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The Effect of Audio Narration in Computer Mediated Instruction on Procedural Fluency by Students of Varying Reading Levels

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THE EFFECT OF AUDIO NARRATION IN COMPUTER MEDIATED
INSTRUCTION ON PROCEDURAL FLUENCY BY STUDENTS OF VARYING
READING LEVELS

BY

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ABSTRACT

This study compares the effect of text-based and narration-based multimedia presentation modalities on the accuracy and efficiency of procedural performance, a combination that the introduction to the New Standards for Elementary, Middle, Secondary, and Continuing Education of the New York State Education Department uses as the definition of "procedural fluency" (New York State Education Department, 2005). In addition, this study also examines the influence of reading skill on both procedural fluency resulting from and student choices of presentation modalities. By studying community college students with low computerized placement test scores, a wide range of reading skill levels was sampled. The independent variable, was the mode of presentation (text only, narration only, and learner’s choice) in instruction to teach a new computer procedure.

While results showed no overall advantage for any of the treatment conditions in procedural fluency, improvement was seen in the amount of time it took for students to complete the tutorial lesson when they were allowed to choose their preferred mode for receiving the lesson. The results showed that a disproportionately large portion of those students who failed to complete the procedure at all had been placed into the mode where reading was chosen for them. It was recommended that unless other factors dictate that the use of spoken presentations is counter-productive to the learning at hand, narration be included as an alternative presentation modality. This was recommended to increase the accessibility of the instructional product, to reduce the amount of time spent going through the lesson, and to increase the likelihood that learning of the procedure will take place.
CHAPTER 1:

INTRODUCTION

Background

As the capabilities of multimedia computers keep improving and prices decrease, they become increasingly attractive to educators. The ability to record and play audio is now a standard feature, and video is a common option. However, little instructional software actually includes the use of audio (Bishop, 2000). Bishop's study found that the use of sound in instruction has generally been limited to system warning beeps and reinforcing feedback like beeps and buzzers.

Failure to include sound in a meaningful way in instructional software has been attributed to technical, human physical, or logistical problems (Hogg, 2001), as well as to a lack of empirical evidence that sound makes a difference in the effectiveness of instruction. (Koroghlanian & Sullivan, 2000). Designers may think it is a good idea to use sound in instructional software because of its being our most natural form of communication. But a lack of research-based guidelines for where and when it is to be used leads to a feeling that it is slow, intrusive, and tiresome (Gardenfors, 2001). Research on the use of sound should focus on how and when to use it to achieve its maximum learning benefit. This research could lead to the development of guidelines for designers of instructional materials.

Media comparison studies often reach a conclusion that there is no significant difference in the amount of information students successfully acquire that could be uniquely attributed to the choice of media. Richard Clark (1983) took note of the lack of
successful studies and suggested that the media form that delivers the content has as much importance for learning as the truck that delivers groceries has for nutrition. Clark's message to media researchers is that it is important to maintain constancy in content and method in order to attribute learning differences to attributes of media.

Clark's point of view is considered controversial. In response to Clark, Kozma (1991) argued that different media forms have structures that support different symbol systems (cf. Salomon, 1979). For instance, while text is extremely stable, it may sometimes be ambiguous. In such a case, a change from a stable medium to a transient medium such as speech, could be used to resolve ambiguity and increase the likelihood that learning will occur. A point Kozma makes in response to Clark is that the choice of instructional media is integrated into the method of instruction. Part of the business of designing instruction is to anticipate what learners need and to choose the medium that best fulfills that need. This entails an awareness of the attributes different media forms possess and integration of the strengths of these attributes into the way instruction is designed.

Sound, as a stimulus, provides information from which we can learn. However sound is a media attribute rather than a medium of its own. The ability to deliver sound is a characteristic of some media forms and not of others. Paintings, posters, filmstrips, overhead projectors, and blocks of text do not have this ability. Multimedia computers, video and audio tape do. If Clark's delivery truck analogy were extended to the use of sound, sound might occupy the position of refrigeration in the truck. Fresh groceries delivered in vehicles with refrigeration, whether the vehicles are trucks, trains, or ice cream wagons, will be nutritionally different than fresh groceries delivered in vehicles without refrigeration.

Bishop and Cates (2001a) claim that sound has yet to be fully integrated into educational portions of most applications in ways that assist learning. While it is used very successfully in games to increase believability, arouse emotions, and enhance immersion, they argue, "its ability to do this has not been taken advantage of in educational software design." Going back to Clark's analogy again, what they claim is the equivalent of saying that nobody has yet turned on the refrigeration in the delivery truck.
In their call for small steps of research about how to use sound effectively in instructional software, they include a call for research that indicates whether sound will be effective for particular groups of learners, such as poor readers (Bishop and Cates, 2001b). It is generally acknowledged that acquisition of information from reading, once reading skill reaches a moderate level, becomes faster than acquisition of information from listening (Taylor, 1964). Reiser and Gagne (1983) expect proficient readers to prefer printed materials to spoken materials. On the other hand, Anderson-Inman et al (1990) note that several studies of less proficient readers point to the conclusion that for these learners, listening to speech provides an additional, possibly supplemental, information channel that can enhance learning.

**Significance of the Study**

Perhaps the inclusion of sound in instructional software can be used to increase the effectiveness of instruction for a learning population with poor reading skills. This would seem to be especially true where procedural skills are taught because the students can perform the steps leading to the skill while listening to the instruction. It will be helpful to see whether instructional software using narration to teach procedures will make a difference in how well the procedures are learned. The New Standards for Elementary, Middle, Secondary, and Continuing Education of the New York State Education Department defines procedural fluency as "the skill in carrying out procedures flexibly, accurately, efficiently, and appropriately." (New York State Education Department, 2005). When providing instructions about procedures, the goal is to see that the learners become fluent with the procedures they learn.

