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Audio Narration and Reading Ability in Programmed Instruction

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IN PROGRAMMED INSTRUCTION

by

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This study compared the effects of audio, textual, and audio-textual narration in a programmed instructional module on the performance of individuals with different reading abilities. One hundred eighty-four college students were randomly assigned to audio, textual, or audio-narration. Dependent variables were posttest score and instruction completion time. An ANCOVA was used to analyze the results, with ACT reading test scores as the covariate. No differences were found between the groups on posttest scores ($p = .56$) or completion time ($p = .90$), and there was no interaction between narration type and reading score for either dependent variable. Audio narration did not benefit learning in this study. Its benefits may be limited to instruction in which narrative and visual components cannot be understood in isolation, and when visual components do not require a great deal of searching.

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Wendy Jaehnig

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INTRODUCTION

The Need for Instructional Research

In 1983, the National Commission on Excellence in Education (NCEE), an organization appointed by then Secretary of Education Terrel M. Bell (Peterson, 2003), published a report called *A Nation at Risk*. The report described a failing American educational system of unqualified instructors, underperforming schools, and underachieving students, which compared unfavorably to the educational systems of other industrialized nations. The commission warned that our educational system was "being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people" (NCEE, 1983, p. 113).

The NCEE (1983) recommended reform for all schools in five major areas: (a) Content, (b) Standards and Expectations, (c) Time, (d) Teaching, and (e) Leadership and Fiscal Support. Content recommendations included curriculum requirements that ensure that students get a core of education in the new basics: English, mathematics, social studies, and computer science. Standards and Expectations recommendations were to implement higher, more measurable academic standards. Time recommendations were to devote more hours to teaching students the new basics. Teaching recommendations included higher educational standards and increased pay for instructors. Finally, Leadership and Fiscal Support recommendations were that citizens hold educators and politicians responsible for achieving the reforms and provide financial support.

Twenty years following *A Nation at Risk*, our educational system is still struggling. "U.S. education outcomes, measured in many ways, show little improvement since 1970" (Peterson, 2003, p. 11). Why has there been so little progress in education since the report? One potential reason is that the report failed to address a major area of change: using instructional techniques that have been empirically validated as effective.

Changing content and increasing standards and school time will have little impact if classes are not taught in an effective manner. Likewise, increasing educational standards for instructors and schools does not guarantee that teachers can effectively produce learning. It is vital that students are taught with empirically-validated methods of instruction.

In 2001, Congress passed the *No Child Left Behind Act* to address academic achievement gaps (Kozberg, 2001). One thing emphasized by this act, unlike the report of the NCEE, was implementing educational programs that have been empirically demonstrated to be effective. Thus, it is now a particularly appropriate time to examine factors that influence the effectiveness of instruction.

Addressing the Limitations of the Traditional Classroom

Behavioral research has established principles of learning in both laboratory and applied settings that can be applied to the design of instruction. Unfortunately, due to the limitations of the traditional classroom arrangement, the educational practices employed by most schools do not embrace these principles.

In the traditional arrangement, a single instructor lectures to numerous students. Typically the instructor does most of the speaking and there is limited active responding by the students. In addition, there is a great deal of time between when students make responses on papers and tests and when they receive information on the correctness of those responses (Skinner, 1968). Thus, if information about an answer being correct functions as a reinforcer, its delivery is too delayed to reinforce making the correct response. Also, by the time learners receive feedback on their response, they may have moved on to a different topic, and do not benefit from the feedback. Another limitation is that students all progress through the materials at the same rate, regardless of their abilities (Skinner, 1983). Thus, some students are presented with information they are not ready for yet, while others are progressing at a much slower pace than is necessary.

One approach to addressing the limitations of the traditional classroom is to use an automated teaching device. Before computers entered the mainstream, several people created such devices. In 1936, Mellan reported that over 600 automated teaching devices were registered with the U.S. Patent Office, beginning as early as 1809. Most of these devices failed to gain popularity.

In 1923, Sidney Pressey invented a device that presented learners with multiple-choice questions (Skinner, 1986). If learners made the correct response, they were presented with the next question. If they made an incorrect response, they pressed another key to continue. After answering all the questions, the device presented only those questions that were answered incorrectly. Pressey (1950) reported that the device produced performance gains when compared to traditional quizzes. However, Pressey's device tested previously-acquired behavioral repertoires, rather than shaping new behaviors (Vargas & Vargas, 1996).

B. F. Skinner (1968), unaware of Pressey's device at the time, sought to address the limitations of the standard classroom arrangement with his teaching machine. Unlike an instructor teaching a classroom full of students, the teaching machine could require active responding from individual students, give students immediate feedback on their responses, and allow students to progress at their own rates.

Skinner's first teaching machines provided "drill and practice" of concepts that had already been presented (Vargas & Vargas, 1996). However, his later versions of teaching machines were designed to shape new behaviors. Programmed instruction was born out of these later versions of teaching machines.

Computers can now function as the new teaching machines. Advances in computer technology allow instructional designers to use techniques that were not possible or practical with the original teaching machine, such as the addition of audio, graphics, or video. However, such effects should not be added just because they're available. The efficacy of such effects needs to be investigated. This study sought to do that. Specifically, it investigated the effect of audio narration on learning in programmed instruction.

In the remainder of this chapter, I will (a) describe the major characteristics of modern programmed instruction, (b) describe computer-based instruction and e-learning, and (c) summarize the audio narration literature.

Characteristics of Programmed Instruction

Learning occurs through behavioral contingencies made up of three components: (a) antecedent stimuli that evoke a response, (b) the response, and (c) consequences of the response (Skinner, 1968). Skinner described teaching as the advantageous arrangement of these contingencies. Programmed instruction is made up of behavioral contingencies arranged in a logical sequence, and typically employs the following principles: (a) active, meaningful response requests, (b) immediate feedback, (c) stimulus fading, (d) logical sequencing, and (e) testing and revision. These principles are described next.

Active, Meaningful Response Requests

Meaningful

Programmed instruction generally requires the learner to make active, overt responses in the presence of antecedent stimuli. However, not just any active response will do. Markle (1990) maintained that the response must also be *meaningful*. A meaningful response uses the behavioral repertoire that the instruction is designed to teach.

For example, consider the frame in Figures 1 and 2, intended to teach learners how to correctly format attributes in HTML tags. In the Figure 1 frame, the learner can make the correct response of "attributes" without responding to or comprehending the majority of the instructional text. The learner can simply copy the underlined word. Thus, this response request requires, at most, a duplic (Skinner, 1957) response. The repertoire meant to be taught—correctly formatting attributes in HTML tags—is not required to make a correct response. Hence, this response request is not meaningful. However, the response request in Figure 2 requires the learners to respond to all the stimuli presented and to use the targeted behavioral repertoire to make a correct response. Thus, this is a meaningful response request.

<u>Attributes</u> are written after the main command with a space between them.

A command can have more than one attribute. Put a space between multiple attributes.

In the tag <FONT FACE SIZE>, FACE and SIZE are examples of ______________s.

Figure 1. Frame with non-meaningful response request.

<u>Attributes</u> are written after the main command with a space between them.

A command can have more than one attribute. Put a space between multiple attributes.

Write the tag for the command FONT, using FACE and SIZE as attributes: ____________

Figure 2. Frame with meaningful response request.

Holland and Kemp (1965) created a measure known as the blackout ratio to determine the effectiveness of a module of programmed instruction. Previously-developed instructional programs are tested with new learners with varying amounts of text eliminated. The proportion of the total words that can be removed without affecting the program's error rate is known as the blackout ratio. If a program contains many non-meaningful response requests, that program will have a high blackout ratio. For instance, in the frame with a non-meaningful response request, the learner can make a correct answer even when the majority of the text has been blacked out (see Figure 3).

<u>Attributes</u> are written after the main command [redacted]

In the tag <FONT FACE SIZE>, FACE and SIZE are examples of ____________s.

Figure 3. Blackout on frame with non-meaningful response request.

Active

There have been several studies examining the importance of active, overt responding in programmed instruction. Overt responding has been compared to covert responding, in which the learner is asked to "think" of the answer, rather than write or select it. It has also been compared to "passive" responding, in which the answer is already filled in and the learner simply reads it. Covert responding can still be active. However, covert behavior is not directly observable by anyone but the behaver. Thus, the instructional designer cannot be sure that the response has occurred. Overt responding does not have this limitation.

The studies have had mixed results. In 1967, Anderson examined nine different studies and found no difference in the effect of response mode on learning. However, Tudor and Bostow (1991) found that overt and covert responding produced similar effects on learning, and both were superior to passive responding. Other studies have also found overt responding produced more learning than passive responding (Miller & Malott, 1997, in press; Tudor, 1995).

The reason for the discrepancy may be related to the adequacy of the instruction. Kemp and Holland (1966) got blackout ratios for the first 50 frames of 12 modules of instruction that were used in previous covert responding research. The four programs used in studies showing that overt response requirements were superior had the lowest blackout ratios, ranging from 11.1% to 25.4%. The eight programs used in studies that showed no advantage of overt responding had the highest blackout ratios, ranging from 31% to 74.6%. This suggests that studies may have failed to find an advantage of overt responding due to the use of ineffective instructional modules.

The form of the response request used varies by the instructional designer. Some, such as Skinner, used only construction response requests, in which the learner is asked to compose a response, rather than select alternatives. Skinner (1968) recommended using construction response requests exclusively because (1) the learner needs to be able to make the response, not just recognize that it is correct, and (2) the inclusion of incorrect options in a multiple-choice arrangement may strengthen incorrect responses. However, Markle (1990) suggested that the appropriate form of the response request should depend on the terminal behavior of interest. For example, if the instruction is designed to teach learners to discriminate between music from different classical composers, multiple-choice will be sufficient, and more efficient. Types of response requests are not limited to construction and multiple-choice questions, however. They can involve more complicated responses. For example, the module of instruction that was used in this investigation requires learners to open, close, and save computer files.

Covert Responding

Requiring overt responding is practical because it is observable by the instructor. However, that is not the only behavior of interest. When a person viewing instruction is "learning," that person is engaging in a variety of covert verbal behavior that is comparable to overt verbal behavior.

For example, when answering questions, the learner is making overt intraverbal and duplic responses; the feedback, or the person who previously programmed the feedback, functions as a listener. For instance, in the response request shown in Figure 1, the learner correctly responds with <FONT FACE SIZE> and receives feedback accordingly. The learner's inclusion of the brackets and the placement of components within the tag are intraverbal responses evoked by stimuli such as "tag," "command," and "attribute." The inclusion of "FONT," "FACE," and "SIZE" are duplic responses evoked by the textual stimuli with point-to-point correspondence. The feedback may function as a reinforcer for the correct response.

However, the instructional content also evokes a great deal of *covert* verbal behavior. For example, the learner who reads the phrase "Attributes are written after the main command with a space between them" may engage in covert codic or duplic behavior, such as privately repeating or visualizing the phrase. In addition, the learner may engage in intraverbal behavior, such as covertly saying "after command" when viewing the word "attribute," or "before attribute" when viewing the word "command."

In such cases, the learner is acting as both the speaker and the listener. The covert stimuli associated with the learner "understanding" the instruction function as a conditioned reinforcer, as a result of having been paired with other reinforcers through educational reinforcement. For example, the learner probably has a history in which making the appropriate verbal response in the presence of a stimulus, such as saying "apple" or "red" when viewing the word "apple," was positively or negatively reinforced by parents and teachers. As a result, the stimuli associated with making the correct response, such as the point-to-point correspondence between the stimulus and the response-product for codic and duplic behaviors, come to function as conditioned reinforcers. Covert intraverbal behavior can occur because it is advantageous to have one word come to strength when another is presented, i.e., "contiguous usage" (Skinner, 1957). For example, it benefits the learner for "after command" to come to strength when the learner views the word "attribute," because it allows the learner to correctly place the attribute in the HTML tag.

Immediate Feedback

Feedback occurs immediately after a response and provides information about the correctness of the response. Skinner (1968) described feedback as differential reinforcement of correct responses. Feedback could also serve as differential punishment of incorrect responses. However, a recent review of feedback in programmed instruction suggested that the primary function of feedback is not to reinforce correct responses or punish incorrect responses, but to provide additional instruction to evoke the correct response, when needed (Jaehnig & Miller, in press).

Early research suggested that instruction with feedback did not produce more learning than instruction without feedback (Feldhusen & Birt, 1962; Moore & Smith, 1961, 1964; Rosenstock, Moore, & Smith, 1965; Wentling, 1973), or even produced less learning (Lublin, 1965). However, Kulhavy (1977) and Roper (1977) reported that most of this research involved poorly-designed instruction that was over-prompted or had feedback visible before the learner responded. For example, in at least two of the studies (Lublin; Rosenstock et al.), the feedback was placed directly under the frames and was always visible to the learner. Like frames with non-meaningful response requests, frames with feedback visible before responding allow learners to make a correct response without using the behavioral repertoire intended to be taught. Such frames are called "copy frames." Copy frames have been shown to be less effective in promoting learning, both when the frames have the feedback visible before the learner responds (Anderson, Kulhavy, & Andre, 1971, 1972), and when the instruction uses non-meaningful response requests (Anderson & Faust, 1967).

There are several ways to arrange feedback. Knowledge of results (KR) simply tells the learner whether a response is wrong or not, while knowledge of correct responding (KCR) specifies the correct answer. Elaboration feedback gives the correct answer with additional information, such as an explanation of the correct answer

(Pridemore & Kline, 1991). Review feedback re-presents incorrectly answered response requests. Another approach is postfeedback delays with the feedback in view, contingent on incorrect responses (Anderson et al., 1971; Crosbie & Kelly, 1994).

Research on the effectiveness of different feedback arrangements suggests the following: feedback produces more learning on a criterion measure than no feedback; KR is ineffective; KCR was inconsistently effective, so additional study is needed to determine under what conditions it is appropriate; delayed feedback and review feedback have no advantage over immediate feedback; and, elaboration feedback and postfeedback delays with visible question and feedback appear to be the most effective (Jaehnig & Miller, in press).

Logical Sequencing

Programmed instruction is designed to shape the learners' behavior. Frames are arranged in a logical sequence of successive approximations to the terminal responses. Successful completion of one response request depends on completion of previous response requests (Skinner, 1968).

However, there are no clearly defined rules on shaping successive approximations in programmed instruction. For example, Skinner (1968) recommended making each step as small as possible, to maximize reinforcement frequency. Markle (1990), however, argued that small steps are inefficient and suggested starting out with large steps in the first draft and adding additional material as indicated by testing.

Stimulus Fading

In stimulus fading, the antecedent stimuli that evoke a specific response or response class are gradually reduced in magnitude until the minimum required stimuli will evoke the correct response. For example, Figure 4 shows a sequence of response requests testing the learners' ability to format values in HTML tags. In the first frame, the learner is presented with options that include all the components and the functions they serve (as indicated by their locations within the tag), but with different arrangements. In the second frame, the options are faded out and the learner is only provided with the components of the tag and the functions they serve. In the third tag, the functions have been faded and the learner must make the response using only the components. This is an example of stimulus fading in instruction. However, the change in the form of the response request between frames one and two should not be confused with stimulus fading. The learner could have been asked to reproduce rather than choose the correct answer in the first question; however, that would have required additional time with no benefit.

In which opening tag is the value written correctly?

- <FONT FACE="Times New Roman">
- <FONT FACE Times New Roman>
- <FONT FACE=Times New Roman>
- <FONT FACE: "Times New Roman">

To create a bulleted list with circular bullets, you would use the command "UL", the attribute "SHAPE", and the value "circle".

How do you write the opening tag? ______________

Write the opening tag to make the font color red and the font size 6:

____

Figure 4. Sequence of frames illustrating stimulus fading.

Although stimulus fading has been demonstrated in other applied settings (Ducharme & Worling, 1994; Pace, Ivancic, & Jefferson, 1994; Patel, Piazza, Kelly, Oschsner, & Santana, 2001), I could not locate any research investigating the use of stimulus fading in programmed instruction. This is not surprising, because conducting such research would be impractical. The most effective use of fading varies by the instructional program. A program should only use as much fading as necessary, as determined by testing with learners.

Testing and Revision

Programmed instruction should be tested with the target audience and revised based on the results. Even an experienced instructional designer cannot know how learners will perform on instruction without testing it. Unfortunately, testing and revision are steps that are frequently omitted by instructional designers, because they are time-consuming and expensive.

Research investigating the effects of different arrangements of instruction should always use instruction that has been demonstrated as effective via testing and revision. Failure to do so may result in a lack of external validity; the results may not generalize to effective modules of instruction.

Computer-Based Instruction and E-Learning

Programmed instruction can be either paper-based or computer-based. Computer-based programmed instruction offers several advantages over paper-based instruction. For one, computer-based instruction (CBI) can be programmed to deliver feedback only after the learner makes a response. It can even require the learner to make a correct response before proceeding. In contrast, paper-based instruction restricts feedback delivery. It must be displayed either near the response request, which allows learners to intentionally or inadvertently view it before responding, or separated, which can be awkward for the learner. Also, CBI allows branching, in which different instructional sequences are presented on the basis of how the learner responds. In addition, CBI offers more supplementary stimuli options, such as audio and video. Plus, CBI can be delivered via the Internet, and thus can reach several people simultaneously. Paper-based instruction requires the provision of physical copies to each learner.

On the other hand, CBI requires the availability of a computer, and some degree of computer fluency by the learner. Also, CBI development demands aptitude in computer programming, in addition to instructional design skills. However, these issues become less of a handicap as computers become more prevalent, people become more fluent in computers, and instructional authoring software becomes more user-friendly.

Computers have become increasingly accessible in schools. The ratio of students to instructional computers with Internet access in U. S. public schools has decreased from 12.1 to 1 in 1998 to 4.8 to 1 in 2002 (U. S. Department of Education, 2003b).

There is also increased computer availability in homes. According to the Census Bureau in the U.S. Department of Commerce (2001), the number of American households with one or more computers has been steadily climbing since 1984, when the Bureau first began collecting data on computer ownership. Similarly, the percentage of households with Internet access has been increasing since data started being collected in 1997 (U. S. Department of Commerce, 2001). In 2000, 51% of households had at least one computer, and 41.5% had Internet access (U. S. Department of Commerce, 2001). Of households with children aged 3-17, 65% had at least one computer in 2000 (U. S.

Department of Commerce, 2001). In a 2003-2004 survey, 97% of polled students in grades 9 through 12 reported that they had a computer in their home (Hart, 2003).

In addition to becoming increasingly accessible, computers are being utilized more in training and education. E-learning—instruction delivered or facilitated by electronic technology, such as the Internet, or CD-ROMs (Imel, 2002)—is rapidly growing in popularity. For example, even though corporate training spending did not increase in 2003, the amount devoted to e-learning grew 22 percent (Mullich, 2004). In 2002, 15.4% of corporate training overall and 25.5% of Fortune 500 corporate training was done via e-learning, an increase since 2000 from 8.8% and 18.7%, respectively (Mullich, 2004). E-learning is expected to grow to a $10.7 billion industry in the U.S. between 2004 and 2007 (Allen, 2003).

E-learning is also being used more in education (McArthur, 2003). In 2000-2001, 89% of public 4-year colleges in the United States offered distance education courses (U.S. Department of Education, 2003a).

With the increasing implementation of e-learning in education and training, it becomes more important to examine frequently-employed practices, such as multimedia instruction. Multimedia instruction contains at least two types of media, such as text, graphics, animations, audio, or video (Beccue, Vila, & Whitley, 2001). The decreased cost and increased prevalence of computer sound and video technology mean that multimedia instruction and training are becoming increasingly accessible, making it more important to assess the effects on learning of adding such options. This project will examine the impact on learning of one component of multimedia instruction: audio narration.

Audio Narration

Audio narration is the presentation of spoken words as principal instructional content simultaneously with visual instructional components, such as text, diagrams, and animations. Not all uses of spoken words in instruction are audio narration. For instance, a module on customer relations could include, as an example, video footage of a conversation between an employee and a customer. In such a case, the spoken words are not an example of audio narration. Audio narration can replace, supplement, or match textual narration in instruction.

Audio narration is becoming more accessible in e-learning. The most popular authoring tools used by instructional designers (Bersin & Associates, 2003)—Flash™, Dreamweaver™, Authorware™, Director™, Powerpoint™, FrontPage™, and Toolbook™—all have the capability to incorporate audio narration. Audio narration is very popular in e-learning. I performed an Internet search for custom e-learning developers using the Google™ search engine (http://www.google.com) with "custom" and "e-learning" or "elearning" as the search terms. Of the first twenty custom developers found, fourteen definitely used audio narration in some of their instruction, determined by either course descriptions, sample courses available on their websites, or responses to email inquiries. The remaining six did not specify whether they did or did not, and did not respond to email inquiries.

The addition of audio narration to instruction can be time-consuming, expensive, and resource-intensive. Achieving high sound and presentation quality may mean paying for professional voice-over recording services. If changes are made to instructional content, audio must be re-recorded accordingly, and by the same person. This is a concern for organizations that periodically update their instructional content. In addition, the use of audio requires greater bandwidth and disk space.

Thus, it is important to assess the effects on learning of adding audio narration to instruction. A number of researchers have investigated different arrangements of audio narration.

Types of Instruction used in Research

Different instructional design studies that appear to be investigating the same independent variables often get different results. One probable reason for this is the vast differences that exist in the instructional content, ranging from very short media presentations to lengthy programmed modules. I have identified three categories of instruction or presentation that I found during the literature review: (1) media presentation, (2) instruction presentation, and (3) active instruction.

Media Presentation

Several researchers have used media presentations rather than instruction when investigating the effects of audio narration. For example, a researcher may present a video and see how much of its content participants can recall. I categorized this as media, rather than instruction, because it was most likely not created with any clear instructional objectives. Also, it is limited because learners cannot progress at their own rates.

Media presentations were not included in the literature review for two reasons. First, I am interested in the effect of audio narration in instruction, not media. Second, the majority of audio narration research using media presentations has investigated whether participants learn more from video footage or from audio narration; they typically have not compared audio narration to textual narration, which is the focus of this investigation. For a summary of review articles, see Jasper (1991).

Instruction Presentation

Instruction differs from media presentations in that it is designed to teach specific objectives. For example, a researcher may use a module of CBI designed to teach learners how the human respiratory system works (e.g., Mayer & Sims, 1994). It is still limited, however, because it does not require the learner to actively respond while completing the module. I categorized this approach as instruction presentation. The majority of studies in this literature review fall into this category.

Active Instruction

Active instruction is also designed to teach specific objectives, but includes active response requirements and feedback. Programmed instruction would fall into this category. There are very few examples of active instruction in the audio narration literature.

Literature Review

First I will describe the procedures and results of individual studies, which I will present in chronological order. Then I will summarize the results.

This review will use "audio-only" to refer to instruction with audio narration, "textual-only" to refer to instruction with textual narration, and "audio-textual" to refer to instruction with both audio and textual narration. Unless otherwise specified, audio and textual narration contain identical content, and differ only in presentation mode. These labels are used to emphasize the properties of the instruction that are manipulated by the experimenters within individual studies. Thus, audio-only instruction may contain visual components, but unless otherwise specified, those components do not vary between groups.

Individual Studies

Klement, Lumdsen, and Shearon (1973) administered two versions of CBI, consisting of numeration problems and instructions on solving the problems, to participants enrolled at an adult learning center. One group received the textual-only version, containing problems and instructions in textual format. The other received the audio-textual version, containing problems and instructions in both textual and audio formats. After viewing the CBI, participants completed numeration problems with pencil and paper. The authors stated that the participants were able to view the instruction and complete the problems three days per week, but did not specify whether all participants did, or how many weeks were involved. Participants took a posttest after completing the materials, and no statistically significant difference was found between the two groups.

Kroll (1974) used pre-existing SAT reading scores to divide 120 fifth- and sixth-graders into two groups: high-ability readers (scored above the median), and low-ability readers (scored below the median). The author adapted a paper-based programmed text on the scientific method by rewriting the frames and answers as prose, dividing the prose into short passages, and adding a question for each passage. The participants did not answer the questions overtly, but were told to "think" the answers.

Half of the high-ability and low-ability readers were assigned to the textual-only group, and the other half to the audio-only group, for a total of four groups (Kroll, 1974). The textual-only groups received all the materials in textual format and the audio-only group received all the materials in audio format. The criterion test consisted of a 30-item test, in which 15 of the questions were from the original instruction (not included in the adapted version), and 15 were created by the experimenter. Participants in the textual-only group received their instruction in paper booklets and their criterion tests on sheets of paper. Participants in the audio-only group were given cassette tapes with verbatim recordings of both the instruction and the criterion test.

The high-ability readers performed better than the low-ability readers overall ($p < .001$), but neither ability group was affected by presentation mode (Kroll, 1974). However, the author reported that the low-ability readers performed only slightly higher than chance on the criterion measure, suggesting a potential floor effect. Thus, the adapted instruction was not particularly effective in general.

Barton and Dwyer (1987) divided 52 adult learners into high-IQ (above the mean) and low-IQ (below the mean) groups. Each group was divided into a sub-group that received textual-only or audio-textual instruction, for a total of four groups. The textual-only groups received instruction consisting of a printed booklet with approximately 60-80 words and a drawing of the heart that illustrated the content of the text. The audio-textual groups received the same booklet, plus a 15-minute audio tape that corresponded with the text in the booklets, played while the learners read the text.

