
18. I was motivated to explore	Low	3.0	1.05	3
all the information about poetry	Mid	3,78	.80	3
on this website.	High	3.7	.86	3
	Low	4.2	.56	2
	Mid	4.33	.62	2
	High	3.75	.58	2
	Low	3.93	.73	1
	Mid	4.06	.75	1
	High	3.75	.85	1
22. When I make an error or get	Low	4.33	.62	3
something right, the computer	Mid	4.21	.70	3
lets me know.	High	4.05	.69	3
	Low	4.27	.59	2
	Mid	3.93	.96	2
	High	4.25	1.00	2
	Low	3.71	1.05	1
	Mid	4	1.12	1
	High	4.1	.85	1

Attitude Statements Related to Interactivy Grouped by Treatment

Question	Level	M	SD	Treatment
25. I interacted with the	Low	3.67	.82	3
website to complete my	Mid	4.07	.62	3
study guide.	High	3.7	1.03	3
	Low	4.25	.58	2
	Mid	4.47	.52	2
	High	4.25	.58	2
	Low	4	.68	1
	Mid	4	.71	1
	High	4.05	.69	1

N=146. The scale for these items was: 5= strongly agree, 4 = Agree, 3 = Uncertain, 2 = Disagree, 1 = Strongly Disagree, except for item # 2, which was a negatively coded item.

Appendix O

Two-way ANOVA of Learner Control Group by Treatment

Main Effects -Learner Control by Treatments

Source	Sum of Squares	df	Mean Square	F	Sig.
Main Effects	132.89	4	33.22	2.79	.03
Ability	4.85	2	2.43	.20	.82
Treatments	128.12	2	64.06	5.38	.00
2-way Inter	14.13	4	3.53	.29	.88
Explained	147.02	8	18.38	1.54	.15
Total	1778.45	145	12.27		

Appendix P

Two-way ANOVA of Navigation Group by Treatment

Main Effects - Navigation by Treatments

Source	Sum of Squares	df	Mean Square	F	Sig.
Main Effects	82.97	4	20.74	2.97	.022
Treatment	57.85	2	28.93	4.14	.018
Level	23.853	2	11.93	1.70	.185
Explained	153.04	8	19.13	2.74	.008
Total	1110.96	145	7.66		

Appendix Q

Two-way ANOVA of Interactivity Group by Treatment

Main Effects - Interactivity by Treatments

Source	Sum of Squares	df	Mean Square	F	Sig.
Main Effects	41.33	4	10.33	2.34	.058
Treatment	32.51	2	16.25	3.68	.028
Level	3.84	4	.96	.22	.93
Explained	45.168	8	5.65	1.28	.26
Total	649.78	145	4.48		