**Purpose of the Study**

The purpose of this study was to investigate the effect of sound in computer mediated software designed to teach procedures on student performance by both proficient and less proficient readers.
Research Questions

Specific research questions investigated by the study include:
1) What is the effect on procedural fluency when students learn from narrated rather than textually presented multimedia software?
2) Is there a differential learning effect for low reading ability learners of learning a procedure from narration rather than text?
3) If narration is optional and under user control, will learners with low reading ability choose to use it?
CHAPTER 2:

LITERATURE REVIEW

Introduction

The literature related to the choice between speech and text as a way to present information to learners contains numerous items, of which few are backed by empirical research. A long history of instructional models based on lecturing leads to a presumption that listening to a human voice is a natural part of human learning. But this conclusion seems so intuitive that it is rarely tested. Instead, theories about the nature of human cognition are called on in support of teaching by speaking.

This chapter looks at cue summation and dual channel theories to explain how they both support the use of speech as a way of presenting instruction. The information-processing model of human cognition is considered along with recommendations that can be derived for the use of the human voice in delivering instructional messages. Two aspects of instructional design, a need for redundancy and a need to get attention are considered.

Empirical evidence from attempts to introduce sound in earlier technologies will be examined. Media research is included that involves the effectiveness of human speech as it as been presented in media forms of radio, film, television, and computers. The choice of variables for the present study is based on previous media research studies and their results. An explanation is presented of why a demonstrable result was likely to be seen from the present study. Finally, a section is included indicating what results are expected and the reasons why these expectations are likely to be met.
Theories

Cue-summation and dual-modality models of human cognition provide a theoretical framework for expecting sound to enhance instructional presentations. According to a cue-summation model, the presence of a spoken explanation adds auditory cues to the many different cues otherwise already included with the presentation, thereby giving learners more opportunities to find appropriate cues. Dual modality models hold that the human senses each have a portion of short-term memory devoted to tasks associated with remembering that particular sensory input. According to the theories behind these models, information can be brought to memory more efficiently in multiple sensory channels, as long as there is no conflicting or distracting information in the information carried by these channels. It is likely that sound can serve several roles in the learning process. In addition to providing redundancy, sound is known to be useful in gaining and keeping attention.

Redundancy, the presentation of messages more than once, improves how reliably messages are delivered. Increased reliability gained through redundancy, however, requires the addition of more time and resources to the repetition of the message. Sound enables spoken text to add redundancy to visually presented text. But it requires more time for learners to complete their instruction since readers typically acquire information much faster by reading instead of listening, particularly those in later grades. Using sound redundantly, therefore, risks providing unneeded support that wastes the time and energies of learners who do not need it.

Supporting Theoretical Considerations

For purposes of concentrating on what to include in instructional software, the information-processing model is most commonly used as the foundation of current design models (cf. Reynolds & Iwinski (1995), Clark (1995), and Bishop & Cates (2001b). Most information processing models include the following features that characterize both
computer systems and human learners: 1) The presence of at least two different types of memory - long term and short term - with long term being more stable and short term being volatile and immediate; 2) The presence of sensory registers that accumulate information from the outside environment; 3) Movement of information through short term memory and into long-term memory; 4) ability to retrieve information from long term memory and use it to produce some type of observable effect. Within this framework, narration is one form of information input that uses the human auditory system to get information from outside the system to short term memory.

Theoretical support for the inclusion of sound usually involves theoretical discussion of the limitations and properties of different parts included within the main model. Cue summation theory (Severin, 1967) claims that as long as the cues provided for the multiple sensory channels are all relevant to the subject, learning will be more effective as the number of available cues or stimuli are increased. However the introduction of irrelevant cross-channel cues will result in inferior communication and less effective learning. Standing alongside this theory is the dual coding theory. Paivio (1971) held that recall and retention of information would increase when the information is supported by both verbal and non-verbal cues. While Paivio originally suggested the two channels mentioned, supporters of cognitive load theory (Mayer, 1997; Kalyuga, Chandler, & Sweller, 2000) associated the channels of instructional message processing with the sensory modalities by which they are delivered. Mousavi, Low, and Sweller (1995) found experimental support for this position. In investigations involving geometry learning by 8th grade students, they found that groups receiving information presented simultaneously in both visual and auditory channels consistently solve both similar and transfer problems in testing conditions in significantly less time than groups receiving information presented by a combination of visual text and visual illustrations.

Fleming and Levie (1978) suggested as a result of studies contained in their analysis of instructional message design that the capacity for processing seems to be larger when two modalities are used in the presentation. Studies they examined indicated that multichannel combinations of words and related images provide maximum gain effect. However, multichannel combinations of the same verbal content presented in both text and audio forms provide no communication gain, while multichannel communication
of unrelated cues causes interference and reduction of message reception. These conclusions indicate that mixed results of studies are to be expected, and that design of multichannel combinations is needed to enable the combination of channels to be used effectively for instruction.

**Redundancy**

Theoretical positions about communication lead to different and conflicting views of the value of redundancy for learning. Barron and Atkins (1994) used the issue of redundancy to separate the single channel (cue summation) theory from the dual channel theory. In their study of undergraduate education majors learning about CD-ROM technology from two computer based training programs that differed in the levels of spoken and textual redundancy presented, they suggested that a finding of no significant difference between treatments could lend support to the single channel theory (Broadbent, 1958). However, while they found no significant difference in learning that could be attributed to the amount of redundancy present, their finding could as easily be explained by the dual coding theory since the treatments of visually presented and auditorily presented text both use the verbal channel. One limitation to their experimental design was that it did not allow learners to switch the sound on or off as needed. It was also confined to a population, senior level college undergraduates, for whom text-based presentation is generally regarded favorably as a presentation method.

While acknowledging that the most efficient mode of instruction depends on the experience level of the learners, Kalyuga, Chandler, and Sweller (2000) include among the principles of cognitive load theory a caution that redundancy imposes an additional cognitive load and thereby reduces learning effectiveness. Kalyuga's (2000) analysis of studies where learning effects from dual mode presentation fail to occur indicates that total redundancy of spoken and textual presentations typically characterizes these failures. Bishop and Cates (2001b) place redundancy into the Shannon and Weaver (1969) communication model as useful for reducing distracting noise but costly because it simultaneously reduces message acquisition rate.

In studies related to learning effects achieved by audio redundancy, Lai (2000) found that for college students learning computer-programming languages, the addition of audio to the text made the learning take longer. This indicates that audio slows down the
acquisition of text based material if it is limited to a redundant duplication of what the
text says. Within the same study, Lai also found that non-redundant audio increases the
learning that results from the use of dynamic graphics (animations).