The criterion test consisted of three sub-tests: identification—parts and positions of the heart, terminology—terms and definitions about the heart, and comprehension—facts and functions of the heart (Barton & Dwyer, 1987). The composite score incorporated all three sub-tests.

Barton and Dwyer (1987) found that the low-IQ textual-only participants had significantly higher identification sub-test and composite scores than did the low-IQ audio-textual participants ($p < .05$). Conversely, the high-IQ audio-textual group performed significantly better on the identification sub-test than the high-IQ textual-only group ($p < .05$). There were no significant differences found on the other subtests. Thus, the low-IQ learners benefited from textual-only arrangement and the high-IQ learners benefited from the audio-textual arrangement.

The results were contrary to the authors' hypothesis that the low-IQ learners would benefit from the audio. As an explanation, the authors suggested that the addition of the audio may have caused learners to have to continually shift their attention between the different sources of stimuli, causing difficulties for the low-IQ students, but potentially benefiting high-IQ learners as an additional source of stimuli (Barton & Dwyer, 1987). They also suggested that the pace of the audio tape may have rushed low-IQ learners through the content faster than their reading and comprehension levels.

Mayer and Anderson (1991) compared the effects of presenting audio narration and an animation successively or simultaneously. In Experiment 1, they presented a computer animation showing how a bicycle tire pump works, with audio narration describing the animation, to two groups of 15 college students. The simultaneous group received three 30-second presentations of the audio narration and the animation concurrently. The successive group received three 45-second presentations of the audio narration first, then the animation. The simultaneous group performed statistically significantly better than the successive group on the criterion measure ($p < .02$), which consisted of four problem-solving questions.

In Experiment 2, the same instructional arrangements were used with two new groups of participants (Mayer & Anderson, 1991). However, the authors added a second dependent variable—a verbal recall test that asked participants to describe how a bicycle tire pump works. Once again, the simultaneous group performed significantly better than the successive group on the problem-solving questions ($p < .02$). However, there was no significant difference in performance on the verbal recall test.

In two experiments, Mayer and Anderson (1992) compared eight versions of animation and audio narration, including four different successive arrangements. Experiments 1 and 2 used the same procedures, but Experiment 1 used instruction on a bicycle tire pump and Experiment 2 used instruction on a car's braking system.

The authors (Mayer & Anderson, 1992) presented the following arrangements to seven different groups: (1) simultaneous narration and animation, (2) animation followed by narration (ANANAN), (3) narration followed by animation (NANANA), (4) animation only then narration only (AAANNN), (5) narration only then animation only (NNNAAA), (6) animation only (AAA), and (7) narration only (NNN). An eighth group served as a control, and did not receive any instruction.

The dependent variables were a problem-solving test, and a verbal recall test (Mayer & Anderson, 1992). On the recall test, all treatment groups (Experiment 1) or all treatment groups except the AAA group (Experiment 2) performed significantly better than the control group ($p < .05$), but there were no statistically significant differences between the treatment groups. On the problem-solving test, the simultaneous group performed significantly better than the other seven groups in both experiments ($p < .05$), and there were no other differences between the groups.

Barron and Kysilka (1993) presented CBI that taught CD-ROM technology to three course sections of an undergraduate university class. Sixty students were randomly assigned to one of three groups. The textual-only group received all textual instruction, the audio-textual group received instruction in audio and textual formats, and the audio-bulleted group received the audio instruction with a bulleted version of the text, rather than full text.

The authors used three dependent measures: an achievement test, a questionnaire that asked for participants' opinion about the instruction, and instruction completion time (Barron & Kysilka, 1993). There were no statistically significant differences between the three groups in achievement test scores and responses on the questionnaire. However, the textual-only group had a significantly shorter instruction completion time than the audio-textual group ($p < .05$).

Barron and Atkins (1994) presented 100 undergraduate students one of three versions of CBI teaching CD-ROM technology: audio-only, audio-textual, and audio-bulleted (see Barron & Kysilka, 1993). They used three dependent measures: a questionnaire that asked the participants' opinion about the instruction, a criterion test with 30 multiple-choice questions, and a retention test with similar questions, taken three months later. There were no significant differences between the three groups on any of the measures.

Mayer and Sims (1994) investigated the relationship between spatial ability and simultaneous versus successive audio, using an animation of a bicycle air pump (Experiment 1) or the human respiratory system (Experiment 2), with accompanying audio narration. In Experiment 1, 86 college students with little knowledge of mechanical devices were randomly assigned to one of three groups. One group received three presentations of the animation and narration together (simultaneous), one group received three presentations of the animation followed by the narration (ANANAN), one group received three presentations of narration followed by animation (NANANA), and a control group received no instruction. In Experiment 2, only the simultaneous, NANANA, and control arrangements were used.

Based on the participants' performance on a spatial ability test, the authors categorized them as high-spatial ability (above median) or low-spatial-ability (below median; Mayer & Sims, 1994). Following instruction, participants completed a problem-solving test and a verbal retention test.

In both experiments, all treatment groups performed significantly better than the control group on the verbal recall test ($p < .05$), but there were no significant differences between the treatment groups (Mayer & Sims, 1994). However, on the problem-solving test, participants who received simultaneous audio and animation performed significantly better than the other groups ($p < .05$), and the successive group/s performed significantly better than the control group in Experiment 2 ($p < .05$), but not Experiment 1. In addition, the high-spatial-ability participants who received simultaneous audio and animation performed significantly better than those who received successive audio and animation ($p < .05$) in both experiments. This effect was not found for the low-spatial-ability groups.

Mousavi, Low, and Sweller (1995) conducted six experiments using different arrangements of audio and textual narration in paper-based instruction with Year-8 (Experiments 1-4) and Year-4 (Experiments 5-6) students in Australia. For Experiments 1-4, the instruction was composed of geometry examples, consisting of diagrams and associated proof statements. In Experiments 1 and 2, one group of participants received a visual diagram with textual statements (textual-only), one group received a visual diagram with audio-taped statements (audio-only), and one group received a visual diagram with audio-taped and textual statements (audio-textual). In Experiment 1, the length of time the participants spent with the instruction was dictated by the duration of the audio-taped recording for the audio-only and audio-textual group, but not for the textual-only group. In Experiment 2, the textual-only group time was limited to the length of the audio tape, so all three groups had equal time with the instruction.

A test phase followed in which learners completed two sets of two geometry problems—one set was similar to those in the instruction, and one set was transfer problems that used the same geometric theorems in a different way (Mousavi et al., 1995). The amount of time it took to correctly complete the problems was recorded. On the two similar problems, the audio-only group performed better than the textual-only and audio-textual groups in Experiment 1 ($p < .05$), and better than the textual-only group in Experiment 2 ($p < .05$). For the two transfer problems, there were no statistically significant differences in performance between the groups in either experiment.

In Experiments 3 and 4, the authors presented the diagrams and proof statements in textual-only and audio-only formats under both simultaneous and sequential presentation conditions, for a total of four conditions (Mousavi et al., 1995). For the sequential conditions, the diagrams and proofs were never presented at the same time. For example, if the proof statements were being presented, the diagram was covered. As in Experiment 2, the time for the textual-only groups was limited to the length of the audio tape during Experiment 4.

Participants who received either version of audio-only instruction performed better on both similar and transfer problems than those who received the textual-only instruction ($p < .05$; Mousavi et al., 1995). The sequential presentation did not affect their performance.

In Experiment 5, Mousavi et al. (1995) presented four versions of instruction about rectangular dimensions to participants: (1) problems in diagram format with accompanying audio-taped statements (diagram-audio), (2) problems in sentence format with accompanying audio-taped statements (sentence-audio), (3) problems in diagram format with accompanying textual statements (diagram-textual), and (4) problems in sentence format with accompanying textual statements (sentence-textual).

The authors performed a 2 (diagram or sentence) x 2 (audio or textual) factorial analysis (Mousavi et al., 1995). On both similar and transfer problems, there were significant main effects favoring learners in the auditory groups and learners in the diagram groups ($p < .05$). There were no significant interactions between the two factors.

Finally, in Experiment 6, Mousavi et al. (1995) presented one group of learners with textual problems and solutions (textual-textual) and the other with audio-taped problems and solutions (auditory-auditory). There were no significant differences between the two groups.

Tindall-Ford, Chandler, and Sweller (1997) conducted three experiments. In Experiment 1, they presented paper-based instruction consisting of electrical diagrams and corresponding statements to three groups of 10 trade apprentices at an Australian company. Neither the diagrams nor the statements could be understood in isolation. The audio-only instruction contained diagrams and tape-recorded statements, the textual-only instruction contained diagrams with textual statements, and the integrated instruction contained textual statements integrated in the appropriate place within the diagrams.

The criterion test had two sections—written and practical (Tindall-Ford et al., 1997). The written test asked learners to indicate on four diagrams where leads are placed in different electrical tests (Section 1), answer ten multiple-choice questions about relations between electrical tests (Section 2), and answer two transfer questions (Section 3). The practical test required participants to perform four electrical tests. The participants re-completed the instruction and took the same tests again a month later.

The results were consistent for both phases. Participants who received audio-only and integrated instruction performed significantly better on transfer questions and the practical test than did participants who received textual-only instruction ($p < .05$; Tindall-Ford et al., 1997). The authors suggested that the repertoire tested by the transfer questions and practical questions required integration of materials, whereas the repertoire tested by the first two sections of the written test could be acquired by rote learning. Learners in the textual-only group could not simultaneously perceive the diagrams and textual statements, as could the other two groups, and as a result did not effectively learn content that required integration.

In Experiment 2, the authors used instruction that consisted of electrical tables and explanatory statements (Tindall-Ford et al., 1997). The textual-only group received the table with textual statements, and the audio-only group received the table with tape-recorded statements. The authors described the table as being high in "element interactivity" (p. 267), meaning that individual elements of the table must be combined with other elements to be understood.

After viewing the instruction, participants rated the difficulty of the module and took the criterion test, which asked them to fill in missing information in an electrical table (Section 1), answer questions that required understanding the table format (Section 2), and select cables for different electrical installations (Section 3; Tindall-Ford et al., 1997). The instruction and test were re-administered to the participants two weeks after the first administration.

On all test sections, audio-only learners performed significantly better than did textual-only learners ($p < .05$; Tindall-Ford et al., 1997). On Section 1 questions, there was a significant interaction between test phase and group, in which the textual-only group improved more from the first to the second test administration ($p < .05$). Participants in the audio-only group rated the instruction as less difficult than participants in the visual-only group for both administrations ($p < .05$).

In Experiment 3, the authors used an audio-only and textual-only version of instruction on electrical engineering (Tindall-Ford et al., 1997). The instruction was divided in three sections: (1) the meaning of different electrical symbols (deemed to be low in element interactivity), (2) explanations of different electrical circuits (deemed to be high in element interactivity), and (3) a prose passage on electrical safely. The purpose of the third section was to demonstrate that learners in the audio-only group do not perform better simply because listening is easier than reading.

The criterion test contained three sections that tested the repertoires taught in the corresponding three sections of instruction (Tindall-Ford et al., 1997). The instruction and tests were re-administered one month later. The audio-only group performed significantly better on section 2 of the test than the textual-only group ($p < .05$). There were no significant differences in performance between the two groups on the first and third sections of the test.

Jeung, Chandler, and Sweller (1997) presented CBI, consisting of geometric shapes and corresponding statements, to Year-6 (Experiments 1 and 2) and Year-4 (Experiment 3) students in Australia. In Experiment 1, they used two versions of instruction: one that was designed to require learners to devote time searching for the visual shape components that corresponded with the statements (high-visual-search), and one that was designed to not require much search time (low-visual-search). Each version was presented in three arrangements: textual-only (statements in textual form), audio-only (statements in audio form), and audio-only flashing (like audio-only, plus the appropriate visual component of the geometric shape flashed when the auditory statement referred to it).

The criterion test consisted of questions similar to those used in the instruction, and transfer problems in which the information was applied in a new way (Jeung et al., 1997). On the similar questions, participants in the audio-only-flashing group performed significantly better than the textual-only group with the high-visual-search ($p < .05$), but not with the low-visual-search material. On the transfer problems, no significant differences were found.

In Experiment 2, the same procedures were repeated with instruction that had even higher visual search than that used in Experiment 1 (Jeung et al., 1997). The audio-only-flashing group performed significantly better than the other two groups on the similar problems ($p < .05$). There were no significant differences between the groups on the transfer problems.

In Experiment 3, the authors used materials that were extremely low in visual search (Jeung et al., 1997). The audio-only and audio-only-flashing groups both performed significantly better than the textual-only group on the combined similar and transfer problems ($p < .05$). There were no significant differences between the groups on either the similar or transfer problems when analyzed separately.

Mayer and Moreno (1998) presented college students a computer-based animation of the process of lightning (Experiment 1) or a car's brake system (Experiment 2), with accompanying narration. One group received the animation with textual narration and the other with audio narration. The audio-only participants performed significantly better on retention, matching, and transfer test questions than the textual-only participants in Experiment 1 ($p < .001$, .01, .001, respectively) and Experiment 2 ($p < .05$, .05, .01, respectively).

Kalyuga, Chandler, and Sweller (1999) presented one of three versions of CBI on soldering to 34 trade apprentices at an Australian company. The instruction consisted of an animated diagram and narrative statements relating to the diagram. The statements were provided in textual-only, audio-only and audio-textual formats.

Following the instruction, the participants rated the difficulty of the instruction (Kalyuga et al., 1999). Then they took a criterion test that asked them to locate elements that had been incorrectly placed on a fusion diagram, and to complete five multiple-choice questions. Participants in the audio-only group rated the instruction as easier ($p < .05$), and had higher criterion test scores ($p < .05$) than participants in the other two groups.

In two experiments, Kalyuga, Chandler, and Sweller (2000) presented different versions of CBI on cutting machine speed to trade apprentices at two Australian manufacturing companies. The instruction consisted of visual diagrams of a cutting speed nomogram (a diagram that converted cutting speed to rpm), and explanations relating to the monogram in textual and/or auditory format. Neither the diagrams nor the explanations would be understandable in isolation for learners inexperienced in nomogram use. The four groups were textual-only, audio-only, audio-textual, and diagram-only.

In Stage 1 of Experiment 1, the participants completed their version of instruction, rated the difficulty of the instruction, and took a 10-item criterion test (Kalyuga et al., 2000). After the test, they received training on using the cutting speed nomogram used in the instruction, consisting of a worked example with visual explanations and 50 multiple-choice questions, similar to those on the 10-item test. Participants received feedback on the questions (correct or incorrect) and re-answered them until they were all answered correctly.

In Stage 2, another training session, including multiple-choice questions similar to those in the first session, occurred (Kalyuga et al., 2000). Then the learners again completed one of the four versions of instruction. The instruction used a different nomogram, and was more complicated than the instruction used in Stage 1. Next, the learners rated the difficulty of the instruction, and took a criterion test.

The authors performed a 4 (instructional format) x 2 (stage) ANOVA (Kalyuga et al., 2000). No significant main effect was found for the criterion test. However, participants in the diagram-only group spent significantly less time than the other groups on the instruction ($p < .05$), and participants in the audio-textual group rated the instruction as less difficult than did the other groups ($p < .05$). There were interactions between the two factors for instruction time and the criterion test ($p < .05$). In Stage 1, the audio-textual group performed significantly better on the criterion measure than did the other three groups. Thus, inexperienced learners seem to benefit the most from the audio-textual format.

In Experiment 2 (Kalyuga et al., 2000), 38 of the learners from Experiment 1 were given one of two versions of instruction with a different, but similar, nomogram. The instruction was either diagram-only or audio-textual. The results were reversed from the first experiment. The diagram-only group performed significantly better on the criterion measure ($p <. 05$) and the audio-textual group rated the material as more difficult ($p < .05$). Thus, experienced learners did not benefit from the addition of audio. The training resulted in the diagram being intelligible in isolation, and the advantage of audio disappeared.

Koroghlanian and Klein (2000) investigated the relationship between spatial ability and different modes of instruction and illustration. High school students were given a spatial ability test and divided into high-ability (above median) and low-ability (below median) groups. For each of these groups, participants were randomly assigned to one of two instruction modes (textual or audio-partial-text), and one of two illustration modes (static or animation), for a total of four groups for each ability level.

CBI teaching cell mitosis and meiosis, including feedback, review, and practice, was used (Koroghlanian & Klein, 2000). For the textual-only mode, instruction was presented as on-screen text. For the audio-partial-text mode, instruction was presented as audio with limited screen text. The dependent variables used were a 27-item posttest and a mental effort scale.

There were no differences between the groups on the posttest for spatial ability, illustration mode, or instruction mode (Koroghlanian & Klein, 2000). On the mental effort scale, low spatial ability participants rated the task as being more difficult than did high spatial ability participants.

Lai (2000) investigated the relationship between instructional arrangement and IQ with 316 college freshman taking a computer literacy course. A CBI program designed to teach BASIC programming was used, consisting of programming statements accompanied by a graphic or animation.

Participants took an IQ test assessing language and number reasoning and were divided into high-ability, middle-ability, and low-ability groups (Lai, 2000). Then for each ability group, participants were randomly assigned to one of five different instructional arrangements that consisted of textual statements and the following: graphic (one graphic), audio-graphic (one graphic, and audio narration that used analogies to explain each statement), animation (an animation), cued-audio-animation (an animation, and audio cuing the learner to pay attention to the animation), and audio-animation (animation and audio narration). The dependent variables were a 20 multiple-choice questions administered as a posttest, and as a retention test one week later, and time spent completing the instruction.

High-ability participants performed significantly better on the posttest ($p = .05$), and took significantly less time to complete the instruction ($p = .05$) than low-ability participants (Lai, 2000). Participants who received the audio-animation instruction or who received the graphic instruction performed significantly better on the posttest than those who received audio-graphics or animation ($p < .01$). The audio-animation group performed significantly better on the retention test than the audio-graphic group (p = .002). There was no interaction found between instructional arrangement and IQ.

In two experiments, Leahy, Chandler, and Sweller (2003) presented instruction consisting of a temperature line graph and audio or textual descriptions of the graph to two groups of Year-5 students in Australia. In Experiment 1, neither the graph nor the descriptions could be understood in isolation. The two groups were audio-textual and textual-only. They used a criterion test with items deemed high and items deemed low in "element interactivity," defined as the "number of interacting elements that are required to understand or perform a task" (p. 407).

The authors performed a 2 (instruction arrangement) x 2 (interactivity level) ANOVA (Leahy et al., 2003). Performance was significantly better on high-interactivity test items than on low-interactivity items (p = .0001). There were no statistically significant main effects for instruction arrangement. However, there was a significant interaction between instruction arrangement and interactivity. On high-interactivity questions, students in the audio-textual group performed significantly better than those in the textual-only group (p = .014). There was no significant difference on low-interactivity test questions.

Experiment 2 was similar, except that the diagram in the instruction could be understood in isolation of the audio (Leahy et al., 2003). In this version of the instruction, a text box was imbedded into the diagram. One group of participants received the instruction with the diagram and the imbedded text box (textual-only), and the other received the instruction with the diagram, the imbedded text box, and audio narration containing the same general content as the text box (audio-textual).

In this experiment, the textual-only participants performed significantly better than the audio-textual participants ($p = .005$; Leahy et al., 2003). Once again, there was an interaction between instruction arrangement and interactivity ($p = .026$), but the results were the reverse of Experiment 1. Learners in the textual-only group performed significantly better than those in the audio-only group on both high and low interactivity questions, but the effect size was larger for the high interactivity questions. Thus, when the diagram could be understood in isolation, the addition of audio was detrimental to learning.

Summary of Literature

Some researchers performed multiple experiments. Thus, the results are summarized in terms of experiments, not individual journal articles. Many researchers investigated several independent variables, and thus their studies may be included in multiple summaries.

Main effects of audio-only, textual-only, and audio-textual

Several studies used factorial designs and looked for interactions between type of narration and other factors. The interactions will be presented in later sections. The immediately following summaries are based on main effects only.

Seventeen experiments included a comparison of audio-only to textual-only instruction. Twelve of those found an advantage of audio-only (Jeung et al., 1997, Experiment 3; Kalyuga et al., 1999; Mayer & Moreno, 1998, Experiments 1-2; Mousavi et al., 1995, Experiments 1-5; Tindall-Ford et al., 1997, Experiments 1-3), and five did not (Jeung et al., 1997, Experiments 1-2; Kalyuga et al., 2000, Experiment 1; Kroll, 1974;

Mousavi et al., 1995, Experiment 6). None of the experiments indicated an advantage of textual-only.

Eight experiments included a comparison of audio-textual with textual-only. Six did not find a difference (Barton & Dwyer, 1987; Kalyuga et al., 2000, Experiment 1; Klement et al., 1973; Leahy et al., 2003, Experiment 1; Mousavi et al., 1995, Experiments 1-2), and two found an advantage of textual-only (Barron & Kysilka, 1993; Leahy et al., 2003, Experiment 2). In one of those experiments (Barron & Kysilka), the advantage was that the instruction was completed more quickly; however, there was no difference on the criterion test. None of the experiments indicated an advantage of audio-textual over textual-only.

Five experiments included a comparison of audio-textual with audio-only. Two found an advantage of audio-only over audio-textual (Kalyuga et al., 1999; Mousavi et al., 1995, Experiment 1) and three found no difference (Barron & Atkins, 1994; Kalyuga et al., 2000, Experiment 1; Mousavi et al., Experiment 2).

Varying temporal arrangements of audio narration

Out of eight experiments investigating temporal arrangements, six showed an advantage of audio presented simultaneously with other instructional elements over audio presented in other temporal arrangements (Mayer & Anderson, 1991, Experiments 1-2; Mayer & Anderson, 1992, Experiments 1-2; Mayer & Sims, 1994, Experiments 1-2). Two experiments did not find a difference between simultaneous and sequential presentation of audio and other instructional elements (Mousavi et al., 1995, Experiments 3-4).

Partially-redundant audio or textual narration

A few researchers have used partially, rather than fully redundant narration in their investigations. For example, two of the experiments used instruction containing audio with bulleted text and found no difference when compared to audio-textual and textual-only instruction (Barron & Kysilka, 1993) or to audio-only instruction (Barron & Atkins, 1993). Another experiment compared instruction with audio and limited screen text to textual-only instruction and found no difference (Koroghlanian & Klein, 2000). Finally, one experiment used partially redundant audio narration, consisting of analogies of the textual statements, and found no difference between instruction with just the textual narration and instruction with the textual and audio narration (Lai, 2000).

Audio with materials that require integration

Often instruction includes visual images or animations that cannot be easily understood without accompanying textual descriptions, and vice versa. For example, instruction could include an animation of the mechanics of a motor along with text describing what is happening in the animation. In such an example, neither the animation nor the text can be understood in isolation by a naïve learner. Furthermore, they may be best understood if the learner can perceive them simultaneously. If the learner is forced to divide attention between the two sources of information, it may have a detrimental effect on learning.

One way to address this possibility is to integrate the textual descriptions within the visual images, so the learner can perceive them together. However, another approach is to use audio descriptions, rather than textual descriptions. This allows the learner to experience the descriptions and visual images simultaneously. Several researchers have investigated this approach.

For example, in four experiments, Mousavi et al. (1995) used instruction with content and narration that the authors described as requiring integration for understanding. Learners benefited from audio narration when the other instructional content was visual. However, when both components of the instruction were audio (problems and solutions), and thus could not be perceived simultaneously, the benefit disappeared. Similarly, in three experiments, Tindall-Ford et al. (1997) reported that participants only benefited from audio narration on criterion measures that tested repertoires that required integration of instructional components for acquisition.

In two experiments, Kalyuga et al. (2000) reported that only inexperienced participants receiving instruction with a diagram and statements benefited from the addition of audio to instruction. The authors suggested that the diagram and statements were unintelligible in isolation for inexperienced learners, but intelligible for experienced learners.

In addition, in three experiments, Leahy et al. (2003) reported that participants benefited from audio-textual narration on high element interactivity questions when instruction was composed of graphs and statements that could not be understood in isolation, but did better with textual-only instruction on high interactivity questions when the graphs and statements could be understood in isolation.

However, Mousavi et al. (1995) suggested a different explanation for audio-only benefiting learners with materials that require integration. They suggested people have limited working memory, and such materials impose a "cognitive load" (p. 320) on learners' working memory by requiring them to mentally integrate multiple sources of information. They hypothesized that audio-only narration increases learning because people process auditory and visual information through different memory channels, and thus using mixed presentation modes increases a person's working memory. In two experiments, they found that audio-only instruction was superior to textual-only instruction in both sequential and simultaneous formats. If the benefit was primarily due to being able to perceive the narration and other components simultaneously, the simultaneous group should have out-performed the sequential group. However, the six other experiments that compared sequential to different simultaneous arrangements using audio-only narration *did* find an advantage of simultaneous (Mayer & Anderson, 1991, Experiments 1-2; Mayer & Anderson, 1992, Experiments 1-2; Mayer & Sims, 1994, Experiments 1-2). An alternative explanation for these results will be detailed in the *Under What Conditions is Audio Beneficial?* section.