Barton and Dwyer (1987) had earlier seen a negative impact from the addition of a
totally redundant audio track to the amount of content about the heart acquired by adult
learners of low IQ. Their audio presentation method was to use an audio tape that was not
controllable by the users. It was difficult to draw a conclusion about the value of audio
redundancy since unanticipated factors like the tape playback rate being too fast for
acquisition to occur, could have easily influenced the outcome. In addition, their
designation of some adult night class students as low IQ based on the median of a single
class (median IQ = 118), did not find a sample in the general population that could really
be characterized as having low IQs.

Rehaag and Szabo (1995) achieved a mixed result from adding a redundant audio
track to text appearing onscreen. Working with tenth grade mathematics students, they
found that high ability learners had a slower acquisition rate when redundant audio was
added to the text. This may have been expected since high ability students generally
acquire information from reading at a faster rate than that at which they acquire it from
listening. Offsetting this effect, however, was a notable decrease in the time it took for the
same set of students to solve transfer problems. Since quick problem solving indicates
greater automaticity (Sweller, 1999), this may be taken as an indication of the success of
the redundant audio as a presentation method.

In general, the results of research on audio redundancy are mixed. Szabo (2001)
suggests that research on audio in multimedia rarely identifies the type of audio
information involved, which results in confusion about what the results mean. In addition,
another body of research focuses on including redundant audio because doing so
increases inclusiveness and adaptability of multimedia products (Downie & McCann,
2001; Edwards, 1992). To allow focus on a limited number of issues, the use of sound to
enhance computer usability for the blind or visually impaired is not considered in this
study.
**Attention**

Except where there are visual or auditory disabilities, sensory modalities of vision and hearing provide inputs to the brain that continually compete for attention. Mechanisms exist in both these modalities for ignoring as well as for attending. If learning is to take place, it is necessary that the senses be brought into a condition in which they attend to rather than ignore the subject at hand. Gagne, Briggs and Wager (1992) position the gaining of attention as the first event in instruction. In light of the importance of gaining attention, they recommend that lessons be planned with options for gaining attention. To the extent that spoken sound is one of these options, it clearly has a role to play.

The sense of hearing differs from the sense of vision in many ways, among which is a capacity to receive sensory input from any direction. Auditory interface designer Dan Gardenfors (2001) notes that when considered on its own, sound is independent of a screen. Seels, Berry, Fullerton, and Horn (1996) described an effect of the sound track in childrens' television of gaining attention of non-viewing children. They further reported on experimental research on the viewing habits of children watching Sesame Street in which attention to the program dropped significantly when the audio message was degraded enough to become unintelligible (Anderson, Lorch, Field & Sanders, 1981).

**Design Recommendations for How to Use Sound**

Deatherage (1972) conducted a meta-analysis of research on the way sound is used to present information. He concluded that the choice of using sound information, visual information, or a combination of the two depends on properties of the instructional message to be delivered. While recommending particular processing that could be done with the sound, such as increasing the volume of the sound in the frequency range associated with the fundamental frequencies of human speech, he notes that attention is gained by odd sounds. While he specifically mentions warbles, the changing nature of the sound is mentioned as the reason for its attracting attention.

Thompson, Simonson, and Hargrave (1992) conducted a meta-analysis about the value of change in sound as a device for maintaining attention. Like Deatherage (1972),
they reached the conclusion that the audio channel helps gain attention when the audio is interjected rather than constant. They also concluded that narration accompanied by visuals should be presented more slowly than narration without the visuals.

Olsen (1995) conducted another study, this one in the field of advertising, about the use of change in sound to focus attention. He found not only that change helped attract attention, but also that a change to a moment of silence is as powerful at gaining attention as the introduction of new sounds. Whether for a speaker or for background music, pauses for a short moment of silence just before a key point is introduced leads to increased retention of that point.

Change in sound is recognized as an important element in sound's ability to gain and maintain attention. Fleming and Levie (1978), in their book about the design of instructional messages, broke attention into 3 phases: a pre-attention phase in which no message is attended to, a change, and then active attending. They suggest that keeping attention is best done through the frequent introduction of change. And the best effect can be achieved by using change to direct attention to the most relevant parts of the message. They also claim that attention to messages depends on the design of the devices used to summon it.

Fleming and Levie go on to recommend that the instructional messages carried by speech need special care and that points need to be emphasized and brief when presented in the longer speech contexts. Because loading auditory sequences onto short-term memory until the moment of phrase completion constricts auditory perception, long phrases increase the memory load. Narration, when included, needs to be designed so that it does not cause phrase length to exceed perceptual capacity.

Similar concern about the length of spoken messages are carried into the multimedia software field by Boyle (1997) who cautions that speech can provide information without adding visual distraction, but the risk of auditory distraction is substantial unless sound clips are kept short. He also recommends ending clips as soon as learners do anything in their interaction with the computer to indicate that they want to direct their attention to something else.

A similar concern about the power of sound to distract is mentioned by Bishop and Cates (2001a) who advocate the use of sound in multimedia instructional software in
spite of a caution by former Apple interface designer Alan Cooper (1995) that sound is more distracting than valuable. But they see sound as playing a key role because of its attention getting and attention sustaining properties.

Despite cautions about its distracting nature, the ability of sound to focus attention is also a consideration. Shih and Allessi (1996) recommend the use of sound for providing information while not distracting visual attention. The advantages of narration include: 1) an increase in realism that does not inhibit learning by introducing extraneous visual detail, 2) the use of two modalities for learning that takes advantage of research findings indicating that students learn more when information is presented in both seeing and hearing modalities, as well as 3) advantages for working with learners with limited text enablement. (Shih & Alessi, 1996)

Dual modality as an advantage to introducing sound in multimedia is mentioned by Kalyuga, Chandler, and Sweller (2000) among their recommendations for the design of multimedia instruction. They state as one of the principles of cognitive load theory, that the auditory sense provides a second channel for receiving elements of information that reduces the split attention in the visual channel by removing the need for a visual search. Hence, they claim, the replacement of visually presented text with its narration focuses attention on visual presentations.

Sweller (1998), interpreting cognitive load theory, cautions designers to avoid splitting learners' attention. Such splitting occurs when mutually referring, multiple sources of information, that are unintelligible in isolation, are formatted in a manner that restricts attention to only one source at a time. Split-attention can be reduced by physically integrating multiple sources of information. Placing text on a diagram provides a simple example of a way to reduce a split attention effect. Another is replacing some written text with an auditory presentation in order to increase effective working memory size by using both auditory and visual working memory channels.

In the guidebook to using Authorware, a computer program used for creating instructional software, Ruth Clark (1995), notes the need to gain attention as one of the processes required of human learning. She echoes the earlier advice by Bangert-Drowns and Kozma (1989), of the Educational Product Information Exchange, that the value of any of the elements of instructional software is its capacity to support persistence in the
learning task without drawing attention away from the focus on learning. If sound is an element of educational software, it must conform to this same standard.

**Media Research**

The spread of previous technologies into classrooms was accompanied by research into how well these technologies enhanced learning. Research into student learning from radio and film is of particular interest because both radio and film went through transitions in the technological capabilities of the media delivery system that allowed sound to be added to the original media product. This makes them similar to the current improvement of capability that allows computers to include sound as part of computer based instruction. Studies of these earlier media forms, however, showed few results indicating improved learning that resulted from their inclusion of sound.

Findings of no significant difference between instruction delivered by these media forms and instruction delivered by either reading or lectures indicated that while the use of these media forms does not significantly improve learning, neither does it significantly degrade learning. A few studies indicate that how these media are implemented makes a great difference in how effective they will be for enhancing instruction. Studies of the effectiveness of radio, for instance, show that professionalism of the radio speaker's voice improves instructional effectiveness. Studies of instruction delivered via film indicated that integration of the information contained in visual and auditory tracks provides instructional benefit. Studies of the use of sound in multimedia computers should build on other media attribute studies by following their recommendations as closely as possible.

**Radio**

In many ways, the growth in the use of computers parallels a similar growth pattern that occurred nearly a century earlier with the medium of radio. Both media forms underwent a transition from limited use by a few highly trained individuals to ubiquitous use by the general public. In both cases, technological changes in how the media carried information and the kinds of information it carried made growth possible. Radio started
as a means for transmitting bursts of energy that required Morse code to be able to use. Adding sound to the radio's capabilities made it a device that could be listened to for a greater number of purposes. Computers had originally been designed to accomplish difficult mathematical calculations. Changes in what the computer could do and how it presented its accomplishments to a user resulted in computers being used for purposes far removed from those envisioned in their original designs.

In both cases, educators recognized a potential for designing and distributing instruction in ways that had never been tried previously. Studies about early attempts to deliver instruction through radio will generally fall short of being directly applicable to proposals to use computers in new ways because the quality of the medium has improved while knowledge about learning processes has increased.

Quantitative results indicating that learning improves when radio is introduced to a learning environment are rare. Tyler's (1934) study of pupils in the Oakland, California schools occurred before there was a commonly used alternative media form with which radio could have been compared. So his finding of a student preference for dramatic presentation over lecture is based on two different delivery formats for the same medium. And there was no measurement of learning outcome to compare learning from the messages delivered in the formats studied. Williams, Paul and Ogilvie (1957), however, did find that radio delivery of a college anthropology text resulted in higher test scores than when the same material was read from a textbook or delivered in a face-to-face lecture. A factor that may account for the difference between the radio and lecture modes was the professionalism of the radio reader. The positive result for immediate learning was offset by a result in which a retention test administered after eight months indicated that those students who had initially learned from a face to face lecture outscored those who had heard the radio version.

**Motion Pictures**

Just as radio became more accessible to the general public as it added sounds instead of its original beeps of code, film progressed through a similar transition, adding sound to silent films. Unlike radio, however, film achieved commercial popularity before it added sound. Silent movies included a form of sound that was provided by live
musicians playing a musical score that accompanied the film. Initially, the musician did not support the film, but instead played to mask noise produced during reel change intervals. Only after some experimentation did musical accompaniment come to be integrated into the content. Modern day silent film music writer Rodney Sauer (1999) notes that as a medium develops and producers become more sophisticated, they move away from improvisation, which categorizes a medium at an early stage. The movement goes in the direction of planning the sound around the known visual images, and then proceeds to full integration in which visuals complement sounds as sounds complement visuals.

Integration of the visual and sound components of the film medium has long been acknowledged as improving the product. Arnspiger's (1933) review of instructional film teaching effectiveness studies found that in research where learning effects from film were greatest, 93% of the films had good or excellent integration, while in research where learning effects from film were least, only 32% had good or excellent integration. Meta-analysis studies of learning from film were also conducted by Mursell (1937) who found that most results indicated that the music in educational films was useful for enhancing the learner's psychological readiness, and by Hoban (1960) whose analysis indicated that learning from educational films was taking place.

Several additional studies of learning from educational film showed that the inclusion of sound enhanced learning from the films. Zuckerman (1949) found that Navy recruits were able to tie more knots in a fixed interval after listening to the sound track of a training film in second person imperative voice. While his results could be interpreted as indicating a preference for one grammatical form over another, the inclusion of a control group who heard no sounds at all indicates a result in favor of narration. Nelson and Moll (1950) found that college undergraduate test scores were higher when instructional films contained a soundtrack instead of blocks of text. Neu (1950) found that irrelevant sound used as an attention getting device could have a negative impact on learning. Neu (1951) conducted the same experiment a second time and achieved a result indicating that relevant sound was useful for cueing students that important items were being presented.
Additional studies about the inclusion of sound with instructional films showed mixed results. Ortgeisen (1954) found a positive learning result for the combination of sound motion pictures and silent filmstrips as the media used to present soil conservation lessons to high school students. But he also found that students who saw the same silent filmstrips in addition to reading the assigned text achieved higher test scores than those who saw the filmstrips and sound motion pictures in addition to reading the text. This result may be interpreted to mean that a third redundant source of the same information is counter-productive. Grosslight and McIntyre (1955) found a slight negative impact of sound motion pictures on learning of foreign language vocabulary and no instances in which films with sound were associated with higher student test scores. Craig (1956) saw a similar result when he found that grade school student test scores were higher when a teacher inserted comments about a film's visual content than when a soundtrack contained the instructional information. Rosselot (1961), on the other hand, found a positive impact of films with sound on high school French students' oral exam scores while scores achieved on printed exams declined for the same group. Tiemans (1962) played motivational films to high school algebra students and found that their scores on motivation tests increased. Subject matter learning was not measured in his study. Skinner (1963), however, found a positive impact on learning from sound films, but only when the voice used for the film spoke in clear and grammatically correct sentences. Ketcham and Heath (1963) found that the combination of seeing and hearing a film resulted in better test results than listening to the soundtrack. They found this to be the case in trials involving either one or three repetitions of the instructional presentation.