However, this benefit of audio in materials requiring integration disappeared when the instruction contained materials that require a great deal of searching for comprehension. For example, in three experiments Jeung et al. (1997) used instruction composed of geometric shapes and corresponding statements and found that the addition of audio narration only benefited learners with instruction with low-visual search. When instruction required high-visual search, the components of the shape could not be perceived simultaneously with the narration, because the learners had to find the appropriate components. When a flashing component was added to the high-visual search material to draw learners' attention to the components, audio did benefit learners.

These five studies all supported the idea that audio-only narration benefits learners when the instruction contains components that need to be combined to be understood, and one also suggested that audio is not beneficial with instruction requiring high-visual search. It is noteworthy that the only other two studies that showed a main effect of audio-only narration (Mayer & Moreno, 1998; Kalyuga et al., 1999) also used instruction that required the learner to integrate instructional components, although that aspect of the instruction was not specifically manipulated. Thus, this effect could potentially account for every reviewed experiment that showed an advantage of audio-only narration. The effect was largely limited to audio-only narration, except for Leahy et al. (2003), in which audio-textual narration did show a benefit over textual-only on questions high in element interactivity, although there were no main effects.

Interactions between audio narration and learner characteristics

A few researchers have specifically investigated interactions between different arrangements of audio narration and measures of learner characteristics (e.g., IQ, spatial ability, etc.).

One study showed no interaction between type of narration and SAT reading scores (Kroll, 1974). Of the two studies that looked at IQ, one showed an interaction between type of narration and IQ test scores, in which low-IQ learners benefited from textual-only instruction on identification questions, but not terminology and comprehension questions, and high-IQ learners benefited from audio-visual instruction on those same questions (Barton & Dwyer, 1987). The other showed no interaction between IQ and instructional arrangement (Lai, 2000). Of the two studies that examined spatial ability, one found learners with high spatial ability benefited from instruction with simultaneous audio-only narration and animation as compared to successive audio-only narration and animation (Mayer & Sims, 1994), while the other found no interaction between spatial ability and instruction mode (Koroghlanian & Klein, 2000).

Thus, of five experiments that looked for interactions between audio narration and learner characteristics, two found interactions, and the other three did not.

Under what Conditions is Audio Narration Beneficial?

In the literature, audio was beneficial in some cases, had no effect in other cases, and was detrimental in other cases. Thus, the question of whether or not audio narration is beneficial cannot be answered simply. Conditions that may impact the effect of audio narration must be considered.

Except for Leahy et al. (2003), who found that learners did better with audio-textual narration than textual-only narration only on questions high in element interactivity, none of the studies found an advantage of audio-textual over the other narration types. It may be that narration with both audio and textual narration is of no benefit, or even detrimental to learning for people who read at a faster pace than the narrator. If they continue to read at their own pace, the audio may be distracting. If they match paces with the narrator, they may be annoyed with the slower rate. Another possibility is that having the audio in addition to the textual narration is distracting to learners because they have to split their attention between three sources of stimuli -- the two types of narration, and any additional visual instructional components.

Another possible disadvantage of audio and audio-textual narration is that it may take longer to complete, because people read faster than the narrator speaks. Only three studies looked at instruction completion time with narration type; one found that participants in the textual-only group completed the instruction more quickly than those in the audio-textual group (Barron and Kysilka, 1993), and the others found no differences (Kalyuga et al., 2000; Lai, 200).

There are also reasons that audio may be beneficial. One hypothesis is that audio narration may be advantageous when it benefits the learner to look at a diagram or illustration while simultaneously being presented instructions related to that illustration. Viewing written words and viewing a separate illustration are incompatible behaviors. The addition of audio instructions would allow the learner to view the illustration and hear the instructions concurrently. As detailed in the Audio with Materials that Require Integration section, the five studies that investigated this all got results that supported the idea that audio-only narration benefits learners when the narration and other components need to be combined to be well understood.

Conversely, Mousavi et al. (1995) suggested that the benefit of audio under those circumstances is not due to being able to perceive the diagram and narration simultaneously. They supported this with two experiments in which audio-only instruction was superior to textual-only instruction in both simultaneous and sequential conditions. They hypothesized that the benefit is actually because audio and visual information are processed through different memory channels, and thus dual presentation modes increase the learner's working memory.

However, Skinner's (1957) analysis of verbal behavior offers an alternative explanation for the results of those two experiments. In the sequential condition, learners were first presented with either the auditory or the textual statement, which was the first line of a worked geometry example, with the corresponding diagram covered. Then the statement was covered and the learners were shown the diagram. This was repeated until all the statements had been presented. After each statement was presented, it is likely that learners covertly repeated the statement because it would allow them to reinstate the stimulus when viewing the diagram. Repeating the statements covertly can be conceptualized as sub-vocal echoic (audio group) or textual (textual group) verbal behavior. With echoic behavior, the modality of the response-product is the same as that of the stimulus (auditory); however, this is not the case with textual verbal behavior. As a result, precise correspondence between the stimulus and the response-product may be automatically reinforced with echoic behavior, but not textual behavior (Skinner). Thus, the sub-vocal echoic behavior may have produced a stronger stimulus, providing the audio-only instruction with an advantage over textual-only instruction in the successive arrangement. It is also possible, although I think unlikely, that learners in the textual-only condition visualized the stimulus as written words, rather than repeating them covertly. In that situation, the stimulus and response-product would have the same modality. However, the learners would again be faced with dividing their attention between the covert visual statements and the overt visual diagram. Either way, the audio-only group would have an advantage over the textual-only group in the successive arrangement.

An alternative potential benefit of audio is that it forces learners to contact the instruction. Of course, the learners can "tune out" the audio, but they are still exposed to it. In contrast, learners who receive visual statements may simply fail to read them, thus not contacting them at all. Of course, if it is the case that learners are failing to read the instruction, then motivational issues may need to be addressed.

Another hypothesis is that the addition of audio narration may benefit learners who are poor readers. When a learner is a poor reader, textual instruction may be insufficient to evoke the desired responding from the learner. In such a case, the use of audio narration may serve as an additional source of strength to evoke the response (Skinner, 1957).

The impact of audio narration on differing abilities has not been sufficiently examined. The one study that investigated reading scores did not find an interaction between reading scores and the instructional arrangement (Kroll, 1974). However, in this study the learners all performed so poorly on the criterion measure that the scores were only slightly higher than chance, suggesting ineffective instruction, or inappropriate criterion measures.

The Current Study

The audio narration research is incomplete in several ways. First, all but two of the studies reviewed here used instruction presentations rather than active instruction. Of the two that did use active instruction (Koroghlanian & Klein 2000; Kroll, 1974), neither reported having assessed the adequacy of their instruction, and one may have had a floor effect on the criterion measure. No investigators that I could find used tested programmed instruction.

Second, the majority of investigations used very short presentations of instruction, often less than a minute long. However, actual modules of instruction used in education and the workplace are usually much longer. These studies do not necessarily generalize to full-size programmed instructional modules.

Third, the studies that examined the impact of audio narration on learners with different characteristics all lost information by forcing continuous data (e.g., SAT scores) into discrete categories (e.g., high-performers and low-performers).

No study has examined the impact of audio narration on the performance of persons with varying reading skills using a full-length module of tested, effective programmed instruction. This study was designed to do that. I sought to answer the following questions: (1) Is there a difference in the impact of audio narration, textual narration, and audio-textual narration on performance on a criterion test, and time spent completing instruction? (2) If so, is that difference the same along the continuum of reading comprehension ability?

METHOD

Participants

The participants were 216 university students. To qualify, the students had to have basic computer skills, including Internet navigation, and opening, closing, and saving documents, and no experience or knowledge of Hypertext Markup Language (HTML), the subject matter of the instruction.

Participants were recruited from campus with signs posted in on-campus buildings, direct recruitment from classrooms, and a posting on the Psychology department website. Participants were told of the opportunity to learn about HTML, and earn $10 to $25 by participating in two research sessions. See Appendix A for the recruitment sign that were posted in on-campus buildings, the script used for classroom recruitment, and the wording used in the website recruitment.

All participants signed consent forms (see Appendix B). The approval letter from Western Michigan University's Human Subjects Institutional Review Board is included in Appendix C.

A total of 32 participants were excluded from the data analysis. As planned, the participants who scored higher than 20% on the pretest, a total of four, were excluded, to ensure that learners were inexperienced with the instructional topic. Sixteen participants were excluded because they completed only the first session. Nine participants were excluded for failing to complete some portion of the materials during the second session. Two participants were excluded for completing the application section of the pretest prior to the question section. Finally, one participant was excluded because the fire alarm went off during the second session. (Fortunately, she was the only participant during that second session.) Thus, 184 participants completed this study.

Setting

The sessions were run by either the author, or one of seven undergraduate research assistants. The assistants were all trained individually, and had instructions specifying session procedures (see Appendix D for session instructions).

The first session took place in one of six on-campus research laboratories, and was conducted individually for each participant. An experimenter greeted participants in one research laboratory in the same building (Wood Hall, Room 2532) and escorted participants to the research laboratory where the session took place. The experimenter was initially in the room with the participant to answer questions, explain the procedures, and initiate the reading assessment. The participants were alone during the reading assessment, but the experimenter was in Room 2532 to address any concerns.

The second session took place in one of two computer labs with approximately 20 computers (Sangren Hall, Room 2202; Kohrman Hall, Room 2308), and multiple participants took part simultaneously. Although the participants completed the pretest, instruction, and posttest on their own, the experimenter remained in the room during the entire session to address any issues. The number of experimenters present ranged from one to two, based on the number of participants; typically two experimenters were present if there were more than five participants.

Materials

The materials consisted of a criterion test, an ACT reading test, and a module of computer-based programmed instruction. All materials except the reading test were completed via computer.

Criterion Test

The criterion test consisted of a question section and an application section. The question section contained 20 short-answer questions assessing material taught in the CBI module. The questions were presented via computer, and participants typed the answer and clicked a button to proceed. The computer recorded their responses, and participants were not be able to change previous answers.

The application section required the participants to create a very simple web page with specified criteria, using skills taught in the instruction. Participants were given the criteria on a piece of paper and asked to create the web page on the computer, using Microsoft Notepad™. They were asked to save their document as part of the criterion test. However, if they failed to save it correctly, the experimenter saved it for them, to ensure that their responses were recorded.

The criterion test was used as a pretest, to assess learners' preexisting HTML skills, and as a posttest, to assess what skills learners had gained after the instruction. See Appendix E for the criterion test.

Reading Test

An ACT reading test was used to assess participants' reading comprehension skills. It was 35-minute paper-based assessment, composed of 40 multiple-choice items, based on four prose passages in social science, natural science, prose fiction, and humanities topics (ACT, Inc., 1997). Learners completed the reading test before taking the pretest, but their score had no effect on group assignment. The version of the test that was used was the full-length practice test from the 2002-2003 Preparing for the ACT Assessment booklet (ACT, Inc., 2003). See Appendix F for copy of the ACT approval letter.

Programmed Instruction Module

The CBI consisted of a module of programmed instruction, created using Macromedia Flash MX™. This module was developed in a previous project (Jaehnig, 2003) with four phases: development, alpha testing and revision, beta1 testing and revision, and beta2 testing and revision. During the development phase, the instruction and criterion tests were designed and created, based on specified behavioral objectives. During the alpha phase, three subject matter experts went through the instruction in the presence of the experimenter and spoke their thoughts and impressions aloud, and the instruction was revised accordingly. During the beta1 phase, eight participants took the pretest, completed the instruction, and took the posttest; the instruction was then revised based on an error analysis of instruction and posttest performance. Participants who scored greater than 25% on the pretest were excluded. Participants scored an average of 75.1% on the posttest during beta1. The beta1 procedures were repeated during the beta2 phase with eight new participants, using the revised instruction. Participants scored an average of 78.57% on the posttest during beta2. The instruction used in this project contains the revisions made during the beta2 phase. See Appendix G for detailed descriptions of module development method and results.

The module taught introductory HTML, which is the programming language used to create web pages. It contained 83 frames of programmed instruction. Three versions of the instruction were used, which will be detailed in the Independent Variables section. The learners was able to navigate back and forth between frames using arrows at the bottom of the screen.

A total of 24 response requests were used throughout the instruction, including multiple-choice, fill-in-the-blank, and occasionally more elaborate response requests (e.g., saving an HTML document). Feedback on responses to multiple-choice questions was given in the form of a green checkmark for correct answers, and a grayed response option for incorrect answers. Feedback on construction response requests was given in the form of correct answers after learners have made their response. Participants' responses were recorded by the computer. The instruction was designed such that participants could not proceed until they had made a response. See Appendix H for screenshots of all the instructional frames.

Dependent Variables

Two dependent variables were examined: posttest scores and instruction completion time, which was recorded by the computer.

Attribute/Covariate

The ACT reading test was used as a covariate.

Independent Variable

The independent variable was three different arrangements of narration in the instruction: textual-only, audio-only, and audio-textual.

Textual-Only

In this arrangement, the narration was given in textual form only, shown on the bottom quarter of the screen. The top three-quarters of the screen contained a visual representation or synopsis of the text. See Figure 5 for a sample frame.

Audio-Only

In this arrangement, the narration was given in auditory form only, played through the participants' headphones. The text on the bottom of the screen was not shown. The rest of the frame was identical to the textual-only arrangement, except that there was an additional button that allowed the learner to replay that audio if desired. See Figure 6 for a sample frame.

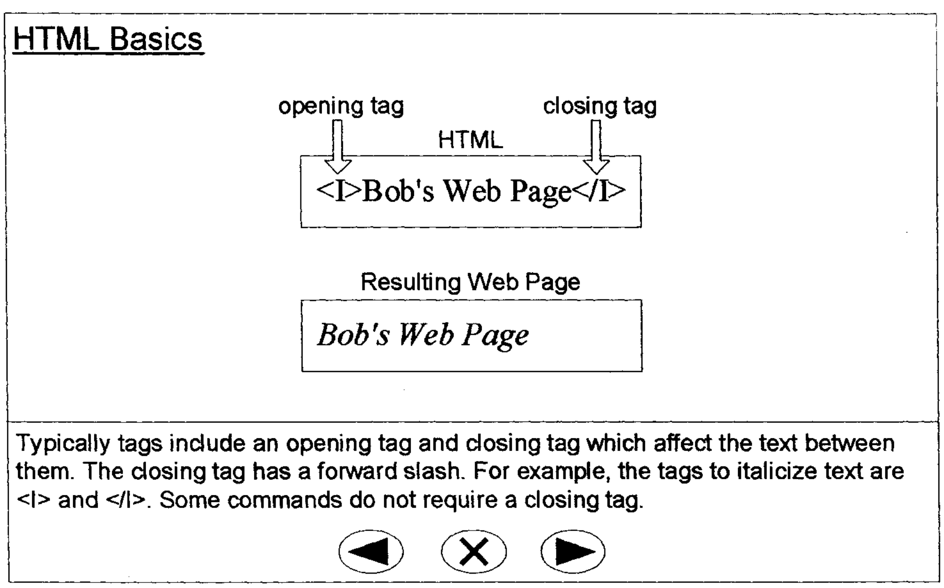

Figure 5. Textual-only instruction frame.

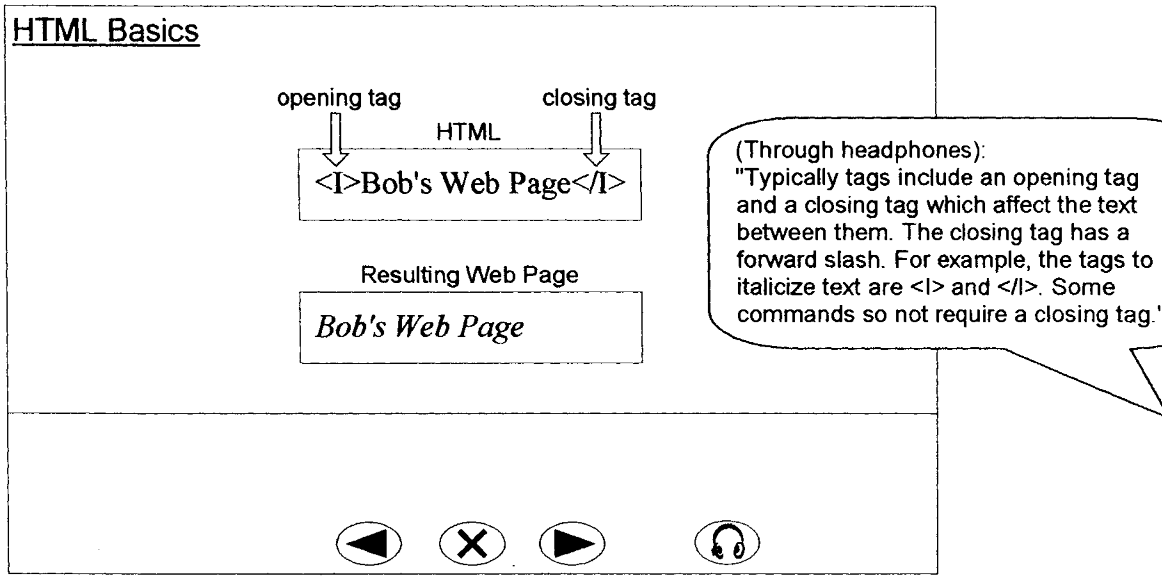

Figure 6. Audio-only instruction frame.

Audio-Textual

In this arrangement, the narration was given in auditory and visual form. The rest of the frame was identical to the frames for the audio-only group. See Figure 7 for a sample frame.

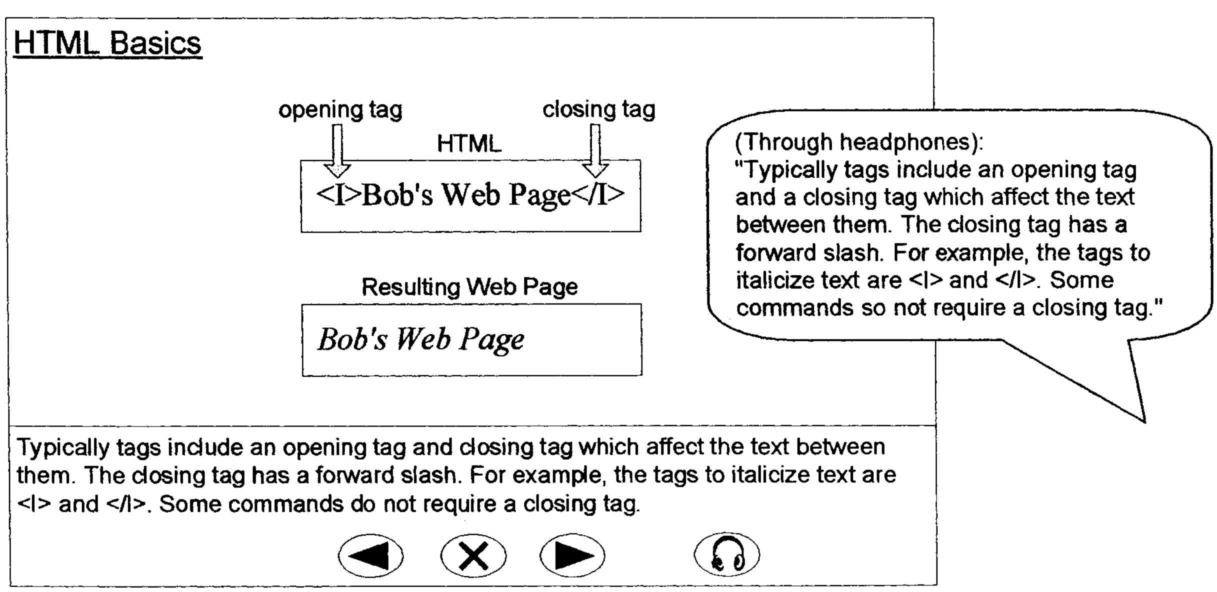

Figure 7. Audio-textual instruction frame.

Experimental Design

A between-groups design was used. The participants were randomly assigned to one of the three groups. After excluding participants due to high posttest scores and other factors, there were 62 participants in both the audio and textual groups, and 60 participants in the audio-textual group.

Procedures

Initial Participant Contact

Before participants came in for a session, I reminded them of the participation requirements, so as not to waste their time if they did not meet them. First, I asked if they had the prerequisite computer skills—Internet navigation, and opening, closing, and saving documents. Next, I asked them to tell me what they knew about HTML. If they knew more than its basic purpose and single-character commands, they had too much knowledge of the subject matter. When that happened, I explained that they had too much knowledge of HTML and thanked them for their time. If they qualified, we selected a time for both sessions.

Pay Procedures

The participants were paid $5.00 for the reading test, $5.00 for completing the instruction, and up to $10 each on the pretest and posttest, based on performance ($10 multiplied by percentage correct). For example, if a participant scored 15% on the pretest, and 80% on the posttest, the participant earned a total of $19.50: $1.50 (pretest) + $8.00 (posttest) + $5.00 (reading test) + $5.00 (instruction). It was necessary to use the same pay schedule for the pretest and posttest, so the participants were not differentially motivated. However, participants were not likely to score very high on the pretest. Thus, the pay schedule was arranged so that a participant who scored 0% on the pretest could still earn a total of up to $20 by scoring well on the posttest. Participants had to complete both sessions to be paid. The payment in check form was mailed within two weeks of the second session.

First Session

The first session was conducted with individual participants. First, an experimenter explained the procedures and the pay structure to the participant, and answered any questions. Next, the experimenter gave the consent form to the participant. When the participant signed the form, the experimenter collected demographic information about the participant.

Next, the participant took the reading test. The experimenter explained the procedures for the reading test, and left the participant to take the test. Participants were limited to 35 minutes to complete the test. Following the test, the experimenter confirmed that the participant could still make the scheduled second session time, and gave the participant a reminder slip detailing the time and location of the second session.

Second Session

The second session was conducted with multiple participants simultaneously. First, the experimenter reminded participants that they would be paid $5.00 for completing the instruction, and up to $10 each for the pretest and the posttest, based on their scores. The experimenter also reminded them that they must have completed all materials for payment, and that they would be paid within two weeks.

Each participant had a computer diskette with a file with a webpage containing links to the pretest, instruction, and posttest. The experimenter opened the file on each computer, so the webpage would be on the screen. All the participants (as a group) were given oral instructions on how to open the links and how to proceed through the materials.

When the participants finished the question section of the pretest, the experimenter gave them the application portion of the pretest on a separate piece of paper, along with oral instructions on where on the computer to find Notepad, which was needed for this section of the pretest.

When each participant completed both sections of the pretest, the participant clicked the appropriate link on the screen to load the instructional module. Assistance was provided when necessary. Each participant was told to complete any instructions given in the module, and make changes if the answers were incorrect.

Following the instruction, the same procedures used for the pretest were used for the posttest.

Debriefing and Payment

After the second session, the experimenter gave participants an initial debriefing letter explaining the purpose of the study, and telling them when they would receive their scores and payment. They were given the opportunity to contact me by telephone or email to ask any questions. I gave them a letter rather than giving the information orally because the sessions were conducted in a group setting and participants did not complete the instruction at the same time. Thus, oral debriefing would have disrupted other participants.

Scoring the tests was a lengthy process, so all tests were scored outside of the session. Within two weeks of the second session, I sent participants a final debriefing letter containing information on the purpose of the study, their scores, and a check with their payment. They were also be provided with contact information in case they had additional questions or concerns. See Appendix I for the initial and final debriefing letters.

RESULTS

Missing Data

The data for instruction completion time was unavailable for two participants, one from the audio group and one from the audio-textual group, due to missing start and stop times in the database. As a result, the calculations involving instruction completion time were made without those data points.

Pretest to Posttest Improvement

Participants in all three groups showed notable improvement from pretest to posttest (see Figure 8). The mean pretest scores for the audio, textual, and audio-textual groups were 4.04% (*SD* = 4.47%), 4.45% (*SD* = 4.5%), and 5.2% (*SD* = 5.73%), respectively. The average posttest scores for the audio, textual, and audio-textual groups were 76.45% (*SD* = 16.61%), 71.05% (*SD* = 21.37%), and 77.8% (*SD* = 17.9%), respectively.