In general, most studies supported the use of moderate amounts of instructional film in classrooms where their novelty provided a welcome change from regular classroom routines. Reports on the effectiveness of film for the purpose of instruction are mixed and generally inconclusive. Consideration should be given to the notion that the motion pictures presented in classrooms were usually produced with budgets far less than those of commercial films. The software products that resulted were often poorly lit, poorly photographed, badly produced, and contained low quality sound tracks (Reid & MacLennan, 1967) which were projected in an environment of high background noise. Under the circumstances, the low effectiveness of instructional films may be attributed to
poor product quality rather than a failure of the medium itself, although the background noise was characteristic of the projectors themselves.

**Television**

Television use in the classroom was limited in comparison to the wide distribution of television receivers (TV sets) in homes. Consequently, much of the research about the effectiveness of educational television deals with effects of viewing Children's television in the home. One exception to this is Gladen (1971). He found significant improvement of content test score gains for first grade students in classes that watched a series of programs about conservation and forest fire prevention, when compared to a control group whose classes were taught by their regular teachers using the scripts from the TV series. Other than this, most research on the effectiveness of television was used internally by the Public Broadcasting System (Seels, Berry, Fullerton, & Horn, 1996). Existing studies of teaching with television tend to focus on how to teach with the medium. For instance, Field and Anderson (1985) looked at test question results that were divided into categories that depended on whether the information required was obtained from the visual track, the auditory track, or both (the AV track). The focus of their study, however, was on cueing learners that there would be a test. The effect they found in favor of cueing led them to support cueing as a practice prior to the presentation of content via television. They reported that the cueing intervention had its greatest effect on the content 5-year-old students learned from the visual track. While learning from the auditory track went up slightly in response to the cueing intervention, the relative constancy of learning in the auditory track was not regarded as a noteworthy result. They did not explore the possibility that the auditory track gets attention from the learner even when no cueing has occurred.

Burns and Anderson (1993) conducted a study of the accuracy of recognition memory for content presented with television. They found that adult viewers who were not looking at the screen when content switched were able to recall 50% of the content of the scene immediately after the switch. They compared this with 90% recall for those viewers who were looking at the screen. They reached an appropriate recommendation that the design of scenes in television should build attention just prior to a scene switch if
the content of the next scene is to be recalled. Their investigations did not examine the reason that 50% of the information in the second scene was recalled when the viewer was not looking at the screen, but this part of the recall could be attributed to the effectiveness of the audio track for holding attention.

**Computer Mediated Environments**

The widespread use of computers in classrooms invites studies about their educational effectiveness. The Apple Classrooms of Tomorrow project led Sandholtz, Ringstaff, and Dwyer (1997) to recommend that teachers can use computers most effectively by switching teaching styles to those that allow learners to actively explore computer mediated learning environments on their own. Bishop and Cates (2001a) suggest that sound is used in other environments, particularly video games, to increase believability, arouse emotions, and enhance immersion. Since these features help hold attention, it is reasonable to expect that sound will have a role to play in instructional software.

Mayer and Anderson's (1991) study of audio compared it with text as a way to add information to existing animated displays of the concepts concerned. Undergraduate students, shown an animated explanation of the operation of a bicycle pump, could answer more correct answers to problem solving questions about the pump when they had seen the animation accompanied with narration than when they had seen the animation accompanied with text.

Barron and Kysilka (1993) found no significant difference in learner achievement among undergraduate students given a lesson about technology integration in text only, full text with redundant audio, and bulleted text with audio forms. They concluded that screen design rather than learning issues provide the main reason for choosing to use audio.

Barron and Atkins (1994) varied the amount of text that accompanied an audio presentation. Among undergraduate students given a lesson about technology integration, they found it made no significant difference whether full text, bulleted text, or no text at all accompanied the narrated explanations. Their finding in the "no text" condition may
be taken to indicate that it is possible to completely replace at least some screen text with corresponding audio without any negative impact on learning.

Fitch and Kramer's (1994) study of learning among anesthesiology students indicates that sound can play an important role for procedural learning from simulations. In this study, rather than the presentation of material being changed to auditory form, the feedback to student performances in the situation was changed to an entirely auditory set of indicators. Fitch and Kramer found that even with time spent learning the auditory codes, students learned procedures more quickly and with greater accuracy than when their feedback was presented as a block of text. A reason the authors give for this result is that the presentation of information (in this case feedback information) about the complex procedure in auditory form allows the learner to maintain visual attention to the visual items in the simulation.

Gretes and Green (1994) conducted a study of specially designed software for improving reading speed and comprehension levels among low literate adult learners. The software was characterized by special attention paid to the choice of subject matter being tailored to interests of adult learners. Audio enhancement was available in the instructions of how to proceed and the presence of pronunciation samples of difficult words. In their study, learners using the software increased grade equivalent (GE) reading level by a mean of 1.4 GEs over the 11 weeks that the software was used. This was a significant improvement over previously used methods that averaged .25 GE improvement in the same time period. There was no study of the separate attributes of the software that indicated the extent to which audio influenced this result.

Koumi and Daniels' (1994) study of Open University students learning about computational methods added additional auditory information to the computer presentations in the form of external audio cassettes. These could be listened to while driving. This study added audio as an enhancement medium, but did not compare its effect with that of any other enhancement. Their finding, taken from survey data, indicated that the audio enhancements were well liked, and that students felt that they learned more during the sessions where tapes were available.

Mayer and Sims (1994) conducted an experimental study that compared the benefits of different narration timings for information presented in conjunction with
animations about bicycle pump operations and about the human respiratory system. They found that students who listened to concurrent narration produced more correct answers to problem solving questions than did students who heard the narration either before or after the animation. They found that this effect was particularly strong for student identified as having a high spatial ability. Both concurrent narration and subsequent narration groups outperformed a control group that was concurrently presented with text.

Mousavi, Low, and Sweller (1995) looked at similar problem solving time and transfer problem solving time among 8th grade math students after the method for solving problems was presented in one of three different ways. Presentation methods compared were a visual diagram with visually presented text, a visual diagram with visually presented and spoken text, and a visual diagram accompanied by only spoken text. Mean problem solving time for both similar and transfer problems was shortest for the students whose presentation consisted of the visual diagram accompanied only by the spoken text. They took their finding as evidence that the presence of the visual text concurrently with the diagram creates a visual distraction that increases cognitive load of the visual channel, and thereby makes learning less efficient.

Rehaag and Szabo (1995) compared math test score results for 10th grade students after they took a computerized math lesson presented either with sample problems and text or with sample problems, text, and redundant audio. They found that when the redundant audio was present, high ability students took longer to complete the lesson. However, they also found that the high ability students who took the lesson with the redundant audio present took less time to complete test questions. Overall test scores were not significantly different between groups.

Nocente (1996) measured test results among 12th grade trigonometry students at the conclusion of lessons presented either with text and diagrams or with narration and diagrams. She found that for students with low math reading ability, the presence of audio resulted in significantly higher test scores. This positive result was offset by a slightly (not significant) lower set of test scores achieved by student with high math reading ability. Survey results indicated that all students appreciated the inclusion of an option to turn off the audio. Monitoring of audio clip usage indicated that low math reading ability students listened to a mean of 21 of 25 available audio clips.
Shih and Alessi (1996) conducted a study of the effect of presentation method on test scores of college seniors enrolled in a photography course. Presentation methods tested were text, text with redundant voice, and voice only. Of these presentation methods, no significant difference was found on student test scores related to the material studied.

Koroghlanian and Sullivan (2000) investigated whether the presentation method affects student achievement, time-in-program, or attitude. The presentation versions they examined - text only, full text with full audio, and lean text with full audio - showed no significant result in favor of any of these treatments. Students finished studying the text only version more quickly. But this was accounted for by the required time for audio media to finish playing.

Lai (2000) conducted a study of the effect of matched redundant audio presentations on the test scores of undergraduate computer programming students. He found a significant improvement in learning result favoring the presentation of information via a combination of text, redundant audio, and dynamic graphics. These were compared with combinations of text, redundant audio, and static graphics; and with text and redundant audio only. The result seems to indicate that the learning effect is most directly related to the use of dynamic graphics. And since audio is used in all three conditions, its value was not under consideration in the study.

Moreno and Mayer (2000) conducted studies of undergraduate student retention of material contained in lessons about lightening formation and hydraulic braking systems. Their study held the presence of narration accompanying animation constant in all conditions while adding additional sounds to the narration in experimental groups. Their result indicated that the combination of narration and animation was significantly degraded by the addition of extra sounds in the form of background music or environmental sounds.

Beccue, Vila, and Whitley's (2001) study measured the effect of audio on pre-test to post-test gain by undergraduate students studying structured problem solving. They found that the inclusion of audio had no significant impact on gain. Survey data collected indicated that students in the audio condition disliked the lack of control over the audio and the requirement that audio clips must be played until they finished.
Solomon and Perez (2002) conducted a study of the effect of corrective feedback method on simulated performance of a mechanical disassembly procedure by vocational education students. They measured two methods of presenting feedback, one involving just text, and the other involving a combination of text, animated agents, audio and presentation of the feedback in question form. The treatments made no significant difference on either the total number of simulated errors made by students or the point at which students made their final error.

Considerations of Variables Chosen for the Present Study

While studies were found where sound-enhanced presentations resulted in increased achievement (Barton & Dwyer, 1987; Nocente, 1996; Williams, Paul & Ogilvie, 1957), many other studies (Barron & Atkins, 1994; Barron & Kysilka, 1993; Beccue, Vila, & Whitley, 2001) found no changes. In most instances where achievement results were anticipated, the tests administered were short multiple-choice tests. A conclusion of Najjar's (1998) meta-analysis of existing empirical research about multimedia principles was a recommendation to match the type of information tested with the type of information learned. Of the studies encountered in this review, only one - Rosselot's (1961) study of oral exam results in foreign language study - measured an auditorily based performance.

On the other hand, when measures other than multiple choice test scores were used as a measure of student learning, results supporting the use of audio were more likely to be found. This was the case with studies by Burns and Anderson (1993) about accuracy of recognition memory, Hartman (1961) about correct name recognitions, Mann (1979) about listening comprehension, and Mayer and Sims (1994) about correct solutions to problems. Mann's (1995) suggestion that visual media support detail learning while auditory media support gist learning may help to explain this measurement phenomenon, since details are often tested with multiple choice tests. Helgesen (1998) describes listening for gist as a form of listening in which each word is given consideration so that main ideas in passages can be discerned. He contrasts this with
listening for specific information, in which the listener approaches the listening task with the thought in mind of focusing only on specific information contained in the passage.

Dependent variables other than test scores have been shown to be better for reflecting gist learning than the detail learning typically measured in multiple choice test results. In situations where a procedure is being learned, desired outcomes of a procedure are usually not confined to verbal knowledge. Other desired outcomes include reduction of time to complete a procedure or increase in the number of procedures completed correctly in a fixed amount of time. Performance measures differ from tests by being limited in terms of available time rather than the available range of scores. This is similar to the measurement of knot tying (knots tied correctly in a 3 minute period) that Zuckerman (1949) used to measure learning from the sound element of film.

**Summary**

Narration has been shown to have positive effects on student learning when it is done with clear, comprehensible voices and is relevant to accompanying images. Even then, multiple choice test results rarely provide indications of increased learning that might result from a change in presentation format. Of existing studies that indicate beneficial effects for learning from narrated text, those that have looked for improvement in learning outcomes other than verbal detail were more likely to find an effect. This makes it likely that learning of a procedure is an area where narration of the procedure to be learned will affect learning from the presentation. Since procedures differ from facts in being subject to continual improvement in their performance, the result of learning will take the form of a performance improvement. For that reason, fluency with the procedure, much like Zuckerman's knot-tying task, is more likely to be affected by improved learning of the procedure than is a knowledge of facts.