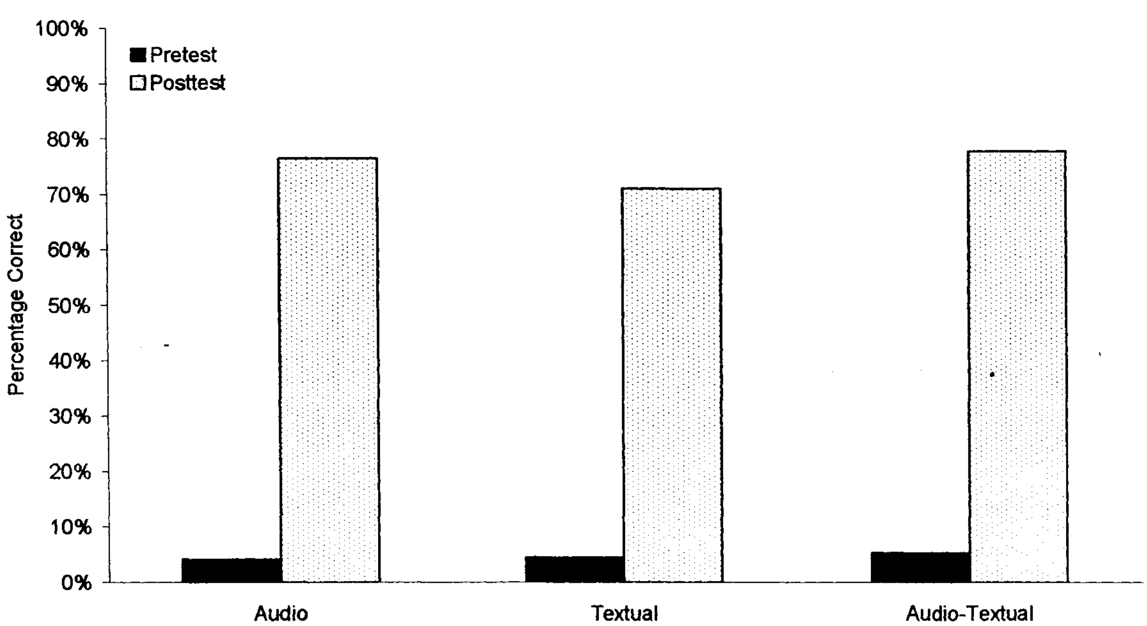

Figure 8. Pretest and posttest scores.

ACT Distribution

Since this study was specifically looking for differences in the impact of narration type along the continuum of reading ability, it was important that a wide range of reading abilities were represented. The distribution of ACT reading test scores for participants in this study is shown in Figure 9. Participants scores varied greatly, ranging from 7 to 40 (M = 25.67). This is somewhat higher than the average reading test score for college-bound high school seniors during the 2004-2005 administration, which was 22.2 (ACT Inc., 2005).Only a few participants scored below 12, but since it was a multiple-choice test with 40 questions with four options, people would be expected to get 10 points by chance.

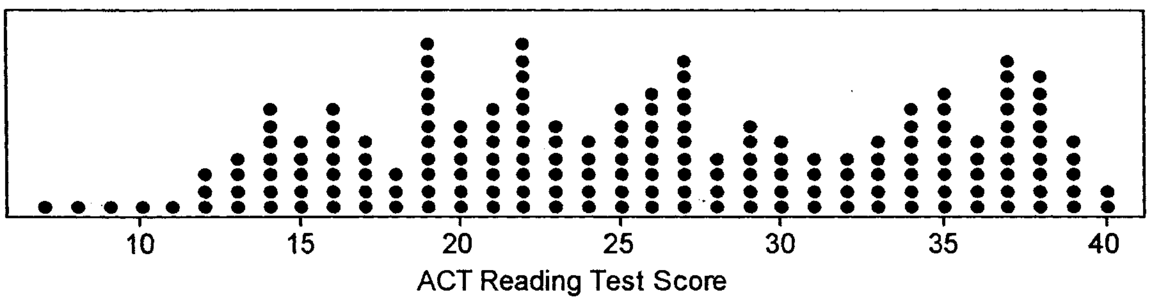

Figure 9. Distribution of ACT scores.

Statistical Assumptions

It is advisable to test statistical assumptions before running any parametric tests, to ensure that the tests are valid. The distributions of both dependent variables met the assumptions of linearity, independent observations, and homogeneous variances. However, normality testing revealed that the posttest score dependent variable had a negatively skewed distribution (see Figure 10), and the instruction completion time dependent variable had a positively skewed distribution (See Figure 11), both of which violated the normality assumption. This negative skew on the posttest score distribution may be due to the posttest upper limits. Since participants scored an average of 75.1% (raw score range of 6 – 40, $M = 30.03$) on the posttest across groups, there was much more room for participants to score below the mean than above. As a result, there are several potential outliers present in the distribution. The mean score is consistent with the results during beta1 and beta2 testing of the instructional materials, in which participants scored 75.1%, and 78.57%, respectively; however, posttest scores during beta1 and beta2 testing were normally distributed, as a result of fewer outliers. Conversely, the positive skew on the instruction completion time distribution may be due to the instruction completion time lower limits.

Since the normality assumption was violated for both dependent variables, I used nonparametric statistical procedures to perform the homogeneity of regression and the ANCOVA tests. Although parametric statistics are typically more robust than non-parametric statistics, nonparametric statistics may have more power when assumptions are violated. Specifically, I used web-based software (Huitema & McKean, 2006) that performed the statistical procedures based on the robust general linear model (RGLM; McKean & Vidmar, 1994). The RGLM is a rank-based procedure that offers a "complete and robust analysis of a linear model" for nonparametric statistics (McKean & Vidmar, 1994, p. 226). It is appropriate for non-normal linear data because it is less sensitive to outliers.

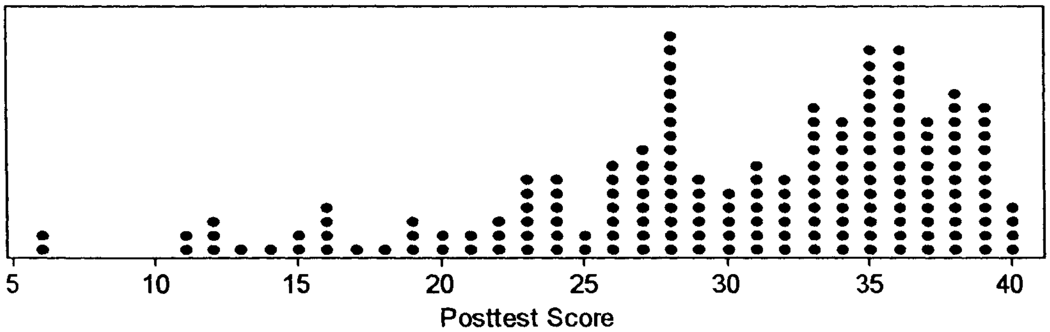

Figure 10. Distribution of posttest scores.

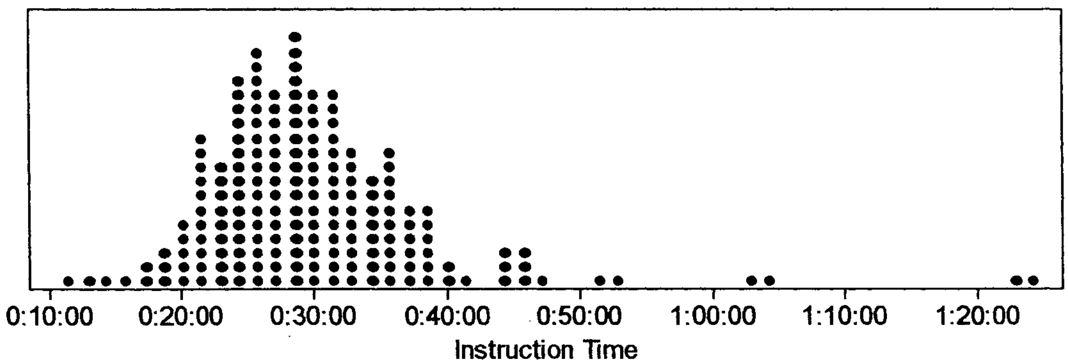

Figure 11. Distribution of instruction times.

Attribute-Treatment Interactions

This project had two research questions: (1) Is there a difference in the impact of the three narration types on the dependent variables? (2) If so, is that difference the same along the continuum of reading comprehension? The second question could be rephrased as: is there an attribute-treatment interaction between ACT score and dependent variable score? It was necessary to investigate the second question first, because the results have an impact on the appropriate data analysis procedure to test for group differences.

To test for an attribute-treatment interaction between ACT score and posttest score, I regressed ACT scores on each dependent variable for each group, and performed a homogeneity of regression test (see Table 1). No statistically significant differences were found between the regression slopes for posttest score ($F = 0.41$, $p = .67$) or instruction completion time (F =.44, p = .64). In other words, there was no difference between the three groups in the impact of narration type on posttest score and instruction completion time along the continuum of ACT scores.

Table 1

Wilcoxon R Homogeneity of Regression Tests

Dependent Variable	F	df	p
Posttest	.40884	2178	.665043
Instruction Time	.442798	2176	.64295

Group Differences

Since the homogeneity of variance slopes assumption was not violated, I was able to perform an Analysis of Covariance (ANCOVA) test on both dependent variables for the three groups, using ACT score as a covariate (see Table 2). Including this covariate increased statistical power by removing reading test score error variation. No statistically significant differences were found between the three groups for posttest score (F = 0.59, p = .56) or instruction completion time (F =.10, p = .90).

Table 2

Wilcoxon R ANCOVA

Dependent Variable	*F*	df	*p*
Posttest	.585563	2180	.557849
Instruction Time	.104927	2178	.900446

Correlations

ACT

As expected, there was a significant positive correlation between ACT reading test score and posttest score, $r = .466, p = 0$. In addition, there was a significant negative correlation between ACT reading test score and instruction time, $r = -.326, p = 0$. This is not surprising, because participants that read quickly are likely to finish the instruction more quickly and to perform better on a timed reading test. Thus, ACT reading test score was an appropriate covariate for both dependent variables.

Instruction Score

There was a significant positive correlation between instruction score and posttest score, $r = .466, p = 0$. There was a significant negative correlation between instruction score and instruction time, $r = -.196, p = 0$. Thus, people who performed better during the instruction tended to take less time to the complete the instruction and performed higher on the posttest. See Table 3 for correlations.

Table 3

Correlations

Comparisons	Pearson r	N	*p*
ACT and Posttest	.466	184	0
ACT and Instruction Time	-.326	182	0
Instruction and Posttest	.466	184	0
Instruction and Instruction Time	-.196	182	0

Interobserver Agreement

Interobserver agreement (IOA) was collected on 100% of ACT reading tests, pretest/posttest question sections, pretest/posttest application sections, and non-multiple-choice instruction questions. (The computer automatically graded multiple-choice instruction questions.) The author served as a primary observer and one of seven undergraduate research assistants served as secondary observers. IOA on the question and application sections of the pretest and posttest were 97.1% and 97.9%, respectively. IOA was 99.5% on the ACT reading test, and 95.2% on the instruction.

DISCUSSION

Narration Type

Although audio narration is commonly held by many in the instructional design field to be beneficial to learning, that conclusion was not supported by this study. No difference was found in the impact of the three narration types on posttest scores. There was also no difference found in the impact on instruction completion times.

It is possible that differences exist, but were not detected by this study. However, this study was designed to have high statistical power. In addition, the results were not even close to being statistically significant. Thus, it seems most likely that no differences exist. This is consistent with the conclusion of the literature review that audio narration was beneficial only when the instruction contained narrative and visual components that cannot be well understood in isolation, and when the visual components did not require a great deal of searching. In the instructional module used in this project, the visual components were typically illustrative of the narration, and would not have to be viewed concurrently with the narration for comprehension.

It is of interest that no difference was found in instruction completion time. It seems likely that the pace of the spoken audio narration is a little slower than the average college student's silent reading pace, so one might have predicted that the textual group would finish more quickly than the other two. It may be that the participants did not read any faster than the speaking pace, or that they tended to read the materials multiple times, but only listened once. It is also possible that participants did not listen to all the audio narration; however, it seems likely that would have impacted their performance, which was not reflected in the results. Another possibility is that there wasn't enough narration to make a substantive difference. Perhaps an instructional module with a larger ratio of narration to visual components would have impacted instruction completion time.

Reading Ability

There was no interaction found between reading ability and narration type. Thus people with different reading abilities did not differentially benefit from one type of narration over another. The ACT scores were sufficiently distributed to represent a range of reading abilities for the population of college students. However, the ACT reading test would not be sensitive to reading abilities at the ends of the scale, i.e., those that are exceptionally low or high.

Practical Implications

The results of this experiment, in combination with the literature review, suggest that two things should be taken into consideration when deciding whether to employ audio or audio-textual narration in computer-based instruction. The first is the instructional content. If the instruction contains narrative and visual components that cannot be understood in isolation, and the visual components do not require a great deal of searching, audio narration is indicated as superior to audio-textual or textual narration.

However, if the instruction does not contain such content, the second consideration is the importance of marketability to the instruction designer. If the instruction designer is concerned only with instructional effectiveness, i.e., what arrangement results in the most learning, the designer is better off employing textual narration; audio and audio-textual narration use more computer resources such as bandwidth and disk space, and are more expensive and less convenient.

However, if marketability is a major concern to the instruction designer, audio-textual narration may be preferred. Audio may appear more sophisticated and jazzier to clients, making them more likely to buy the instruction. Since no detrimental effect of audio-textual narration was found, some designers may find it more practical to employ it in their instruction, so long as the first consideration has been addressed.

Future Research

However, there are still areas that could be explored further. These conclusions may not generalize to modules of programmed instruction with different characteristics. There may be instructional qualities, beyond those identified here, that impact how narration type affects performance. For example, audio narration may have differential benefits with instruction that had more of an emphasis on teaching new vocabulary.

In addition, the results might not generalize to other populations. Although the performance of the participants on the ACT reading test scored varied considerably, it may be that poor readers were insignificantly represented. It's possible that audio narration would have differential benefits for people with exceptionally poor reading skills, who are likely to not be in college. In addition, audio narration may have differential benefits for children, especially those in earlier stages of reading development.

Another area that could be addressed further is instruction completion time. This study did not find instruction with textual narration to require significantly less time, but one of the reviewed studies did. This is an area that could be explored further with different modules of instruction and different populations.

Finally, there is a great deal of interest in learning style in the fields of education and psychology. A recent review of learning style research identified 71 learning style models, and categorized 13 of them as major models (Coffield, Moseley, Hall, & Ecclestone, 2004). The foundation of two of the major models is that people have inherent learning preferences based on the four modalities: visual, auditory, kinesthetic, and tactile (Coffield, et al., 2004). The soundness of these models could be explored using audio and textual narration. For example, can peoples' learning preferences be changed with repeated exposure to effective instruction presented in a specific modality? If so, that would mean learning styles are not inherent. Also, are peoples' preferences consistent with outcomes? That is, do people who report preferring one modality perform better when taught in that modality? Learning style assessments often focus on what style learners report preferring, rather than empirically assessing the issue.

CONCLUSION

This experiment found no difference in the impact of the three narration types on posttest scores or instruction completion time. Nor did it find that people with different reading scores benefited differentially from one of the narration types.

Thus, since textual narration is less resource-intensive than the other two types, it is recommended for functional purposes, However, audio-textual may be preferred for marketability. The exception to this is when the instruction contains visual and narrative components that must be integrated to be understood; in that case, audio-only narration is recommended.

Future research suggestions include: replicating the research using instruction with different characteristics and different populations, looking further into the impact of narration type on instruction completion time, and using audio narration to explore learning style theory.

APPENDIX A

Participant Recruitment Information

Script for Participant Recruitment on Department of Psychology Website
(http://www.wmich.edu/psychology/ug/ugresearch.html)

POSTINGS FOR RESEARCH SUBJECTS

Research Supervisor: Wendy Jaehnig (Dr. Alyce Dickinson)
Research Location: Wood Hall and Sangren Hall
Proposed Project Duration: Fall 2004 – Winter 2005
Seeking (check all that apply): Freshman, Sophomore, Junior, Senior, any major
Prerequisites: Know nothing about HTML and have basic computer skills, including opening and closing documents and navigating the Internet
Project Description: We are seeking students to participate in a research project to investigate the effectiveness of different types of instruction. Participation would involve two sessions. The first would last about an hour and you would take a 35-minute reading test. The second would last about 90 minutes, and you would take a pretest, complete computer-based instruction, and take a posttest.
You can benefit in two ways: (1) You learn a little about HTML for free, and (2) You would earn a little money, from $10 to $25, based on performance.
If You Are Interested in Participating or If You Need Further Information,
Contact: Wendy Jaehnig
Phone: (269) 598-8580
Email:. html@behtech.com
Deadline for participation: None

Script for Participant Recruitment from Classrooms

Hi. My name is Wendy Jaehnig. I am doctoral student in Psychology at Western Michigan University.

I am looking for people to participate in a research project to investigate the effectiveness of different types of programmed instruction. To participate, you must know nothing about HTML and have basic computer skills, such as opening and closing documents and navigating the Internet.

Participation would involve two sessions. The first session would be about one hour, and you would take a 35-minute reading test. This would take place in Wood Hall. The second would last about 90 minutes, and you would take a pretest, complete computer-based instruction, and take a posttest. This would take place in Sangren Hall.

Participating will benefit you because you will learn about HTML and get paid from $10 to $25, based on performance. Your participation is completely voluntary and you may withdraw at any time. If you do withdraw, you will not be paid for the sessions. Your willingness to participate in the study or your withdrawal from the study at a later time will not affect your grade in this or any other class.

If you would like to learn more about this study, please print your name, phone number or email address, whichever is most convenient for you, on a sheet of paper and give it to *me. I am also handing out a poster with my name, email address, and telephone number, and you can contact me by email or telephone if you prefer.*

Does anybody have any questions?

Recruitment Poster
See following page.

Opportunity to be a Research Participant

What's involved?

-1st day: 1 hour - Complete a 35-minute reading test
-2nd day: Take a pretest, go through computer-based instruction on HTML and take a posttest (1-2 hours)
Where: 2532 Wood Hall and 2308 Kohrman/2202 Sangren

How can you benefit?

-Learn valuable computer skills at no cost
-Earn a little extra $$, from $10-$25, based on performance

How do you qualify?

-Know nothing about HTML

AND

-Have basic computer skills, including opening and closing documents and navigating the Internet

How do you get more information?

Contact Wendy Jaehnig at
wendy@behtech.com or 269-598-8580.

wendy@behtech.com
Wendy: 269-598-8580
wendy@behtech.com
Wendy: 269-598-8580
wendy@behtech.com
Wendy: 269-598-8580
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wendy@behtech.com
Wendy: 269-598-8580

APPENDIX B

Consent Form

Western Michigan University, Department of Psychology

Audio Narration and Reading Ability in Programmed Instruction
Principal Investigator: Alyce Dickinson
Student Investigator: Wendy Jaehnig

I have been invited to participate in a study entitled "Audio Narration and Reading Ability in Programmed Instruction." This research is designed to investigate the effectiveness of different ways of presenting narration in computer-based instruction. This project is Wendy Jaehnig's dissertation research, and Dr. Dickinson is her advisor.

Eligibility requirements. In order to be eligible to participate in this study, I must have basic computer skills—Internet navigation, and opening, closing, and saving documents. In addition, I must have no knowledge of or experience in Hypertext Markup Language (HTML).

Explanation of study procedures and length of participation. By consenting to participate in this project, I agree to participate in two sessions. The first session will last about 1 hour, and I will take a 35-minute reading test. In the second session, I will take a pretest, complete a piece of computer-based instruction during which my performance will be recorded by the computer, and take a posttest. This will take approximately 90 minutes. Both sessions will occur within two weeks of each other.

Payment. As compensation, I will receive $5 for the reading test, $5 for completing the instruction, and up to $10 each for the pretest and posttest, based on my performance. I must complete all of both sessions to receive any compensation. The money will be mailed to me in check form, along with my reading test, pretest, and posttest scores, within a week of my second session.

Risks. I may feel some distress if I feel that I have not performed well on the reading test, the pretest and/or the posttest. The reading test will be similar to the ACT or SAT reading test that I took when I applied to Western Michigan University for admission. My score on the test I will be asked to take is likely to be similar to the score I received on my ACT or SAT. I am not expected to do well on the pretest because I will not have received instruction yet on the content that will be tested. If my score on the posttest is low, the score would reflect the inadequacy of the instruction, not my abilities. The difference between my pretest and posttest scores will provide valuable information about different ways of presenting programmed instructional materials.

Benefits. I may benefit from this project by gaining knowledge from the instruction. This research may benefit others by providing information about what makes instruction effective.

Confidentiality. All the information collected from me is confidential. That means that my name will not appear on any papers on which this information is recorded. The forms will all be coded, and Wendy Jaehnig will keep the list with the names of participants and the corresponding codes separated.

Voluntary Participation. My participation in this study in completely voluntary. I may refuse to participate or quit at any time during the study without prejudice or penalty beyond not earning the compensation for completing the sessions.

Who to contact if I have questions. If I have any questions or concerns about this study, I may contact Wendy Jaehnig at 598-8580 or Dr. Dickinson at 387-4473. I may also contact the Chair, Human Subjects Institutional Review Board (387-8293) or the Vice President for Research (387-8298) if questions or problems arise during the course of the study. My signature below indicates that I agree to participate in this study.

This consent document has been approved for use for one year by the Human Subjects Institutional Review Board (HSIRB) as indicated by the stamped date and signature of the board chair in the upper right hand corner. Do not participate in this study if the stamped date is older than one year.

______________________________ ____________

Signature Date

APPENDIX C

HSIRB Approval Letters

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Centennial 1903-2003 Celebration

Date: November 5, 2004

To: Alyce Dickinson, Principal Investigator
Wendy Jaehnig, Student Investigator for dissertation

From: Amy Naugle, Ph.D., Interim Chair Amy Naugle

Re: HSIRB Project Number: 04-10-28

This letter will serve as confirmation that your research project entitled "Audio Narration and Reading Ability in Programmed Instruction" has been **approved** under the **expedited** category of review by the Human Subjects Institutional Review Board. The conditions and duration of this approval are specified in the Policies of Western Michigan University. You may now begin to implement the research as described in the application.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: November 5, 2005

Walwood Hall, Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: February 21, 2005

To: Alyce Dickinson, Principal Investigator
Wendy Jaehnig, Student Investigator for dissertation

From: Mary Lagerwey, Ph.D., Chair *Mary Lagerwey*

Re: HSIRB Project Number: 04-10-28

This letter will serve as confirmation that the change to your research project "Audio Narration and Reading Ability in Programmed Instruction" requested in your memo dated 2/20/2005 (post recruitment advertisement to a second website) has been approved by the Human Subjects Institutional Review Board.

The conditions and the duration of this approval are specified in the Policies of Western Michigan University.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: November 5, 2005

Walwood Hall, Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276

WESTERN MICHIGAN UNIVERSITY

Human Subjects Institutional Review Board

Date: September 14, 2005

To: Alyce Dickinson, Principal Investigator
Wendy Jaehnig, Student Investigator for dissertation
Danielle Gureghian, Student Investigator
Matthew LeGray, Student Investigator

From: Mary Lagerwey, Ph.D., Chair

Re: Extension and Changes to HSIRB Project Number 04-10-28

This letter will serve as confirmation that the extension and changes to your research project "Audio Narration and Reading Ability in Programmed Instruction" requested in your memo received September 14, 2005 (addition of two student investigators) have been approved by the Human Subjects Institutional Review Board.

The conditions and the duration of this approval are specified in the Policies of Western Michigan University.

Please note that you may **only** conduct this research exactly in the form it was approved. You must seek specific board approval for any changes in this project. You must also seek reapproval if the project extends beyond the termination date noted below. In addition if there are any unanticipated adverse reactions or unanticipated events associated with the conduct of this research, you should immediately suspend the project and contact the Chair of the HSIRB for consultation.

The Board wishes you success in the pursuit of your research goals.

Approval Termination: September 14, 2006

Walwood Hall, Kalamazoo, MI 49008-5456
PHONE: (269) 387-8293 FAX: (269) 387-8276

APPENDIX D

Session 1 and 2 Instructions

Session 1 Procedures

Before Participant Arrives

1. Assemble the following materials :
   - These procedures
   - The participant's folder (by code)
   - Pen (for consent form)
   - Pencil (for ACT test)
   - Timer, set to 35 minutes
   - The session 2 schedule for that person

2. Unlock the experimental room and put the SESSION IN PROGRESS sign on the door.

After Participant Arrives

1. INTRODUCTION

When participant arrives to room 2532, address them by name, and say:

Hi ParticipantsFirstName. I'm YourFirstName. I'm a research assistant working with Wendy Jaehnig. Let's go to this room down the hall.

2. OVERVIEW

Take participant to the research room, and say:

I am going to read the information I give you word-for-word, so everybody who participates in this research will hear the same thing.

The purpose of this research is to see how different types of instruction affect learning for people with different scores on a reading test.

If you choose to participate in this project, there will be two sessions.
- *In the first session (which would be this one), you would take the ACT reading test. This session would last about 60 minutes.*
- *In the second session, you would take a pretest, complete a module of computer-based instruction, and take a posttest. That session would last about 90 minutes.*

Potential risks of participation are that you may experience some physical discomfort, minor fatigue, or stress while completing the instruction. To offset this, you may take breaks to relax whenever you want while completing the instruction.

The benefits are that you will learn a little about HTML, and you will be paid for your participation. You will be paid $5 for completing the reading test and $5 for completing the instruction. You will be also paid up to $10 each for the pretest and posttest, based on your performance. For example, if you scored 80% on the posttest, you would receive 80% of $10, which is $8. You are not expected to score very high on the pretest, because the material should be unfamiliar, but even with a score of 0% on the Pretest you could earn between $10 and $20. You must complete both sessions in their entirety to be paid. Your payment will be mailed within 2 weeks of the second session.

Do you have any questions?

3. CONSENT

Answer any questions. Give the participant one consent form and the pen, and say:

This is a consent form. This states the details of the study and your rights as a participant. By signing this, you are agreeing with the conditions stated, including the right to have your results used (anonymously) in future papers and presentations. Please read through it and let me know if you have any questions. If you agree to participate, sign the consent and we'll begin.