**Hypotheses and Rationales**

1) Students who learn a procedure from narrated rather than textually presented multimedia software will perform the procedure correctly at a higher rate.
Rationale: Nocente's (1996) finding of an improvement of trigonometry learning when presentation of new information was provided with an auditorily enhanced lesson indicates that the form in which information is presented affects the learning that takes place from that presentation. While Nocente's study measured test scores, which are an appropriate measure for recall of presented information, the current study seeks to find an effect on the fluidity and automaticity of student performance of the learned procedure. Dorn and Soffos (2001) hold that inference to higher order cognitive processing - the kind in which the process becomes automatic - is inferred from behavioral changes in how students respond to the learning task. If students use the process faster or more accurately, this would be an indication of the process learned being more automatic. Such a measure more closely aligns with Mann's (1995) concept of learners having acquired the "gist" of the presented material. Learning of the "gist" in this case could be described as the ability to perform the procedure more quickly than those who are still struggling with the learning. While there is likely to be an increase in the time it takes to complete the lesson in its narrated form, this increase is generally limited to the time it takes for the narration to take place (Barron & Kysilka, 1993). But in light of the result seen in Rehaag and Szabo's (1995) study of math problem solving performance, the learned procedure is completed correctly in less time by the group who learned the procedure by hearing it.

2) Among low reading ability learners, the effect of learning from narration will be more pronounced than it will be for high reading ability learners.

Rationale: The finding by Gretes and Green (1994) that low literate adults see a greater gain for auditorily presented material indicates that students who are less reliant on reading may see a greater benefit to the use of audio. The present study is expected to repeat this earlier result. It differs from the Gretes and Green (1994) study by seeing if the same result is likely to be obtained when a procedure rather than a body of subject matter is being learned.

3) If narration is optional and under user control, learners with low reading ability will choose to use it for most learning situations.

Rationale: Nocente's finding that learners choose to listen to over 80% of the available audio clips indicates that there is little reluctance on the part of learners to accept listening to narration as a way to learn. On the presumption that learners will try to
use the presentation form from which they learn best, Gretes and Green's (1994) study leads to the expectation that this will make the auditory option more attractive to the lower reading group. Studies by Neu (1950) and by Barton and Dwyer (1987) lead to the expectation that if the audio incorporated is irrelevant or entirely redundant with presented text, learners will find it uncomfortable and then choose to turn it off. But since neither of these conditions characterize the present study, it is reasonable to expect learners to continue to listen to the audio clips.
CHAPTER 3:

METHOD

The purpose of this study was to assess the value of narrated instructional materials designed to teach a procedural task in comparison with an onscreen text version of the same instruction.

Specifically the three research questions being tested were –
Is the narrated version of the instruction equally effective as the text version?
Will low-level readers benefit more from a narrated version than high-level readers?
Given a choice between materials, will low-level readers choose to use narrated instruction over text-based instruction?

Design

The design was a 2 X 3 analysis of variance design with 2 levels of reading and 3 levels of instructional treatment for the first two hypotheses and a 2 X 3 chi square for hypothesis 3.

Participants

Two samples of student populations participated in the study. These included community college students enrolled in a study and learning skills class and community college students enrolled in either an introductory computer class or a “technology for teachers” course. There were 69 students in study and learning skills (SLS) sections. Their enrollment in this course was a condition of their enrollment in the community college with low entry scores on the College Board Company's Computerized Placement
Test (CPT) (College Board Co., 2002). Participants scored a mean of 72.45 on this test - approximately the equivalent of a 10th grade reading level (Napoli, Raymond, Cofey, & Bosco, 1998), with the minimum reported score being 29 and the maximum being 117. A score of 120 is the maximum that can be achieved on the test. A score of 82 is considered acceptable for admission to the college as a student who requires no remedial services.

Students who score less than 82 are placed into SLS sections. Scores for students enrolled in SLS sections ranged from 29 to 117 with a mean score of 70.10 - still a reading level of approximately 10th grade. Those from this class were considered, for purposes of this study, to have a low reading level, although the statistical analysis for this study was based on CPT scores rather than assignment to SLS sections. 18 additional students were enrolled in the computer technology or educational technology classes. Those from this class were considered, for purposes of this study, to have a normal reading level. Non-SLS student scores ranged from 79 to 117 with a mean score of 93.36.

Participants in both groups were recruited for the study by an offer of extra credit in their courses for their participation. Students had varying levels of experience with Microsoft Corporation’s PowerPoint presentation software. Information about PowerPoint experience was collected from 68 of the participants. Of these, 23 had no PowerPoint experience, 11 had less than one year, 17 had between one and three years, and 17 had over three years of experience. None of the participants had ever created narration for objects on a display, which was the task they would learn to do as part of this study.

Treatments

The three levels of treatment included three versions of computer-based instruction designed to teach the participants how to create narrated labels in PowerPoint, a multi-step procedural learning task. All treatments contained working samples of products similar to those that students were to create in the output file. Illustrations of these samples appear in Appendix 1 of this document where the software versions of the treatments are shown.
Listening Modality (LM) treatment – This was a narration-only version of the instruction. No text appears on the screen and, as a result, the screen looks almost identical to its actual appearance in PowerPoint. Samples of displayed objects with narration were available. The process by which narrated display objects are created was described in a sequence of 18 screens containing a total of 58 audio clips with a total playback time of approximately 6 minutes. Audio clips were very brief (typically around 10 seconds) and were activated by a click on the screen. Of the 18 screens contained in the instruction, 11 included interactive simulated activities consisting of making menu choices, entering text, dragging, and resizing objects. Instructions for completing these activities were introduced at appropriate times in the sequence of activities by spoken narration. An optional "Hint" button allowed a relevant spoken instruction to add verbal information identical to that provided above the "Next" button in the Reading Modality (RM) version. Screens of the Listening Modality treatment may be viewed in appendix A in the part labeled "Screen Comparisons Between Software Versions." Images shown in the right hand column are from the LM treatment.