Leave the participant to read the consent.

If the participant signs the form, give him or her the unsigned copy and say:

This is your copy of the consent.

4. PARTICIPANT INFORMATION

Before we begin, we need to get contact information from you, so we can send you the payment. I will also collect your age and gender for demographic purposes. This information will be kept separate from anything you complete. Anything you complete will be coded and we will keep the list with the names and the codes separate.

After the participant completes it, make sure it is all there (when applicable) and is legible.

5. ACT READING TEST

Let's begin. In this session, you will take the ACT Reading test. You will be paid $5 for completing this test.

The reading test that I am asking you to take is similar to the ACT or SAT reading test that you took when you applied to WMU for admission. Thus, your score is likely to be similar to the score you received on the ACT or SAT.

I will be in the room down the hall while you take the test, if you have any questions or finish early.

Give participants the ACT intro sheet, the ACT Reading test, (upside down), the answer sheet, and a pencil, if necessary, and say:

Now I'm going to read instructions directly from the ACT booklet. Instructions relevant to other portions of the ACT test (such as math) will be omitted. Feel free to follow along with the provided sheet. (Indicate the sheet so the participant can follow along if desired.)

The questions in each test are numbered, and the suggested answers for each question are lettered. On the answer document, the rows of ovals are numbered to match the questions, and the ovals in each row are lettered to correspond to the suggested answers.

For each question, first decide what answer is best. Next, locate on the answer document the row of ovals numbered the same as the question. Then, locate the oval in that row lettered the same as your answer. Finally, fill in the oval completely. Use a soft lead pencil and make your marks heavy and black.

Mark only one answer to each question. If you change your mind about an answer, erase your first mark thoroughly before marking your new answer. For each question, make certain you mark in the row of ovals with the same number as the question.

Only responses marked on your answer document will be scored. Your score on the test will be based only on the number of questions you answer correctly during the time allowed. You will NOT be penalized for guessing. IT IS TO YOUR ADVANTAGE TO ANSWER EVERY QUESTION EVEN IF YOU MUST GUESS.

If you finish the test before time is called, you should use the time remaining to reconsider questions you are uncertain about.

Lay your pencil down immediately when time is called at the end of the test. You may NOT for any reason fill in or alter ovals for a test after time is called for that test.

Do you have any questions?

Follow the instructions on the test. I will let you know when your time is up. You have 35 minutes. Begin now

Start 35-minute timer, close the door, and leave the room.

6. WHILE PARTICIPANT COMPLETES ACT TEST
   - Record the participant's full name on the appropriate Session 2 schedule
   - Input the Participant Information into the database
   - Put the Participant Information sheet in the file (top cabinet)
   - Put the signed consent form in the file (top cabinet)
   - Write the participant's first name and ID number on a post-it note and stick it to the participant's diskette
   - Prepare a Session 2 reminder slip for the participant

7. AFTER TIMER GOES OFF:

   Knock on door softly and open it, and say:

   Okay, put down your pencil.

   Answer any questions and thank the participant. Then remind him/her when session 2 is scheduled and give the participant the session 2 reminder slip.

After the Session

1. Take the sign off the door.
2. Put the reading test answer sheet in the Grading-Wendy file.
3. Recycle ACT test and instructions.
4. Return the participant file and the Session 2 schedule to the filing cabinet.
5. Reset the timer for 35 minutes.

Issues

Participant does not show:

If it is more than 15 minutes past the scheduled time and the participant hasn't arrived, call the participant, or call Wendy if you don't know the participant's phone number. (Use phone in the office if you'd like. Dial "9" to get an outside line. Her phone number is 598-8580.)

The participant's folder is missing materials:

There are duplicates of everything in the filing cabinet (top drawer, in the back). Put the participant's number on it if it is the ACT answer sheet, or the Participant Information sheet.

Session 2 Procedures

Before going to Sangren/Kohrman

1. Get the Session 2 schedule for the day and find out which participants are arriving. Get the diskettes from their files.

2. Put the following in the Session 2 Materials folio:
   - The diskettes (Put them in the purple envelope.)
   - The Session 2 schedule

3. Bring the following to Sangren/Kohrman:
   - These instructions (Session 2 Procedures)
   - Session 2 Materials folio (including the diskettes and schedule)
   - The headphones
   - The key to the 2004 Kohrman computer lab (when applicable)

In Sangren/Kohrman – Before Participant Arrive

NOTE: Do not leave the lab unlocked and unattended.

1. For Sangren only: You have to get the key to the computer lab (room 2202) from the front desk in room 3212. Tell them who you are and that you have the lab reserved. They will give you a key.

2. Put the *Looking for Session 2?* sign on the door.

3. Go to the computer lab (Sangren 2202 or Kohrman 2308). Assign a computer to each participant. (Don't use Computer S207 in Sangren – the A drive is faulty. Avoid R-119 in Kohrman – it doesn't have the latest Flash Player version) Put the sticky note with the participant's first name and ID number on each participant's computer..

4. Put Notepad on the desktop of each computer. If necessary (Sangren and computer R-119 in Kohrman), install Flash Player 7:
   a. Do a search for Flash Player on any search engine.
   b. Go to the Macromedia Flash Player Download Center (probably the first link)
   c. Click the Install Now button
   d. A gold bar will appear at the top that says "This site might require the following ActiveX control…" Click on that bar and install ActiveX controls.
   e. Then click the Install button on the pop-up

5. For participants in audio groups (A or AT): Attach headphones (jack is on a speaker) and test the audio level for participants:
   - Open the file on the Audio file diskette.
   - Play any of audio files
   - Adjust volume to a good listening level

6. Open up the open_me file on each computer.

In Sangren/Kohrman – After Participants Arrive

NOTE: Do not leave participants unattended in the lab.

1. As the participants arrive, ask them their names and *personally* show them to their assigned computers. Instruct them not to open anything yet. Show them where Notepad is on the computer, and point out the sticky note with the ID number.

2. INTRODUCTION AND PRETEST – QUESTION SECTION

   After everybody has arrived (or it looks like they're not coming), stand at the front of the room and say the following to the entire group:

   I am going to read the information I give you word-for-word, so everybody who participates in this research will hear the same thing.

   In this session you will complete a pretest, go through a module of computer-based instruction, and complete a posttest. You have already earned $5 from the reading test. You will be paid $5 more for the instruction. You will also be paid up to $10 each for the pretest and posttest, based on your performance. For example, if you scored 80% on the posttest, you would receive 80% of $10, which is $8. You must complete both sessions in their entirety to be paid. Your payment will be mailed within 2 weeks of the second session.

   You will begin with the pretest. There are two sections of the pretest and posttest – the question section and the application section. The question section is on the computer. When you have completed that section, let me know, and I'll give you the application section. I do not expect you do well on the pretest because you have not yet received instruction on the material that will be tested. Don't be alarmed if you find that you cannot complete any of the application section during the pretest. By comparing your pretest scores to your posttest scores, we will be able to determine how much you learned from the instruction.

   Then you will go through the instruction. If there are headphones attached to your computer, your instruction has audio. You must wear the headphones while completing the instruction. Do not remove the headphones or turn off the audio. You may adjust the volume to your comfort level, but do not turn off the audio. If there are no headphones attached to your computer, your instruction does not have audio.

   To complete the instruction, just follow the directions on the screen. Be sure to answer any question that is asked in the instruction. The computer will be recording your answers.

   Finally, you will take the posttest, which is identical to the prettest. If your score on the posttest is low, the score reflects the adequacy of the instruction, not your abilities. The difference between the pretest and posttest scores will provide valuable *information about different ways of presenting instruction.*

Proceed through the material at your own pace. Don't be concerned at the pace of those around you. The materials everybody is viewing vary, and some will be completed more quickly than others. While completing the pretest and posttest, do NOT try to find the answers online or elsewhere. That is considered cheating.

Let's begin. Click on the link to the Pretest. Once it opens, Enter your ID Number where indicated, and follow the instructions on the screen. Note that you cannot change an answer once you've entered it, so DO NOT try to push the Back button.

When you've completed the question section of the pretest, raise your hand and I will give you the application section.

Walk around and make sure everybody is able to open the pretest. Assist if necessary.

While everybody is taking the pretest, put the *Experiment in Progress* sign on the door. If any participants have not arrived, leave the *Looking for Session 2* sign up. Otherwise, take it down.

3. PRETEST – APPLICATION SECTION

After the participants completes the question section, give them the application section and say:
This is the application section. You may not be able to complete any of it at this point. That's okay, just try your best. Use only knowledge you currently have. If you don't know how to do it, do not *try to find the answers online. Raise your hand when you're done.*

4. INSTRUCTION

When they complete the application section, save their Notepad document from the application section (if they did anything) as IDpretestOurSave.txt (for example, A-01pretestOurSave.txt) in the My Work folder on the diskette. This is to ensure that it is saved in case they did not do it correctly.

Close any documents in Notepad or Internet Explorer.

Then tell them to open the instruction on the diskette (assist if necessary) and say:
Complete any instructions given in the module. If you make an incorrect response, try again until it is correct.

While they are completing the instruction, watch to make sure that people in audio groups use their headphones and don't turn the volume down.

5. POSTTEST – QUESTION AND APPLICATION SECTION

When participants complete the instruction, tell them to open the posttest on the diskette (assist if necessary). Give them the application section when they complete the question section and prompt them to raise their hands when they are done.

When they are done, check their computer for the posttest – if it's on the desktop, tell them to leave the computer as it is. If the posttest is not on the desktop, check the diskette to make sure they saved it there. (If not, ask them where it is.) After they leave, save their Notepad document as IDposttestOurSave.txt. (You can wait until after the session if you want.)

6. DEBRIEFING

When participants complete all the materials, give them the appropriate debriefing letter (based on group), ask them if they earn extra credit for their participation (if so, fill out one of the letters and give it to the participant), invite them to ask any questions, and thank them for their time.

After Session 2

1. Save everybody's Posttest application section as IDposttestOurSave.txt.

2. Close down any open files and take the diskettes out of the drives. Make sure the ID on the post-it matches the ID on the diskette.

3. Email me a copy of the participant's work (should be in the My Work folder, but check elsewhere just in case). Send each participant's work as a separate email with the ID in the subject line. My email address: wendy@behtech.com

4. When leaving the computer lab - Turn off the computers, printers, speakers, and lights and make the doors are closed and locked behind you.

5. Sangren lab only – return the key to the front desk (3212) or the door slot.

6. Return materials to the Wood Hall lab:
   - Return the diskettes to the participants' folders
   - Move the participants' folders to the back (in order)
   - Return Kohrman key

Issues

The participant gets an "Invalid ID. Please try again." message when trying to enter pretest.

The participant probably pressed <ENTER> instead of clicking on the button after entering the ID. That will cause an error. Delete anything in the field (be sure to delete all lines) and retype the ID and click the button.

When trying to enter instruction, the computer says the participant needs to finish the pretest first.

The materials are programmed so that the participant cannot go through the instruction until he/she has finished the pretest. To tell the computer that he/she has completed the pretest, the participant needs to click on the large END button at the end of it.. If the participant fails to do this, he/she won't be able to open the instruction. Re-enter the pretest and click to the last page and press the END button.

When trying to enter posttest the computer says the participant needs to finish the instruction first

The materials are programmed so that the participant cannot go through the posttest until he/she has finished the instruction. To tell the computer that he/she has completed the instruction, the participant needs to click on the large END button at the end of it.. If the participant fails to do this, he/she won't be able to open the instruction. Re-enter the instruction and click to the last page and press the END button.

APPENDIX E

Criterion Test Questions and Answers

Pretest/Posttest

Question Section[1]

Answer the following questions to the best of your ability:

1. What is HTML used for?

   Answer: Writing web pages

2. What does universality mean in regards to HTML?

   Answer: Any computer can read HTML

3. Where is HTML written and saved?

   Answer: In a text editor or word processor (either text editor or both is acceptable)

4. An HTML tag is made up of up to three components. What are they?

   Answer: command attribute value

5. When saving an HTML document so it can be viewed as a web page, what extensions can you use?

   Answer: .html .htm

6. What type of document should your HTML document be saved as?

   Answer: text only

7. Is HTML case-sensitive?

   Answer: no

8. What will happen on your web page if you put spaces between HTML tags?

   Answer: nothing (no spaces will appear on web page)

9. The command to make text bold is B. Write the code (including opening tags, closing tags, and affected text) that would result in this: **frog**

   Answer: <B>frog</B>

[1] This section was presented to learners via computer during testing. However, the application section was presented as shown.

10. What opening and closing tags are used at the very beginning and very end of your HTML document?

    Answer: <HTML> </HTML>

11. What is an attribute (or what does an attribute do)?

    Answer: Provides options for tag commands

12. How do you put spaces between lines in your HTML document?

    Answer:
 or <P> (either both or just <P> is acceptable)

13. Write the tag to indent your text 24 pixels, using the information provided below.

Command	Attribute	Value
SPACER	TYPE	Horizontal
	SIZE	24

    Answer: <SPACER TYPE=horizontal SIZE=24>

14. Under what circumstances is it NOT necessary to use quotation marks for values?

    Answer: When there are only text, numbers, periods, or dashes (no special characters)

15. Write the closing tag for the following opening tag:
    <FONT SIZE="4" COLOR="red">

    Answer: </FONT>

16. What two sections is your HTML document divided into?

    Answer: HEAD and BODY

17. Where does the information that you put in the TITLE section of your HMTL document appear on the web page?

    Answer: In the titlebar

18. What section of your HTML document includes the TITLE?

    Answer: HEAD

19. What section of your HTML document includes the visible content of the web page?

Answer: BODY

20. What section of your HTML document is not visible on the web page?

Answer: HEAD

That is the end of the question portion of the pretest/posttest.

Please get the application portion.

Application Section

In this section you will create and save a very simple HTML document to be viewed as a web page. Create your HTML document in Notepad. Leave the document open when you are finished with this pretest.

The following lists a command, with some potential attributes and potential values. Use that information to format your text as specified:

Command	Attribute	Values
FONT	FACE	Times New Roman, Arial, Arial Narrow
	SIZE	1 to 6
	COLOR	green, red, blue (black is default)

Your HTML document should include the following:

1. All the basic required tags of an HTML document.
2. A titlebar that says *Galapagos Iguanas* (no italics)
3. The first line of your HTML document should say:

    Iguanas of the Galapagos Islands

    Use a green Arial Narrow font, size 4.

4. The second line should be a space.

5. The third line of your HTML document should say:

    The Galapagos Islands are located off the coast of South America in the Pacific Ocean. The Galapagos are a province of Ecuador.

    The Galapagos Islands are home to a variety of flora and fauna. Some of the most well known inhabitants of the Galapagos Islands are the marine iguanas.

    Use a black Arial font, size 3, and include the spacing between paragraphs.

6. Save your document as IDposttest (for example, AT-01posttest), but leave it open. Open your document in Internet Explorer to view it as a web page; feel free to make changes if it doesn't look like you expected it to look, and be sure to resave your document as a web page.

7. Leave both the HTML document (Notepad) and web page (Internet Explorer) open.

END OF APPLICATION SECTION

Application Section Answers[2]

<HTML>***21***

<HEAD>***22***

<TITLE>***23*** Galapagos Iguanas***24*** </TITLE>***25*** </HEAD>***26***

<BODY>***27***

<FONT FACE="arial narrow"***28*** SIZE=4***29*** COLOR=green***30***>
Iguanas of the Galapagos Islands***31***
</FONT>***32*** <P>***33***
<FONT FACE=arial***34*** SIZE=3***35***>The Galapagos Islands are located off the coast of South America in the Pacific Ocean. The Galapagos are a province of Ecuador.***36***<P>***37***The Galapagos Islands are home to a variety of flora and fauna. Some of the most well known inhabitants of the Galapagos Islands are the marine iguanas.
</FONT>

</BODY>***38***

</HTML>***39***

Correct save ***40***

[2] The numbers given in the application section directions do not correspond to the numbering of the response requests. Instead, the different response requests are indicated here by the bold, italicized number that follows them.

APPENDIX F

ACT Approval Letter

ACT
INFORMATION FOR LIFE'S TRANSITIONS

April 14, 2004

Ms. Wendy Jachnig
6627 Apt. B Mill Creek Drive
Kalamazoo, MI 49009

Dear Ms. Jachnig,

Enclosed please find two booklets, *Preparing for the ACT Assessment*, and the *Technical Manual for the ACT Assessment*. Inside these two booklets, you should find what you need.

Inside the *Preparing for the ACT Assessment* booklet, on page 32, you will find a copy of the Reading test from a past administration. Feel free to make as many copies as you like for your study. The material is protected by copyright laws, but, as long as you are only doing an academic study, this should not be a problem. The key top the test can be found on page 57, and the raw score to scale score conversion table is on page 58.

The technical manual has material on the validity and reliability of the test. Reliability information can be found in Chapter 3, particularly on page 32. Validity information is in Chapter 4.

I hope this material is of some assistance to you. Please feel free to contact me by phone (319/337-1709) or e-mail (james.sconing@act.org) if you have any questions.

Sincerely,

Sincerely,
Jim
Stat... nent
Res... Jim Sconing, Director

500 ACT Drive P.O. Box 168 Iowa City, Iowa 52243-0168 319/337-1000 www.act.org

APPENDIX G

Method and Results of Instructional Module Development

CHAPTER II[3]

METHOD

Participants

Three university computer science students served as subject matter experts (SMEs), and 16 university students with no knowledge of the subject matter served as learners. The SMEs were recruited through an email message to computer science professors, who were asked to forward the message to qualified students. The learners were recruited through flyers posted in on-campus buildings and information listed on the Psychology department website. Learners were told that they must have no training or experience in HTML to qualify. If they scored greater than 25% on the pretest, they were disqualified.

Two learners who completed the instruction were removed from the data analysis. One was removed because he did not have enough to time to complete the session and had to leave for a class without finishing the posttest application section. The other was dropped because only his first response to the posttest question section was recorded; it is not clear whether he failed to answer the rest of the questions, or if the computer failed to record them.

The research was approved by Western Michigan University's Human Subject Institutional Review Board (HSIRB), and all participants signed a consent form prior to participating. The HSIRB approval letter is in Appendix A and both versions of the consent form are in Appendix B.

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[3] This is the method and results sections from: Jaehnig, W. (2003). *Development of a computer-based programmed instruction program*. Unpublished thesis. Western Michigan University, Kalamazoo. It explains how the instruction used in this dissertation was developed and tested.

Setting

The sessions took place in a private room with a laptop computer. The experimenter was present during SME sessions. Learners were alone in the room during their sessions but the experimenter was in an adjacent room to provide any needed assistance.

Materials

Instruction

A module of programmed instruction was developed, tested, and revised in this project using Macromedia Flash MX.

The module taught basics of Hypertext Markup Language (HTML), which is the programming language used to create web pages. The instruction consisted of approximately 80 frames of programmed instruction. There were different versions of the instruction, which will be described later in this manuscript, so the number of frames varied. Each frame was divided into two sections. Instructional text was shown on the bottom quarter of the frame. A visual representation or synopsis of the instructional text or a meaningful response request was shown on the top three-quarters of the frames. Learners were able to navigate between frames using forward and back arrows available at the bottom of the screen. See Figure 1 for a sample frame.

A combination of multiple-choice, fill-in-the-blank, and occasionally more elaborate response requests (e.g., saving an HTML document) were interspersed throughout the instruction. There were a total of 23 or 24 (varied by version) response requests. Correct answers to multiple choice questions were indicated with a green checkmark, and incorrect answers were indicated by graying the answer. Correct answers to construction response requests were shown after learners made their response. Learners were instructed to answer all questions and complete instructions before moving to the next frame, but were not forced to do so. Learners could view the correct answer by clicking the forward arrow rather than answering the question. Learner responses were recorded by the computer. Instruction questions and answers are provided in Appendix C.

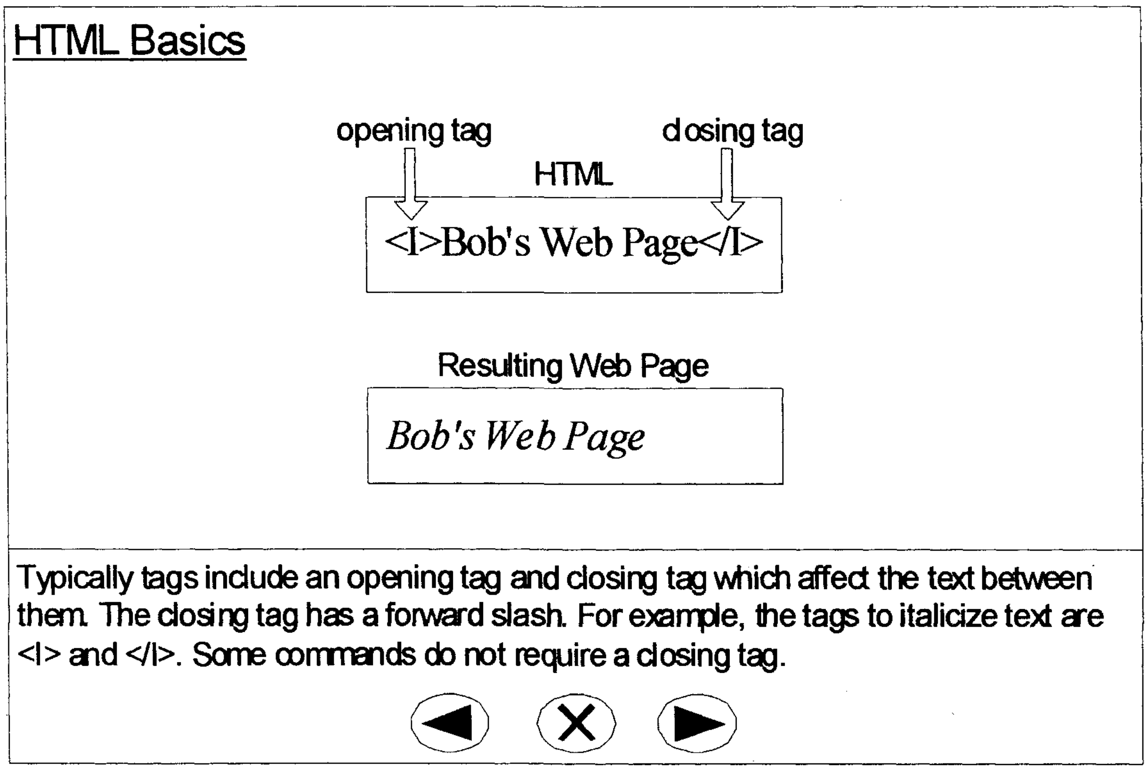


Figure 1. Reproduction of an Instructional Frame.

Criterion Test

A two-part criterion test was developed, consisting of a question section and application section. The question section was a 20-item fill-in-the-blank test covering material taught in the instruction. The questions were presented on the computer and learners typed their answer and clicked a button to submit their answer. They could not answer the questions out of order or change a prior answer. The application section asked learners to make a simple web page with specific characteristics, using skills covered in the instruction. The learners were given the instructions on a piece of paper and created the web page using Microsoft Notepad™. Criterion test questions and answers are provided in Appendix D.

Question section responses were recorded by the computer. Application section responses were saved as a document by the learner as part of the test. If the learner failed to save correctly, the experimenter saved the document after the learner left the session. This was possible because the learners were instructed to leave the document open on the computer.

Dependent Variables

The criterion test functioned as both pretest and posttest. The primary dependent variable was the posttest score, with the pretest score as a covariate. A secondary variable examined was errors during the instructional session, which included multiple-choice and construction response requests.

Independent Variables

This project tested three versions of the instruction. Specific changes to each version are discussed in the Procedures section.

Experimental Design

A between-groups design was used to test the effectiveness of two versions of instruction on learning. Eight participants received the Beta1 version of the instruction and eight participants received the Beta2 version. Participants could not be randomly assigned to groups, because the Beta2 version was created based on the results from Beta1 participants.

Procedures

Development Phase

The creation of the first version of instruction occurred in this phase. First, a subject matter for the instruction and the appropriate target audience were selected. HTML was chosen as a subject because (1) it's useful, (2) there are many people who have no experience in it, making it easier to find participants, and (3) it lends itself to a variety of different types of response requests. Adults with a minimum of a high school education with no training or experience in HTML were chosen as the target audience.

Prerequisites for completing this instruction were determined to be basic word processing skills (opening, saving, and closing files), basic computer skills (opening programs, navigating between windows) and basic Internet navigation skills.

The next step was determining behavioral objectives. This module was targeted to people with no HTML experience, so very basic skills were chosen. Learners were taught the general structure of HTML code and HTML documents. Focus was placed on teaching skills that could generalize to a variety of HTML commands, rather than memorization of specific commands. See Appendix E for a list of the behavioral objectives selected for this module.

The objectives were then divided into component tasks, when appropriate. For example, saving an HTML document involves the following steps:

1. Select *Save As* from the Notepad File menu.
2. When the *Save As* window is up, select the appropriate folder for the document
3. Under File Name, type the name of the document followed by a .htm or .html extension
4. Click Save

Next, probable learner confusions were identified as key teaching points. For example, a likely error for early HTML learners is to use a backlash instead of a forward slash in a closing tag. Thus, the correct closing tag to make text bold is </B>, not <\B>. These key points were specifically addressed in the instruction.

Key teaching points were identified as follows:

- Use a forward slash, not a backslash for closing tags
- There is a space between multiple attributes
- A single tag can have more than one attribute
- Values require quotation marks when they include spaces or slashes
- There is an equal sign between an attribute and its value
- Universality does not mean web pagess will look the same in different browsers

Finally, the instruction was created using behavioral principles of learning, including shaping, discrimination, and stimulus fading. Every objective was covered in the instruction and had at least one response request associated with it.

The criterion test was created to test all behavioral objectives.

Testing and Revision Phases

Alpha Testing

The purpose of this phase was to check the veracity of the subject matter, and see if there were any obvious problems with the instruction. The SMEs were instructed to go through the instruction frame-by-frame. They were told to "think aloud" as they completed the module, and were instructed to comment on anything, including inconsistencies, incorrect subject matter coverage, and frames they did not like for whatever reason. Their comments were recorded on audiotape, and their behaviors, including answering questions and hesitations at specific frames, were noted. After completing the instruction, the SMEs were given the opportunity to make additional comments or observations. They were paid $10.00 for their participation.

Alpha Revision

The instructional material was revised after Alpha testing, based on the performance and comments of the testers. The SMEs identified no significant content errors, but some potential revisions were identified based on their responses and suggestions.

The following revisions were made after Alpha testing:

- Added Submit button to construction response requests (frames 35, 37, 39, 43, 48, and 51)
- Put the "what you've learned" and "future information" VO on the same frame
- Added an END button to record end time.

Beta1 Testing

During this phase, eight participants who were members of the target audience completed the instruction. After reading and signing the informed consent form and completing the pretest, the experimenter opened the instruction to the first frame. The learners were shown where on the computer to find Notepad and Internet Explorer, which are used during the instruction. The remaining instructions were provided by the computer. After completing the instruction, learners took the posttest.

Learners were paid $5.00 for completing the instruction, plus 25 cents per point on the pretest and posttest. A cap was set at $20.00, and payment was rounded to the nearest dollar. For example, if a learner scored 6 of 40 on the pretest and 36 of 40 on the posttest, the learner received $16.00: $5.00 + $1.50 + $9.00.

Beta1 Revision

Beta testing was followed by revision of the instructional materials based on an error analysis of instruction and posttest performance. The error analyses are summarized in the Results section.

The following revisions were made after Beta1 testing:

- Changes to instruction:
  - Added response request for creating closing tag in instruction
  - Added a second example of when to use quotation marks in values
  - Added arrows and labels pointing to situations in which quotation marks would be required for values
  - Reworded question from "T/F: The TITLE appears at the top of your web page as a heading" to "Where does the TITLE appear on your web page?"
- Changes to posttest:
  - Changed required font from Arial Black to Arial Narrow.

Beta2 Testing

A second series of beta testing followed the first, using 8 new participants, and the revised version of the instruction. Beta2 testing procedures were identical to those of Beta1 testing. Final revisions of the instruction were made following this round of testing.

Beta2 Revision

Only simple revisions were made after Beta2 because (1) learner performance was already very high, and adding or changing instruction could have a detrimental effect, (2) instruction was already very long and lengthening it could frustrate learners, and (3) the purpose of the instruction is to use it in subsequent research; thus, any radical changes could alter the standard deviation used in the power analysis.

The following revisions were made after Beta2 testing:

- Added labeled visual depiction of the navigation arrows
- Specified that learners should make a correct answer before moving on
- Added "What you will learn" heading to frame 4
- Cleaned up voice over language by removing redundancies:
    - Frame 2: Removed voice over about being required to open other programs
    - Frame 23: Moved "Values are often enclosed in quotation marks" to next frame which discussed that issue
    - Frame 62: Changed "a review of what you just learned" to "a review"
    - Frame 63: Changed feedback from "Yes, the TITLE belongs in the HEAD section" to "Right!"
    - Frame 70: Changed feedback from "To save it as an HTML document, you should save it as Text Only" to "Right!"
    - Frame 73: Removed "click on the correct answer" from voice over
    - Frame 74: Changed feedback from "Yes, the visible content goes in the BODY section" to "Right!"
    - Frame 76: Changed instructions from "Now resave your file as a text only HTML document" to "Now resave you file correctly"
    - Frame 81: Took out statement about "future lessons..." since there are currently no plans for such modules
- Frame 77: Took out voice over about part about two potential web browsers and just had them open Internet Explorer

CHAPTER III

RESULTS

Error Analysis

Visual inspection of bar graphs depicting overall learner performance on the posttest and during instruction identified response requests with high error rates, defined as less than 60% of learners making the correct response. Instructional revisions were made based on the results of this error analysis.

A few participants failed to make all the responses during instruction. Specifically, one participant in Beta 1 skipped 5 response requests and another skipped 8 of the 23 response requests. During Beta 2, data are missing for one response for one person, but this is believed to be a result of Internet connection problems. For purposes of error analysis, skips were ignored rather than counted as errors.

Beta1

Beta1 posttest performance is depicted in Figures 2 and 3. Performance ranged from 25% to 100% correct across response requests; with an average of 75.31% correct. Response requests with high error rates were identified as 9 and 11 on the question portion and 28, 30, 32-35, and 38 on the application portion. (See Appendix D for posttest questions and answers.)

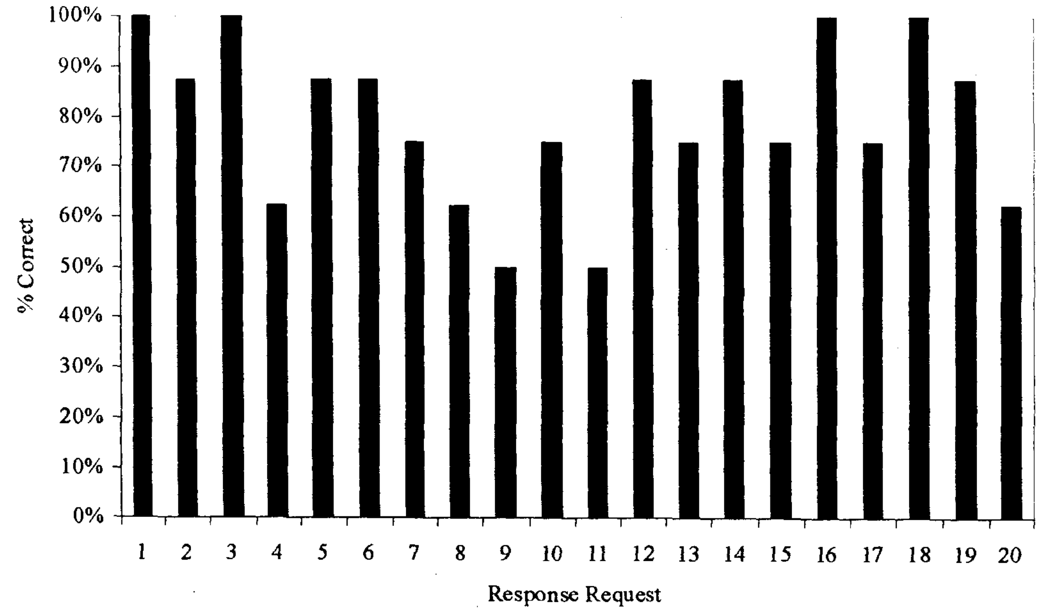


Figure 2. Betal Performance on Question Section of Posttest, across Questions.

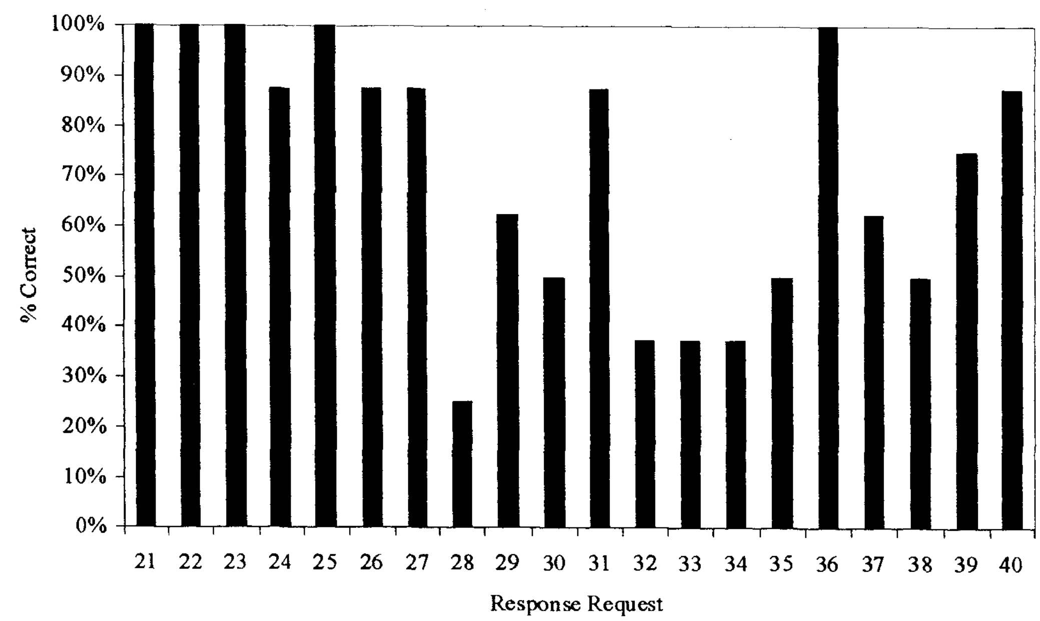


Figure 3. Betal Performance on Application Section of Posttest, across Response Requests.

Performance on Beta1 instruction is depicted is Figure 4. Performance ranged from 38% to 100% across response requests. On average, learners made the correct response on the first attempt on 80.2% of the 23 response requests in the instruction. Response requests with high error rates were identified as 5, 11, 14, 15 and 19. (See Appendix D for instruction questions and answers.)

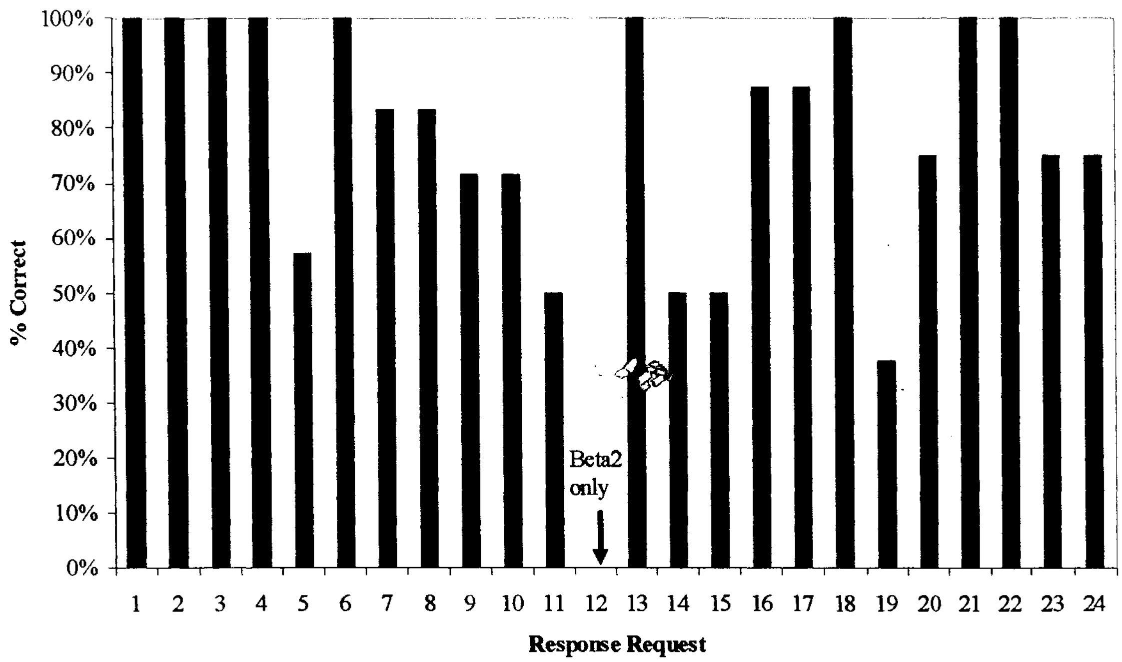


Figure 4. Beta1 Performance on Instruction, across Response Requests.

It should be noted that a high error rate on a question during instruction did not necessarily mean that an equivalent question on the posttest would have a similarly high error rate. Table 1 shows that only one of the five instruction questions that had high error rates had high error rates for corresponding posttest questions. One possible reason for this discrepancy is that that learners benefited from feedback when they made the error during instruction and thus made the correct response during posttest. Another possible reason is that the posttest questions that were determined to be equivalent with instruction questions may have actually assessed different repertoires.

Table 1

Percentage Correct across High Error Rate Instruction Response Requests and Corresponding Posttest Response Requests for Beta1

Instruction Response Request	% Correct	Corresponding Posttest Response Requests	% Correct
5	57.14%	28	25.00%
		32	37.50%
11	50.00%	13	75.00%
14	50.00%	22	100.00%
		26	87.50%
		27	87.50%
		38	50.00%
15	50.00%	23	100.00%
		24	87.50%
		25	100.00%
19	37.50%	7	75.00%

Learner responses to high error rate response requests were examined to see if there were consistent types of errors. Priority was given to errors on posttest questions, but instructional errors were also considered. After errors were identified, their causes were hypothesized, and potential revisions were determined, as shown here. The revisions that were made are detailed in the Procedures section of Chapter 2.

- *Error:* Failure to put quotation marks around values when required

  Hypothesized Cause:: Insufficient information on situations in which quotation marks are required

  Potential Fix: Include additional information on situations in which quotation marks are required, with clear examples
- *Error:* Using incorrect font name

  Hypothesized Cause: Confusion of the font Arial Black with a black Arial font

  Potential Fix: Change to a less confusing font name
- *Error:* Failure to include closing tags

  Hypothesized Cause: Insufficient practice with closing tags

  Potential Fix: At least one additional response request for closing tags
- *Error:* Incorrectly stating where the TITLE goes on the web page

  Hypothesized Cause: Unclear response request

  Potential Fix: Rewrite response request

<u>Beta2</u>

Beta2 posttest performance is depicted in Figures 5 and 6. Performance ranged from 14.29% to 100% correct across response requests, with an average of 78.57%. On average, posttest performance on Beta1 and Beta2 was very similar. However, the questions most frequently answered incorrectly changed from Beta1 and Beta2. Beta2 response requests with high error rates were identified as 9-11, 13, and 15-16 on the question portion and 28 and 34 on the application portion. Thus, it appears that learners generally made fewer errors on application response requests but more errors on questions.

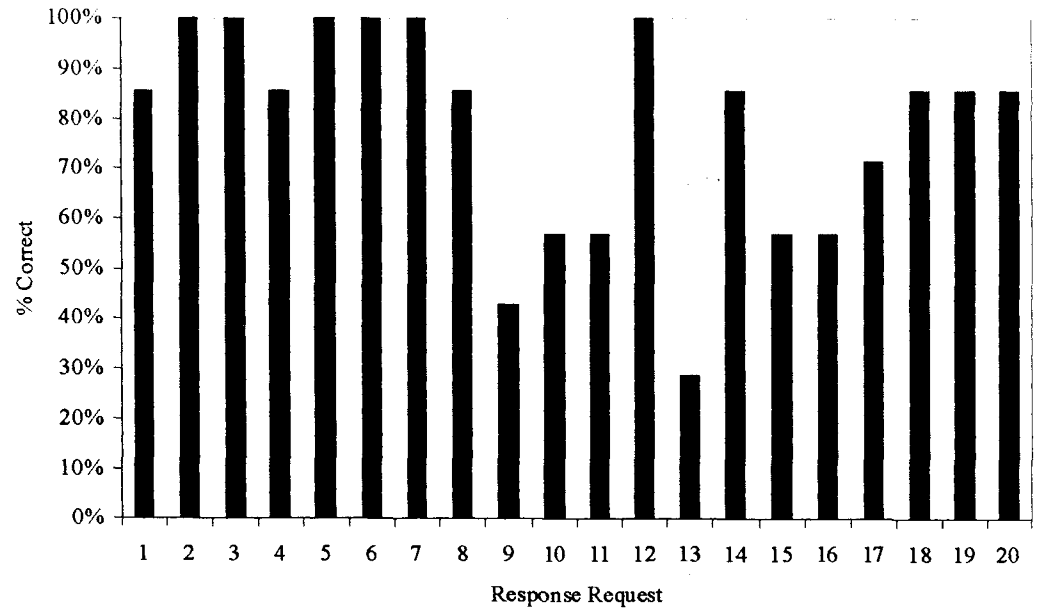


Figure 5. Beta2 Performance on Question Section of Posttest, across Questions.

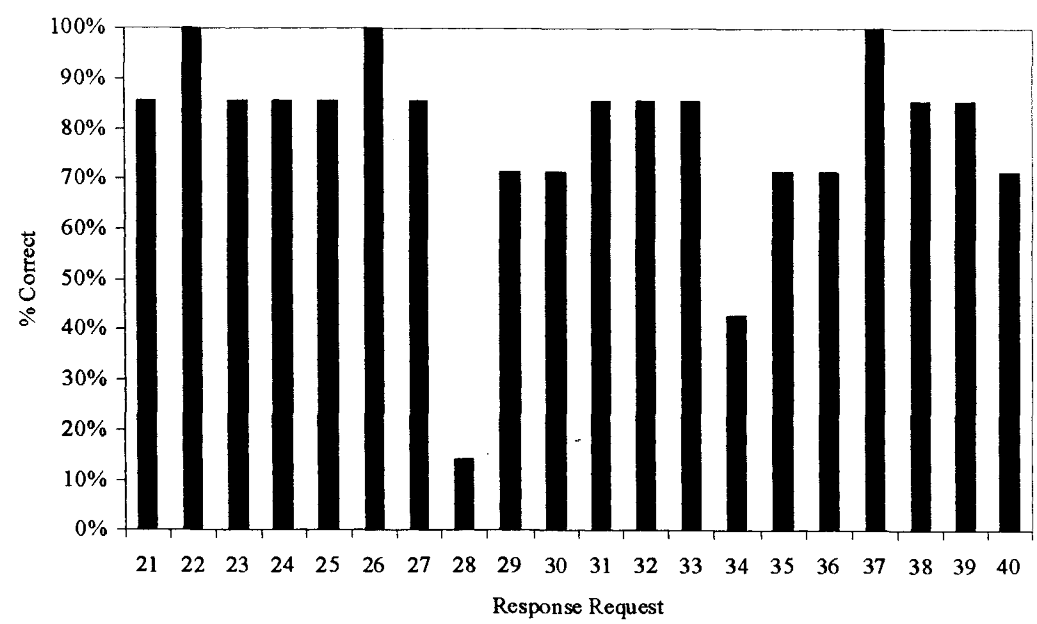


Figure 6. Beta2 Performance on Application Section of Posttest, across Response Requests.

Performance on Beta2 instruction is depicted in Figure 7. Performance ranged from 12.5% to 100% across response requests. On average, learners made the correct response on the first attempt on 83.3% of the 24 response requests in the instruction. Response requests with high error rates were identified as 11, 14, and 15.

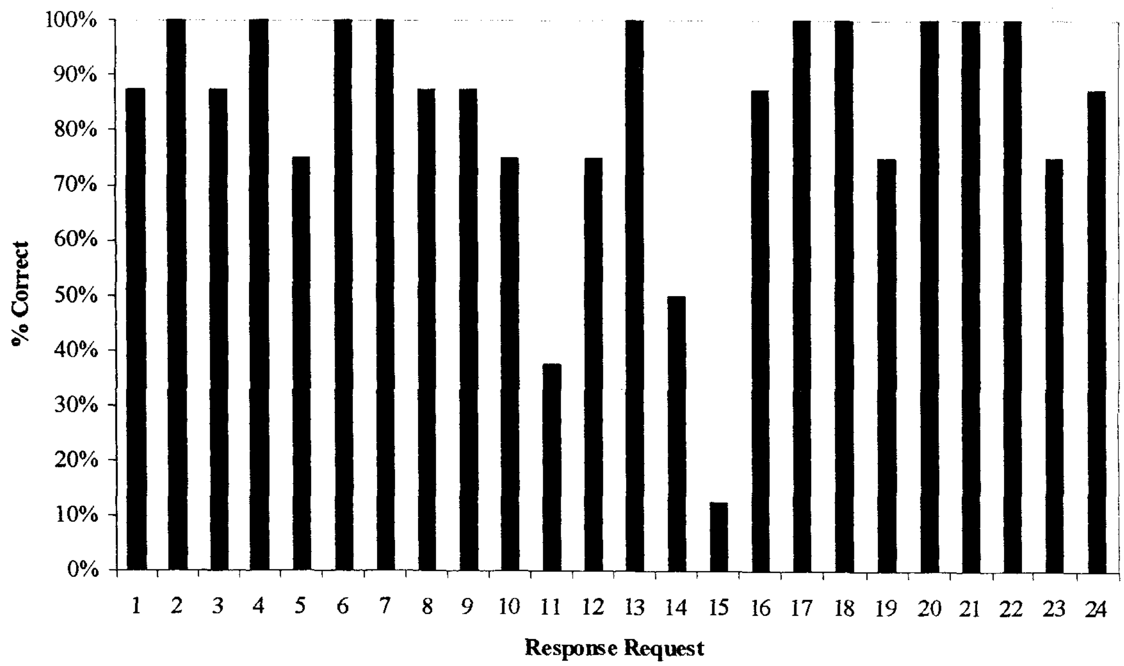


Figure 7. Beta2 Performance on Instruction, across Response Requests.

Again, high instructional error rates did not always mean high error rates on equivalent posttest questions. Table 2 shows that only one of the high error instruction response requests had a high error rate for the corresponding posttest question.

Table 2

Percentage Correct across High Error Rate Instruction Response Requests and Corresponding Posttest Response Requests for Beta2

Instruction Response Request	% Correct	Corresponding Posttest Response Requests	% Correct
11	37.50%	13	25.00%
14	50.00%	22	87.50%
		26	87.50%
		27	87.50%
		38	75.00%
15	12.50%	23	75.00%
		24	75.00%
		25	75.00%

Priority was given to posttest response requests that had high error rates in both Beta1 and Beta2 versions. Those response requests included 9, 11, 28, and 34. Potential causes of learner errors were again hypothesized and potential revisions were determined:

- *Error:* Putting the values for the FACE attribute with the FONT command

  Hypothesized Cause: History in which the name of a font is labeled as a "font" rather than a "font face"

  Potential Fix: Consider this a key teaching point and point it out to learners
- *Error* Failing to use quotation marks when required for values

  Hypothesized Cause: Insufficient practice using values

  Potential Fix: Fluency training in creating novel HTML tags

Revisions that were made are detailed in the Procedure section of Chapter 2.

Pretest-to-Posttest Improvement

The Beta1 and Beta2 versions of the instruction both produced significant improvements from pretest to posttest. (See Table 3)

Individual participants' pretest-to-posttest improvement are depicted in Figures 8 and 9. Every participant scored higher on the posttest than the pretest. However, analysis of the Beta2 data identified one score as an outlier, $V(1, 13) = 33.39$, $p<.01$. It's not certain why the outlier occurred. The learner who attained the outlier score revealed to the experimenter that he had been an undergraduate student for about ten years. It's possible that he had weak reading skills or other learning deficits. Results are provided with and without the outlier; data without the outlier are identified as modified.

Table 3

t-Tests of Pretest-to-Posttest Improvement

Version of instruction	Mean difference	Correlated-t	df	*p*
Beta1	.7094	9.52	7	0.00
Beta2	.6656	7.02	7	0.00
Beta2-modified	.7429	11.69	6	0.00

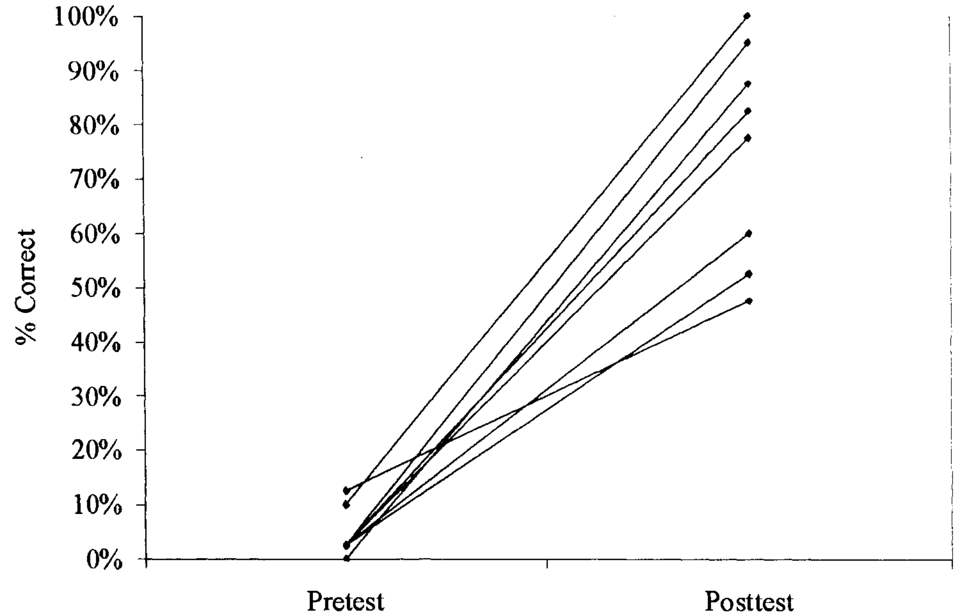


Figure 8. Beta1 Pretest-to-Posttest Improvement.

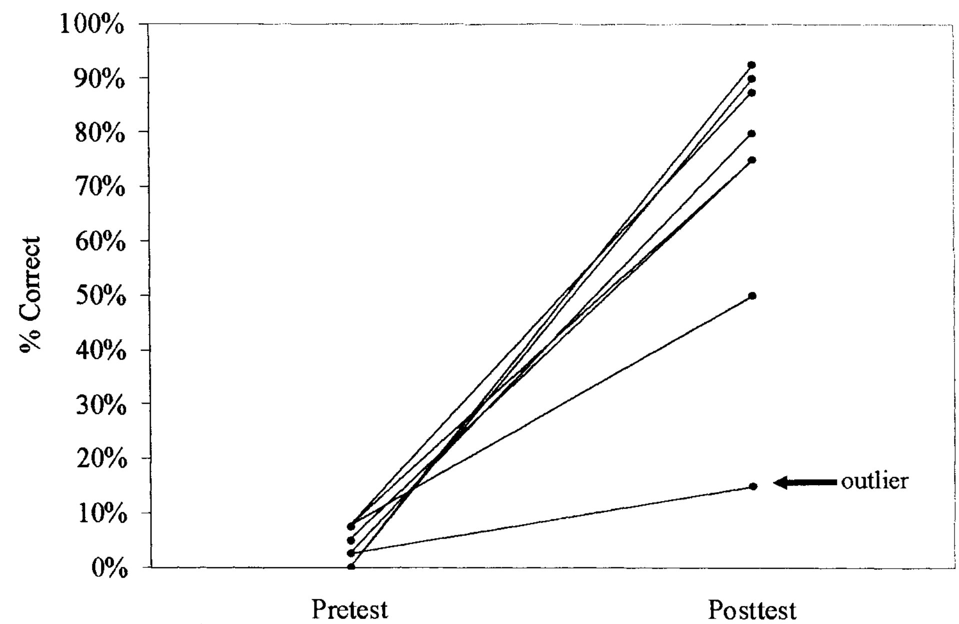


Figure 9. Beta2 Pretest-to-Posttest Improvement.

Posttest Improvement and Instruction Correlations

Correlations between posttest improvement scores and performance during instruction are shown in Table 4 and Figures 10 and 11. A moderate correlation was found for Beta1 data, and a significant correlation for Beta2 data. However, when the outlier was removed from Beta2 data, no significant correlation remained.

Table 4

Correlations between Posttest Score and Instruction Improvement Score

Version of instruction	Pearson r	n	*p*
Beta1	.605	8	.112
Beta2	.769	8	.026
Beta2-modified	.088	7	.852

Comparison of Beta1 and Beta2

Posttest

No statistically significant difference was found between Beta1 and Beta2 posttest scores, when the pretest score was used as a covariate, with the complete data set $F(1, 13) = .18, p = .68$ or with the modified data $F(1, 12) = .12, p = .73$.

Instruction

No statistically significant difference was found between participants' performance on Beta1 ($M = .789$, $SD = .114$) and Beta2 ($M = .823$, $SD = .124$) instruction with the

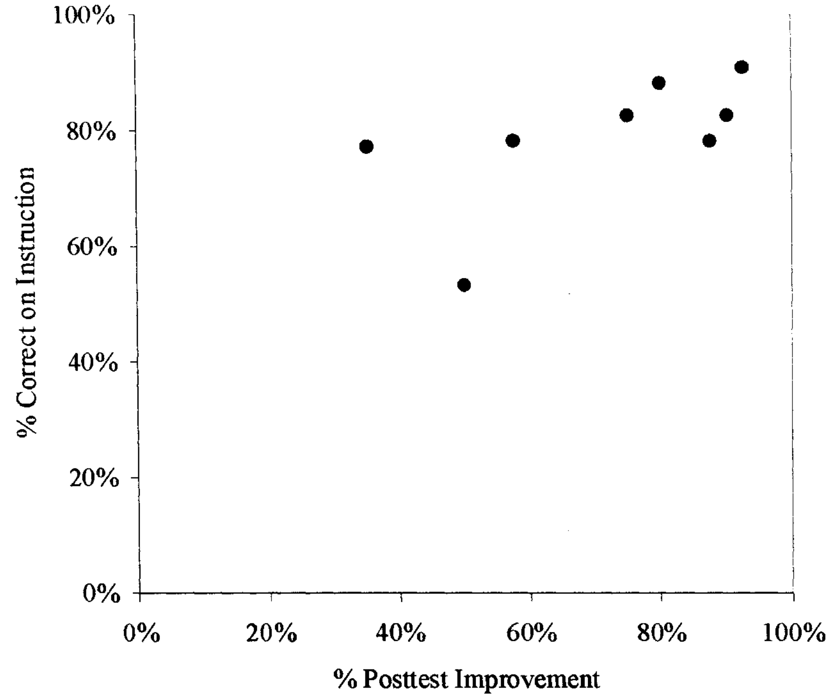


Figure 10. Correlation between Beta1 Posttest Improvement and Instruction.

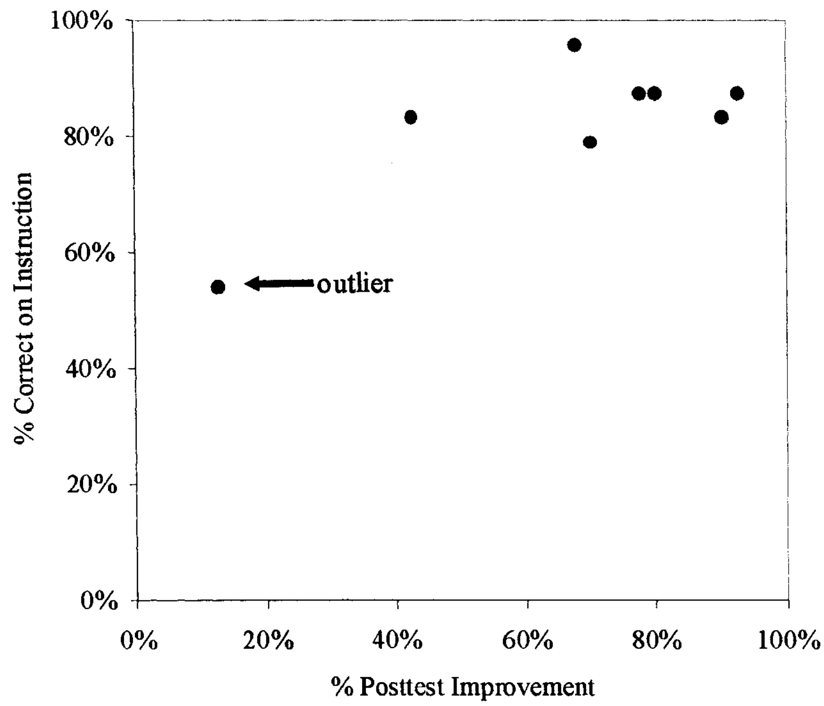


Figure 11. Correlation between Beta2 Posttest Improvement and Instruction.

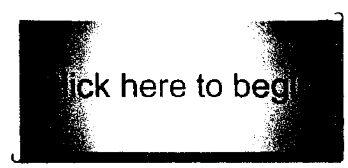
data set, $t(14) = -.56$, $p = .58$, or with the modified data ($M = .8631$, $SD = .0522$), $t(13) = -1.64$, $p = .13$.

APPENDIX H

Screenshots of Instructional Module Frames

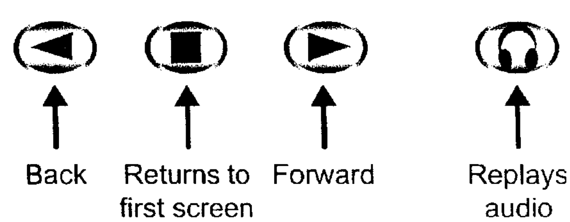
Introduction to
Hypertext Markup Language
(HTML)

Enter your ID above



Navigation

- This lesson is divided into screens
- Navigate with buttons on the bottom



Welcome to *Introduction to HTML*. Before we start the lesson, you must learn how to navigate.The lesson is divided into screens. You can navigate between screens by clicking on the buttons below. Click the Forward arrow now.

Screen 1 of 81

Navigation

- Some frames require more than reading
- Complete all instructions

You should complete every screen before proceeding. That means you should read everything on the screen, and *follow any instructions* that are given. Some screens will require you to do more than read, such as answer questions.

Screen 2
of 81

Introduction

What you will learn:

- What HTML is used for
- Basic structure of HTML
- Required tags
- Saving an HTML document
- Viewing HTML document as a web page

Let's begin! This lesson will introduce you to HTML. You will learn what it's used for, what its basic structure is, some tags that are required in every HTML document, how to save an HTML document, and how to view it as a web page.

Screen 4
of 81

What is HTML

```
<HTML><HEAD> <TITLE>Toads</TITLE></HEAD>

<BODY BGCOLOR="7B52A5">
<H1> REASONS TO LOVE TOADS</H1>

<IMG SRC="toad.jpg" ALT="Toad">

<P>Some people dislike toads. These people have
obviously not been told of all the wonderful things
there are about toads.<P> Thus, I present to you
some of the many reasons to like toads:
```

← Compose HTML document in in a text editor or word processor

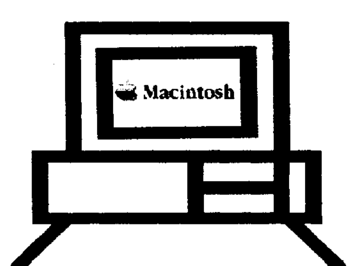
View as web page →

HTML, or Hypertext Markup Language, is the language used to create web pages. All web pages are created using HTML. HTML is written in a text editor or word processor and viewed as a web page using an Internet browser.

Screen 5 of 81

What is HTML

HTML Document



Because HTML is saved as Text Only or ASCII, any computer can read HTML, regardless of whether it is an IBM or Macintosh, and regardless of the operating system used. This feature is called universality.

Screen 6 of 81

What is HTML

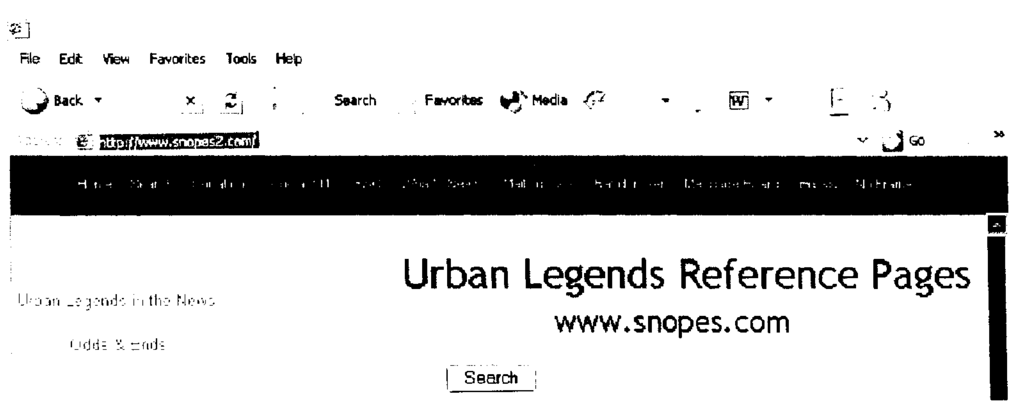
Affect a web page's appearance:

- User's computer
- Internet connection speed
- Monitor
- Browser

However, universality does not mean that web pages will look exactly the same to everybody. A variety of things, such as the user's computer, Internet connection speed, monitor, and particularly the person's browser can affect how a web page looks.

Screen 7 of 81

What is HTML



Hold your mouse over the page to see the same webpage in a different brower.

For example, the same webpage might look different in Internet Explorer and Netscape Navigator. This is why it's ideal to view the page in both Netscape and Internet Explorer (the two most popular browsers) when writing HTML code.

Screen 8 of 81

What is HTML

Where can HTML be written? (choose ALL that apply):

- O ***in a text editor***
- O ***in a word processor***
- O ***in a web page***

Click on the correct answers.

Let's do a quick review. Answer the questions.

Screen 9
of 81

What is HTML

Where can HTML be written? (choose ALL that apply):

- ✓ ***in a text editor***
- ✓ ***in a word processor***
- *in a web page*

Right! HTML is viewed on a web page, but it is written in a text editor or word processor.

Screen 10
of 81

What is HTML

What does universality mean in reference to HTML?

- O ***Any computer can read HTML***
- O ***Web pages created with HTML will look the same.***

Click on the correct answer.

Screen 11
of 81

What is HTML

What does universality mean in reference to HTML?

✓ ***Any computer can read HTML***

Web pages created with HTML will look the same.

Right! Any computer can read HTML but the web pages may not look the same.

Screen 12
of 81

HTML Basics

```
<HTML>
<HEAD> <TITLE> Brad's Web Page</TITLE></HEAD>
<BODY>
<P>Welcome to my web page.
<P>I live in Dallas Texas, and I like to write poetry and play soccer.
Click on the links below to read original poetry.
</BODY>
</HTML>
```

Now that you know what HTML is used for, let's look at the content of an HTML document. An HTML document consists of text and tags. Tags are special instructions that are enclosed between the "greater than" and "less than" symbols, which are called angle brackets.

Screen 13
of 81

HTML Basics

opening tag — HTML — closing tag

<I> Bob's Web Page </I>

Resulting web page

Bob's Web Page

Tags usually include an opening tag and a closing tag which affect the text between them. The closing tag has a forward slash. For example, the tags to italicize text are <I> and </I>. Some commands do not require a closing tag.

Screen 14
of 81

HTML Basics

affected text

HTML

<I> Bob's Web Page </I>

Resulting web page

Bob's Web Page

The tags will not show up on your web page. Only the affected text will be visible.
The tags tell the computer how to format the content of the web page.

Screen 15 of 81

HTML Basics

<FONT>

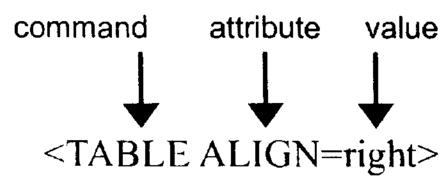
<font>

<fOnT>

Tags are not case sensitive. You can use any combination of uppercase and lowercase letters. The commands are written in uppercase in this instruction to make them easier to see.

Screen 16 of 81

HTML Basics



Tags like the <I> tag are very straightforward and include just the command. However, an HTML tag can include up to three parts: the command, attributes, and values.

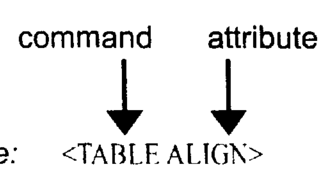
Screen 17 of 81

HTML Basics

Attributes:

- Options for HTML tags
- One command can have multiple attributes
- Put a space between command and attribute
- Put spaces between multiple attributes

Example:



Attributes specify options for the command. For example, the ALIGN attribute specifies alignment options for the TABLE command. Attributes are written after the main command with a space between them. A command can have more than one attribute. Put a space between multiple attributes.

Screen 18 of 81

HTML Basics

In which tag is the COLOR attribute written correctly?

- O *<FONTCOLOR>*
- O *<FONT COLOR>*
- O *<FONT> <COLOR>*

Click on the correct answer.

Let's see if you understand how to format attributes.

Screen 19 of 81

HTML Basics

In which tag is the COLOR attribute written correctly?

<FONTCOLOR>
✓ *<FONT COLOR>*
<FONT> <COLOR>

Right! The COLOR attribute is written after the FONT command with a space dividing them.

Screen 20 of 81

HTML Basics

In which tag is the COLOR attribute written correctly?

<FONTCOLOR>
✓ <FONT COLOR>
<FONT> <COLOR>

What is the best way to write COLOR and SIZE attributes for the FONT command?

o <FONT COLOR;SIZE>
o <FONT COLOR SIZE>
o <FONT COLOR> <FONT SIZE>

Click on the correct answer above.

Now can you identify how to format two attributes for one command?

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HTML Basics

In which tag is the COLOR attribute written correctly?

<FONTCOLOR>
✓ <FONT COLOR>
<FONT> <COLOR>

What is the best way to write COLOR and SIZE attributes for the FONT command?

<FONT COLOR;SIZE>
✓ <FONT COLOR SIZE>
<FONT COLOR> <FONT SIZE>

Right! COLOR and SIZE are both attributes of the FONT command and thus come after the command, with a space between every word. The third option would work, but it's simpler to put both attributes in the same tag.

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HTML Basics

Values

- Attributes have values
- Written after attributes with an equal sign

attribute value

Example <TABLE ALIGN=left>

Attributes usually have values. For example, the ALIGN attribute for the TABLE command can have values that can align the table to the left, right, or center. Values are written after an equal sign following the attribute.

HTML Basics

When do values not have to be enclosed in quotation marks?

- When they contain no special characters (only letters, numbers, periods, or hyphens)

Example <FONT SIZE=4>

slashes

Nonxamples <A HREF="http://www.fakepage.com">

space

<IMG SRC=image.gif ALT="frog photo">

Values are often enclosed in quotation marks. But they are not required when values only contain letters, numbers, periods, or hyphens. If they include any other characters, such as forward slashes or spaces, they must be enclosed in quotation marks.

HTML Basics

When in doubt, use quotation marks for values

However, it's never wrong to use quotation marks in values. Thus, if you're not sure, use quotation marks.

Screen 25
of 81

HTML Basics

In which example is the value written correctly?

- O ***<FONT FACE="Times New Roman">***
- O ***<FONT FACE Times New Roman>***
- O ***<FONT FACE=Times New Roman>***
- O ***<FONT FACE: "Times New Roman">***

Click on the correct answer above.

Screen 26
of 81

HTML Basics

In which example is the value written correctly?

✓ **<FONT FACE="Times New Roman">**

<FONT FACE Times New Roman>

<FONT FACE=Times New Roman>

<FONT FACE: "Times New Roman">

Right! The value has spaces which are special characters, and must be enclosed in quotation marks. Values follow equal signs, not colons.

Screen 27 of 81

HTML Basics

In which example is the value written correctly?

O ***<TABLE BORDER="4">***

O ***<TABLE BORDER: "4">***

O ***<TABLE BORDER=4>***

O ***<TABLE BORDER 4>***

Click on the correct answer above.

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HTML Basics

In which example is the value written correctly?

✓ **<TABLE BORDER="4">**

<TABLE BORDER: "4">

✓ **<TABLE BORDER=4>**

<TABLE BORDER 4>

Right! Quotation marks are not required because there are no special characters, but they can always be used. Thus, either answer is correct.

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of 81

HTML Basics

What is the opening tag for making text bold?

- O <\B>
- O <B>
- O </B>

Click on the correct answers above.

Let's do a quick review of opening and closing tags. Given that the command for making text bold is "B", what would the opening tag look like?

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of 81

HTML Basics

What is the opening tag for making text bold?

<\B>

✓ <B>

</B>

What is the closing tag for making text bold?

- O <\B>
- O <B>
- O </B>

Click on the correct answers above.

Right! What would the closing tag look like for the same command?

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HTML Basics

What is the opening tag for making text bold?

<\B>

✓ <B>

</B>

What is the closing tag for making text bold?

<\B>

<B>

✓ </B>

Right! Remember that the closing tag has a forward slash, not a backslash.

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HTML Basics

Opening Tag

<FONT FACE=Arial COLOR=red>

Closing Tag

</FONT>

Don't use the attributes and values in the closing tag. Only include the command.

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of 81

HTML Basics

Type the opening tag for the command described below:

Submit

Type the correct answer in the box above and click the Submit button.

Example: To create a bulleted list with circular bullets, you would use the command "UL" (which stands for "unordered list"), the attribute "SHAPE" and the value "circle". How do you write the opening tag?

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of 81

HTML Basics

Check your answer.

<UL SHAPE=circle>

<UL SHAPE=circle>

Check your answer.

Your answer should look like the tag below it. If it doesn't, use the Back button and change your answer. If it does, click the Forward button.

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of 81

HTML Basics

Write the closing tag.

Submit

Type the correct answer in the space above and click the Submit button.

Now type the closing tag for the same command.

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of 81

HTML Basics

Check your answer.

</UL>

</UL>

Check your answer.

Check your answer against the one below it. Be sure that you used a forward slash rather than a backslash. Make changes if necessary, or click Forward to continue.

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HTML Basics

Write the correct tag based on the information below.

Submit

Click in the box and type the correct answer above.

Let's try another example. Write the opening tag to make the font color red and the font size 6.

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HTML Basics

Check your answer.

<FONT COLOR=red SIZE=6>

<FONT COLOR=red SIZE=6>

Click in the box and type the correct answer above.

Check your answer and make any necessary changes before proceeding.

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HTML Basics

Write the closing tag.

Submit

Type the correct answer in the space above and click the Submit button.

Type the closing tag for the same command.

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HTML Basics

Check your answer.

<FONT COLOR=red SIZE=6>

<FONT COLOR=red SIZE=6>

Click in the box and type the correct answer above.

Check your answer and make any necessary changes before proceeding.

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of 81

Required HTML Tags

Now that you've learned the basic structure of HTML tags, you should learn some specific tags. You will be creating an actual HTML document in a text editor and viewing it as a web page.

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Required HTML Tags

Certain tags are required in every HTML document. You will learn and practice the tags in this lesson, and eventually copy your work into a document. You will be creating your very first web page in that document.

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Required HTML Tags

First, you need to tell the computer that you are creating an HTML document. You use the <HTML> and </HTML> tags to do this. These tags go at the beginning and end of your document. Write these commands in the space above.

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Required HTML Tags

<HTML>

</HTML>

eck your answ

Great! Now check your answer by holding your mouse over the button above and comparing the correct answer to your answer. (Take the mouse off the button if you want to see your answer again.) The spacing between tags isn't important, but the tags should be identical. Go back and make changes if necessary.

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Required HTML Tags

<HTML>

</HTML>

The HTML tag is actually not required for most web browsers, but it is still appropriate to use, just in case a browser does it require it. It's standard practice to treat it as a required tag.

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Required HTML Tags

HEAD section

- Title
- Keywords for search engines
- Content not visible on web page

Your HTML document is divided into two sections: the HEAD and the BODY. The HEAD contains information about the web page, including the title, and key words for search engines. The information in the HEAD is not visible on the web page.

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Required HTML Tags

HEAD section

- Title
- Keywords for search engines
- Content not visible on web page

BODY section

- Contents of web page
  - --text
  - --graphics
  - --links

The BODY section includes the content of your web page. This includes the text, graphics, and links that will be visible on your web page.

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Required HTML Tags

<HTML>

</HTML>

Add the opening and closing HEAD and BODY tags to your document above. The HEAD section comes first. Remember that the HTML tags are at the beginning and end of your document.

Required HTML Tags

<HTML>

<HEAD></HEAD>

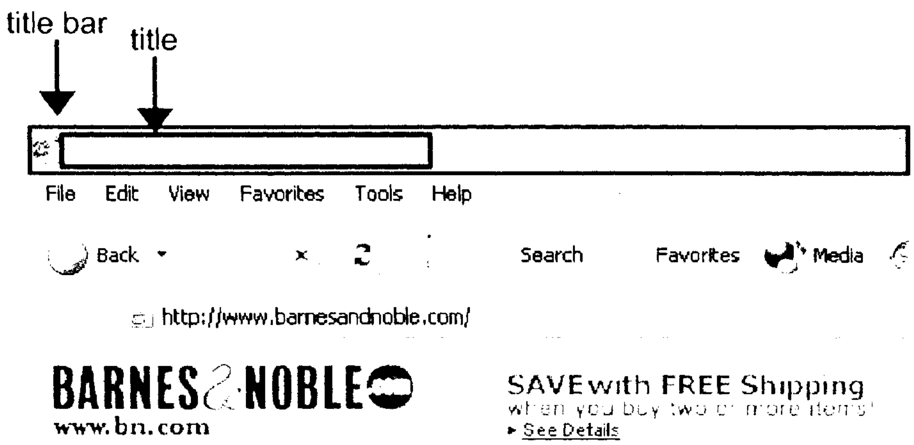
<BODY></BODY>

</HTML>

eck your answ

Check your answer and go back and make changes if necessary. Again, the number of spaces between the tags is not crucial. The computer will ignore any spaces between tags, so you can space them how you like.

Required HTML Tags



The title of your HTML page is included in the HEAD section of the document. A title is recommended for every web page. Typically, the title will appear in the title bar of the web page window. The title is often used by search engines such as Yahoo, and will be used when people bookmark your web page in their browser.

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Required HTML Tags

<HTML>

<HEAD></HEAD>

<BODY></BODY>

</HTML>

Add a title to your document. Remember that the title is enclosed in the HEAD section of the document. First add the opening and closing TITLE tags. Then enclose the title between those tags. Use this title: *Husky's Snowshoe Gear.*

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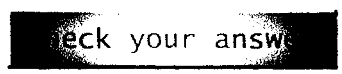
Required HTML Tags

```
<HTML>

<HEAD>
<TITLE>Husky's Snowshoe Gear</TITLE>
</HEAD>

<BODY></BODY>

</HTML>
```



Check your answers and make any necessary changes.

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of 81

Required HTML Tags

```
<HTML>

<HEAD>
<TITLE>Husky's Snowshoe Gear</TITLE>
</HEAD>

<BODY></BODY>

</HTML>
```

These are the tags that make up the skeleton of every HTML document. Now it's time to create an actual HTML document.

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Required HTML Tags

Text Editors	**Word Processors**
• Word Pad (Windows)	• Microsoft Word
• Notepad (Windows)	• Corel WordPerfect
• SimpleText (Macintosh)	• Lotus Word Pro

Create blank Notepad document.

Create a new (blank) document in Notepad. You could do this in any text editor or word processor, such as the programs listed above. But for the purposes of this lesson, you'll be using Notepad.

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Required HTML Tags

```
<HTML>

<HEAD>
<TITLE>Husky's Snowshoe Gear</TITLE>
</HEAD>

<BODY></BODY>

</HTML>
```

Now select all your text above and copy it using CTRL-C (push the CONTROL key and c key at the same time). Then paste it in your Notepad document by either using CTRL-V or by selecting Paste from the Edit menu in Notepad. Now all your tags should be in the Notepad document.

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Saving HTML Documents

Saving an HTML document

- Save as Text Only

Now you need to learn how to save an HTML document. HTML documents are saved as Text Only documents. Text only means that the document only contains ASCII characters. (ASCII is a code that uses binary digits to represent characters.) Text Only does not include formatting such as bold, italics, and so forth.

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Saving HTML Documents

Saving an HTML document

- Save as Text Only
- Use .htm or .html extension

However, although you are saving your file as a text only file, you must give it an .htm or .html extension so you can view it as a web page.

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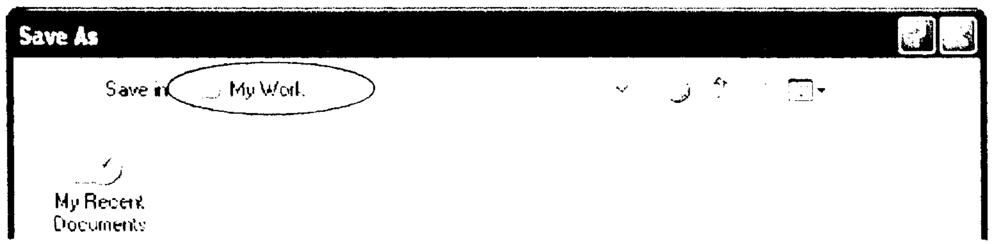
Saving HTML Documents



Open the folder.

For this lesson, you will be saving your documents onto your floppy disk in the My Work folder. Thus, select Save As from the Notepad file menu. Where it says Save In, find the My Work folder on the A drive and select it.

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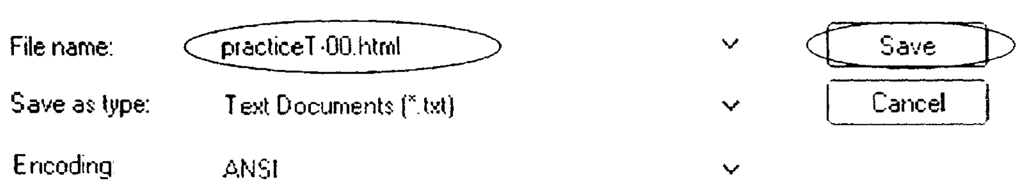
Saving HTML Documents



Save the document.

For File name, type "practice" followed by your ID number. Add a .htm or .html extension to the file name. Then click the Save button.

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of 81

Required HTML Tags

An HTML document is made up of what two sections?

- O ***TITLE and BODY***
- O ***HTML and BODY***
- O ***HEAD and TITLE***
- O ***HEAD and BODY***

Click on the correct answer above.

Great! You've learned the basic structure of an HTML page and how to save an HTML document. Before proceeding, let's do a review. Answer the questions.

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Required HTML Tags

An HTML document is made up of what two sections?

TITLE and BODY

HTML and BODY

HEAD and TITLE

✓ ***HEAD and BODY***

Right!

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Required HTML Tags

Where does the TITLE go in an HTML document?

- O ***in the HEAD section***
- O ***in the BODY section***

Click on the correct answer above.

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of 81

Required HTML Tags

Where does the TITLE go in an HTML document?

✓ ***in the HEAD section***

in the BODY section

Right!

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of 81

Required HTML Tags

Where does the TITLE appear on your webpage?

At the top of the webpage as a heading

✓ ***On the titlebar***

T/F: The contents of the HEAD section of an HTML document are typically not visible on the web page.

- O ***True***
- O ***False***

Click on the correct answer above.

Right! The title will appear in the titlebar. If you want to put a title at the top of your page, you will have to put it in the BODY section.

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Required HTML Tags

Where does the TITLE appear on your webpage?

At the top of the webpage as a heading

✓ ***On the titlebar***

T/F: The contents of the HEAD section of an HTML document are typically not visible on the web page.

✓ ***True***

False

Right!

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Saving HTML Documents

HTML documents should be saved as what kind of files?

- ○ ***Text Only***
- ○ ***Web pages***
- ○ ***Word processing documents***

Click on the correct answer above.

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Saving HTML Documents

HTML documents should be saved as what kind of files?

- ✓ ***Text Only***
- *Web pages*
- *Word processing documents*

Right!

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Saving HTML Documents

Which of these extensions could be used when saving an HTML file? (select ALL that apply)

- O ***.htm***
- O ***.html***
- O ***.exe***
- O ***.doc***

Click on the correct answer above.

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of 81

Saving HTML Documents

Which of these extensions could be used when saving an HTML file? (select ALL that apply)

- ✓ ***.htm***
- ✓ ***.html***
- .exe
- .doc

Right! Either of the first two is acceptable. Just remember to use one of them every time you save your file.

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of 81

Required HTML Tags

What section of your HTML document includes the content that is visible on your web page?

- O ***the HEAD***
- O ***the TITLE***
- O ***the BODY***

Click on the correct answer above.

Now it's time to add some content to your web page. Do you remember what section of your HTML document contains the content?

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Required HTML Tags

What section of your HTML document includes the content that is visible on your web page?

the HEAD

the TITLE

✓ ***the BODY***

Right!

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of 81

Required HTML Tags

Remember that saving your document as Text Only means that formatting, such as bold, text, spacing, etc., is lost. Thus, you must use HTML tags to tell the computer how to format the text on the web page.

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Required HTML Tags

Husky's Snowshoe Gear

Minnesota's premier snowshoe outfitter
since 1887

Type the text above into your document using same spacing.

For example, let's put some text in your document and see how it looks on the web page. In the appropriate section of your HTML document, type the text above. Use the same paragraph spacing. Now resave your file correctly.

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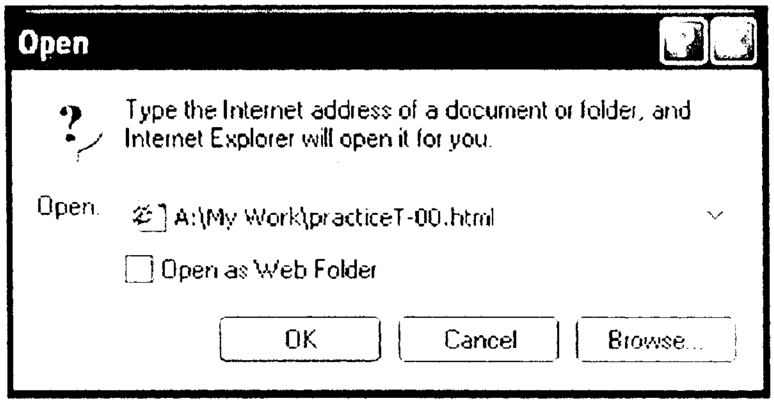
Required HTML Tags



Open the web page you created.

Now you should view the web page you have created. Open Internet Explorer. From the File menu, select Open. Browse to find the file you just saved, and open it.

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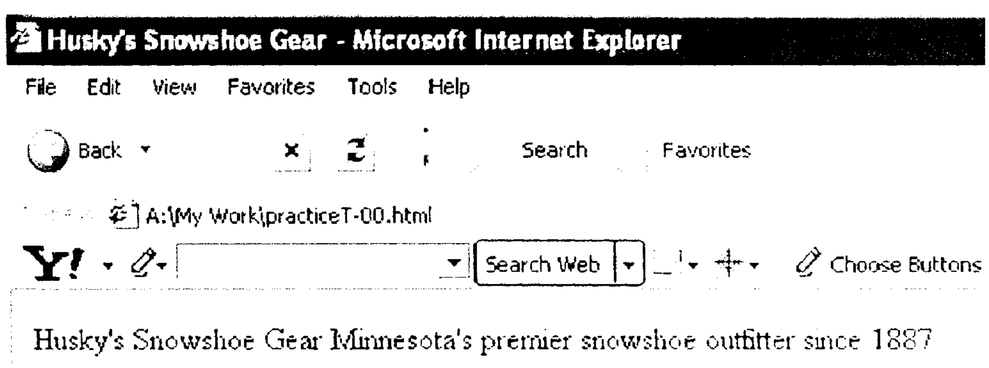
Required HTML Tags



Do you notice anything? That's right, your formatting is gone. Formatting must be done with commands in HTML.

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Required HTML Tags

Tag	Purpose
 	To move to the next line (BR stands for "Break")
<P> & </P>	To skip a line (P stands for "Paragraph")

The closing tag </P> is optional.
**There is no closing tag for
**

Using the tags listed above, put the correct spacing in your document.

So, how can you put in the spaces correctly? The relevant commands are listed above. Use these commands to add the necessary line spacing to your document.

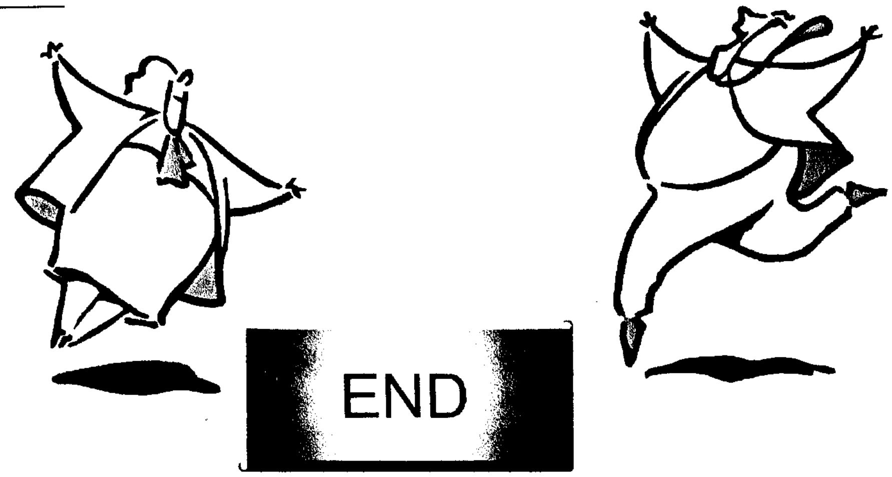
Required HTML Tags

```
<HTML>
<HEAD><TITLE>Husky's Snowshoe Supply</TITLE>
</HEAD>

<BODY>Husky's Snowshoe Gear<P>Minnesota's Premier Snowshoe
Outfitter<BR>since 1887

</BODY>
</HTML>
```

Using the tags listed above, put the correct spacing in your document.

Resave your document. If your browser is still open, click the Refresh button. Otherwise, open your document again in the browser. Does the text look correct now? If not, compare your HTML document to the text above and make any necessary corrections. The spacing between tags doesn't matter.

Conclusion



Please take the posttest.

Congratulations! You've completed the module introducing you to HTML. You've learned what HTML is, the basic required tags, how to save an HTML document, and how to view it in an Internet browser. Click the END button above, and get the posttest.

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APPENDIX I

Initial and Final Debriefing Letters

Dear Participant:

Thank you very much for participating in this research study entitled *Audio Narration and Reading Ability in Programmed Instruction*.

The purpose of the study is to examine how three different types of instruction impact learning for people who score differentially on a reading assessment. The three types of instruction that we are examining are: instruction with audio information, instruction with written information, and instruction with audio and written information. The type of instruction you received was <insert type of instruction>. Your participation is very valuable to us in looking at the effects of these types of instruction.

Your scores on the reading test, pretest, and posttest, as well as your payment, will be sent to you within 2 weeks of this session.

If you have any questions about this study, please contact Wendy Jaehnig at wendy@behtech.com or 269-598-8580.

Again, thank you for your valuable participation.

Sincerely,

Wendy Jaehnig, M.A.

Wendy Jaehnig, M.A.
Psychology Department
3700 Wood Hall
Western Michigan University
Kalamazoo, MI 49008-5439
Date

Participant Name
Address of participant
City, State, Zip Code

Dear Participant Name:

Thank you very much for participating in our research study entitled *Audio Narration and Reading Ability in Programmed Instruction*.

The purpose of the study is to examine how three different types of instruction impact learning for people who score differentially on a reading assessment. The three types of instruction that we are examining are: instruction with audio information, instruction with written information, and instruction with audio and written information. The type of instruction you received was <insert type of instruction>. Your participation is very valuable to us in looking at the effects of these types of instruction.

Your score on the reading test was: <insert score>. Your score on the pretest was: <insert score>, and your score on the posttest was <insert score>.

We have enclosed your payment, which is $5.00 each for completing the reading test and instruction, and up to $10 each for the pretest and posttest, based on your score. Thus, your payment is: $5.00 (reading test) + $X.XX ($10 x <insert pretest score>) + $5.00 (instruction) + $X.XX ($10 x <insert posttest score>).

If you have any questions about this study or your results, please contact Wendy Jaehnig at wendy@behtech.com or 269-598-8580.

Again, thank you for your valuable participation.

Sincerely,

Wendy Jaehnig, M.A.

REFERENCES

ACT, Inc. (2005). 2005 National Score Report: Data Tables. *Five-Year History of College-Bound Student's scores*. Retrieved April 24, 2006, from the ACT Inc. Web site: http://www.act.org/news/data/05/pdf/tsum.pdf.

ACT, Inc. (1997). *ACT assessment technical manual*. Iowa City, IA: Author.

ACT, Inc. (2003). *Preparing for the ACT assessment: 2003-2004*. Iowa City, IA: Author.

Allen, M. (2003, December). The lessons of e-learning. *Optimize,* pp. 51-52, 54-56.

Anderson, R. C. (1967). Educational Psychology. *Annual Review of Psychology, 18*, 129-164.

Anderson, R. C., & Faust, G. W. (1967). The effects of strong formal prompts in programmed instruction. *American Educational Research Journal, 4,* 345-352.

Anderson, R. C., Kulhavy, R. W., & Andre, T. (1971). Feedback procedures in programmed instruction. *Journal of Educational Psychology, 62*(2), 148-156.

Anderson, R. C., Kulhavy, R. W., & Andre, T. (1972). Conditions under which feedback facilitates learning from programmed lessons. *Journal of Educational Psychology, 63*(3), 186-188.

Barron, A., & Atkins, D. (1994). Audio instruction in multimedia education: Is textual redundancy important? *Journal of Educational Multimedia and Hypermedia, 3*(3/4), 295-306.

Barron, A. E., & Kysilka, M. L. (1993). The effectiveness of digital audio in computer-based training. *Journal of Research on Computing in Education, 25*(3), 277-289.

Barton, E. A., & Dwyer, F. M. (1987). The effect of audio redundancy on students' ability to profit from printed-verbal/visualized instruction. *International Journal of Instructional Media, 14*(2), 93-98.

Beccue, B., Vila, J., & Whitley, L. K. (2001). The effects of adding audio instructions to a multimedia computer based training environment. *Journal of Educational Multimedia and Hypermedia, 10*(1), 47-67.

Bersin & Associates. (2003, June). Is Powerpoint an e-learning tool? CA: Author.

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). *Learning style and pedagogy in post-16 learning: A systematic and critical review.* (Reference no. 041543). London: Learning and Skills Research Centre.

Crosbie, J., & Kelly, G. (1994). Effects of imposed postfeedback delays in programmed instruction. *Journal of Applied Behavior Analysis, 27*, pp. 483, 491.

Ducharme, J. M., & Worling, D. E. (1994). Behavioral momentum and stimulus fading in the acquisition and maintenance of child compliance in the home. *Journal of Applied Behavior Analysis, 27*, 639-647.

Feldhusen, J. F., & Birt, A. (1962). A study of nine methods of presentation of programmed learning material. *Journal of Educational Research, 55*, 461-466.

Hart, P. D. (2003). *The state of our nation's youth, 2003-2004*. Alexandria, VA: Horatio Alger Association of Distinguished Americans, Inc. (ERIC Document Reproduction Service No. ED467373).

Holland, J. G., & Kemp, F. D. (1965). A measure of programming in teaching-machine material. *Journal of Educational Psychology, 56*, 264-269.

Huitema, B. E., & McKean, J. W. (2006). RANOVA – RGLM's ANOVA [Computer program]. Available from Western Michigan University's Department of Statistics Web site, http://www.stat.wmich.edu/slab/RGLM.

Imel, S. (2002). *E-learning trends and issues alert no. 40.* Columbus, OH: ERIC Clearinghouse on Adult, Career, and Vocational Education (ERIC Document Reproduction Service No. ED469265).

Jasper, F. (1991). The relationship sound-image. *International Journal of Instructional Media, 18*(2), 161-174.

Jaehnig, W. (2003). *Development of a computer-based programmed instruction program.* Unpublished thesis. Western Michigan University, Kalamazoo.

Jaehnig, W., and Miller, M. L. (in press). Feedback types in programmed instruction: A systematic review. *The Psychological Record.*

Jeung, H., Chandler, P., & Sweller, J. (1997). The role of visual indicators in dual sensory mode instruction. *Educational Psychology, 17*(3), 329-343.

Kalyuga, S., Chandler, P., & Sweller, J. (1999). Managing split-attention and redundancy in multimedia instruction. *Applied Cognitive Psychology, 13*, 329-350.

Kalyuga, S., Chandler, P., & Sweller, J. (2000). Incorporating learning experience into the design of multimedia instruction. *Journal of Educational Psychology, 82*(1), 126-136.

Kemp, F. D., & Holland, V. G. (1966). Blackout ratio and overt responses in programmed instruction: Resolution of disparate results. *Journal of Educational Psychology, 57*, 109-114.

Klement, J. J., Lumsden, D. B., & Shearon, R. W. (1973). Learning of redundant materials presented through one versus two sensory modalities. *Programmed Learning and Educational Psychology, 10*(2), 65-68.

Koroghlanian, C., & Klein, J. D. (2000). The use of audio and animation in computer based instruction. *Annual Proceedings of selected research and development papers presented at the National Convention of the Association for Educational Communications and Technology, USA, 1-2,* 141-149.

Kozberg, L. (2001, December 12). *House-Senate Education Conference Report: No Child Left Behind.* Retrieved March 10, 2002, from the U.S. Department of Education Web Site: http://www.ed.gov/PressReleases/12-2001/12112001b.html

Kroll, H. M. (1974). The relative effectiveness of written and individualized audio instruction on the intermediate grades. *AV Communication Review, 22*(3), 247-268.

Kulhavy, R. W. (1977). Feedback in written instruction. *Review of Educational Research, 47*(2), 211-232.

Lai, S. (2000). Increasing associative learning of abstract concepts through audiovisual redundancy. *Journal of Educational Computing Research, 23*(3), 275-289.

Leahy, W., Chandler, P., & Sweller, J. (2003). When auditory presentations should and should not be a component of multimedia instruction. *Applied Cognitive Psychology, 17*, 401-418.

Lublin, S. C. (1965). Reinforcement schedules, scholastic aptitude, autonomy need and achievement in a programmed instruction course. *Journal of Educational Psychology, 56,* 295-512.

Markle, S. (1990). *Designs for instructional designers* (3rd ed.). Champaign, IL: Stipes Publishing Company.

Mayer, R. E., & Anderson, R. B. (1991). Animations need narrations: An experimental test of a dual-coding hypothesis. *Journal of Educational Psychology, 83*, 484-490.

Mayer, R. E., & Anderson, R. B. (1992). The instructive animation: Helping students build connections between words and pictures in multimedia learning. *Journal of Educational Psychology, 84*, 444-452.

Mayer, R. E., & Moreno, R. (1998). A split-attention effect in multimedia learning: Evidence for dual processing systems in working memory. *Journal of Educational Psychology, 90*(2), 312-320.

Mayer, R. E., & Sims, V. K. (1994). For whom is a picture worth a thousand words? Extensions of a dual-coding theory of multimedia learning. *Journal of Educational Psychology, 86*, 389-401.

McArthur, D. (2003). Why plan for e-learning? *Planning for Higher Education, 31*(4), 20-28.

McKean, J. W., & Vidmar, T. J. (1994). A comparison of two rank-based methods for the analysis linear models. *The American Statistician, 48*(3), 220-229.

Mellan, I. (1936). Teaching and educational inventions. *The Journal of Experimental Education, 4*, 291-300.

Miller, M. L., & Malott, R. W. (1997). The importance of overt responding in programmed instruction even with added incentives for learning. *Journal of Behavioral Education, 7*(4), 497-503.

Miller, M. L., & Malott, R. W. (in press). Programmed instruction: Construction responding, discrimination responding, and highlighted words. *Journal of Behavioral Education.*

Moore, J. W., & Smith, W. I. (1961). Knowledge of results in self-teaching spelling. *Psychological Reports, 9,* 717-726.

Moore, J. W., & Smith, W. I. (1964). Role of knowledge of results in programmed instruction. *Psychological Reports, 14,* 407-423.

Mousavi, S. Y., Low, R., & Sweller, J. (1995). Reducing cognitive load by mixing auditory and visual presentation modes. *Journal of Educational Psychology, 87*(2), 319-334.

Mullich, J. (2004). A second act for E-learning. *Workforce Management, 83*(2), 51-52, 54-55.

National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. *Elementary School Journal, 84*(2), 113-130.

Pace, G. M., Ivancic, M. T., & Jefferson, G. (1994). Stimulus fading as a treatment for obscenity in a brain-injured adult. *Journal of Applied Behavior Analysis, 27,* 301-305.

Patel, M. R., Piazza, C. C., Kelly, M. L, Oschsner, C. A., & Santana, C. M. (2001). Using a fading procedure to increase fluid consumption in a child with feeding problems. *Journal of Applied Behavior Analysis, 34,* 357-360.

Peterson, P. E. (Ed.). (2003). *Our schools and our futures: Are we still at risk?* Stanford: Hoover Institution Press.

Pressey, S. L. (1950). Development and appraisal of devices providing automatic scoring of objective tests and concomitant self-instruction. *The Journal of Psychology, 29*, 412-447.

Pridemore, D. R., & Klein, J. D. (1991). Control of feedback in computer-assisted instruction. *Educational Technology Research and Development, 39*(4), 27-32.

Rosenstock, E. H., Moore, W. J., & Smith, W. I. (1965). Effects of several schedules of knowledge of results on mathematics achievement. *Psychological Reports, 17*, 535-541.

Roper, W. J. (1977). Feedback is computer assisted instruction. *Programmed Learning and Educational Technology, 14*(1), 43-49.

Skinner, B. F. (1957). *Verbal behavior*. Acton, MA: Copley Publishing Group.

Skinner, B. F. (1968). *The technology of teaching*. New York: Appleton-Century-Crofts.

Skinner, B. F. (1983). *A matter of consequences*. New York: Knopf.

Skinner, B. F. (1986). Programmed instruction revisited. *Phi Delta Kappan, 68*(2), 103-110.

Tindall-Ford, S., Chandler, P., & Sweller, J. (1997). When two sensory modes are better than one. *Journal of Experimental Psychology: Applied, 3*(4), 257-287.

Tudor, R. M. (1995). Isolating the effects of active responding in computer-based instruction. *Journal of Applied Behavior Analysis, 28*, 343-344.

Tudor, R. M., & Bostow, D. E. (1991). Computer-programmed instruction: The relation of required interaction to practical application. *Journal of Applied Behavior Analysis, 24*, 361-368.

U. S. Department of Commerce: U. S. Census Bureau. (2001). *Home computers and Internet use in the United States: August 2000*. Washington, DC: Newburger, E. C.

U. S. Department of Education, National Center for Education Statistics. (2003a). *Distance education at degree-granting post secondary institutions: 2000-2001*. Washington, DC: Waits, T., & Lewis, L.

U. S. Department of Education, National Center for Education Statistics. (2003b). *Internet access in U. S. public schools and classrooms: 1994-2002*. Washington, DC: Kleiner, A. & Lewis, L.

Vargas, E. A., & Vargas, J. S. (1996). B. F. Skinner and the origins of programmed instruction. In L. D. Smith & W. R. Woodward (Eds.), *B. F. Skinner and behaviorism in American culture* (pp. 237-253). London: Associated University Presses.

Wentling, T. L. (1973). Mastery versus nonmastery instruction with varying test item feedback treatments. *Journal of Education Psychology, 65,* 50-58.