Reading Modality (RM) treatment – This was a text-only version of the instruction where the information was presented as text over the appropriate screen shots of the PowerPoint program. It contained the same number of screens, with information introduced in the same sequence and step size as the LM treatment. The same text as that narrated in the LM treatment appeared onscreen in the RM version. Screens of the RM treatment may be viewed in appendix A in the part labeled "Screen Comparisons between Software Versions." Images shown in the left-hand column are from the RM treatment.

Choice Modality (CM) treatment – This treatment allowed the participant to choose between the text-based and audio-based presentation at any point in the instruction. While being used, it appeared different from the LM and RM versions only in the presence of a menu item that implemented the switch to the alternate treatment. Prior to beginning this treatment, participants encountered an additional screen on which they were requested to choose their treatment and informed of their option to change their mind about their choice. The screens unique to the CM treatment may be seen in appendix A in the section labeled ” Screens Available in the Choice Modality."
Computerized Placement Test (CPT) scores were obtained from the students themselves or from the college's Office of Enrollment services. The college uses the CPT, to assess the student's proficiency level in math, English and reading. The test itself is produced by the College Board Company and marketed under the name Accuplacer. The Computerized Placement Tests include Reading Comprehension, Sentence Skills, Arithmetic, Elementary Algebra, College-Level mathematics, Sentence Meaning, and Language Use. Its reading comprehension (CPT-READ) section, which the college uses as the basis of placement into remedial reading courses asks students to read passages of 50 to 90 words and then answer questions about their reading. Scores reported in this study, and indicated by the abbreviation CPT, are the reading comprehension scores reported to the college's Office of Enrollment Services. The CPT is used extensively at the community college level for assigning students to reading enhancement courses. In a predictive validity study based on test scores and student performance at Suffolk Community College (NY), Napoli & Wortman used collected data from 1450 students who had enrolled and received grades in a reading-intensive psychology course. They found the CPT to be reliably related to psychology grades (r=.519, p < .0001). In addition, student overall grade point averages were correlated with CPT scores (r=.41, p<.0001). CPT scores were shown in previous studies to correlate strongly with reading test results. Murphy (1995), for instance, noted a correlation of r =.69 with the total Nelson Denny reading test (N =663). Napoli, Raymond, Cofey, & Bosco (1998) found a higher correlation yet (r = .79) with the Degrees of Reading Power test (N = 1154). As a matter of convenience, students were asked to report their own scores. They were frequently unable to do so. All scores used were taken from student enrollment records. In instances where only the student's SAT scores were available, a conversion to an equivalent CPT score was based on a conversion chart developed at a community college based on score overlap averages for between 200 and 300 students (Asheville-Buncombe Community College, date unknown). ACT scores, where they were available, were converted first to equivalent SAT scores using the College Board concordance table (Dorans, 1999), and then the SAT to CPT conversion mentioned. A total of 75 scores
were obtained this way of which 6 were converted from ACT and 6 were converted from SAT scores. Of the 12 students for whom no scores were available, data about how they responded to different treatments was analyzed only when CPT scores were not relevant to the hypothesis being examined.

**Procedure**

All participants completed human-subjects permission forms prior to the study. After the forms were collected, students were seated at computer workstations in which all three versions of the software had been loaded. A random function generator was installed into each computer and was used to select the participant's treatment condition. Student participation in the project consisted of three distinct phases:

- Preliminary checking - In this phase, the audio headset was checked for comfortable levels of recording and playback. Instructions for changing audio levels were included in the menu of the program. Data about the student's previous experience with PowerPoint software was collected at this time.

- Learning the procedure - In this phase, participants proceeded at their own pace through their randomly assigned version of the tutorial portion of the software. In any part of the process where the learner could interact with the simulated program, progress through the program was impeded until the student had successfully engaged in the simulation of the process.

- Using the procedure - In this phase, participants used the procedure learned by applying it to a partially completed Microsoft PowerPoint presentation. Pre-printed scripts that were to be recorded were available at each location. 13 scripts were listed alphabetically and corresponded to 13 labels on the illustrations shown. The tutorial program was open and available in a review mode that made reference material available corresponding to the presentation the participants originally completed. A timer in the tutorial program limited time that participants spent in this phase of the project.
Dependent Variables

The major variable of interest was the fluency with which the procedure learned was performed. The direct measure of this was the number of labels with narration produced by the students during the fifteen minutes immediately following the completion of instruction. A computer controlled timer limited students to fifteen minutes so that the number of labels produced was recorded for each student in the same amount of time. A label was defined as an invisible button that initiated a recorded narration. The number of labels completed in the fifteen-minute production phase of the study was the dependent variable measured in procedures that investigated the first and second hypotheses.

The third hypothesis concerned the extent to which low-reading users in the CM treatment group would choose to learn from an LM rather than an RM presentation. Choice was measured in two different forms: initial and majority choice. The initial choice was the one that study participants made when they were first presented with the option to choose between their presentation modalities. Majority choice was the modality in which they chose to actually proceed through the presentation. Because the CM version of the software was designed to allow participants to switch, at any time, into whichever modality they were comfortable with, it was possible that they could try one modality, decide that it wasn't helpful, and then switch to the other modality for later parts of the presentation. Participants did not take advantage of this feature in this study, with the result that the data for majority choice matched that for initial choice.

The software used in the study was designed to keep track of additional variables that may have been of interest, but were not the major focus of the study. Two of these - the number of sounds recorded and the amount of time it took students to complete the tutorial were recorded. Analysis of student performance on these variables is included in the study's discussion chapter.
Data Analysis

Because there was no prior knowledge of the procedure learned and practiced in this project, all scores were taken by counting the number of successfully completed labels in what had been the partially completed PowerPoint files in which the student created labels during the "using the procedure" phase. Analysis of variance tests were performed using an alpha of .05 as a test of significance. Measurement of the main effect compared mean rates of label production for participants in all three of the treatment conditions.

The experimental design and analysis were designed to provide information regarding main effects for the instructional mode as well as a possible interaction between the instructional mode and participant CPT score. Because a difference in interaction between treatment conditions and CPT scores was expected to be more pronounced at extreme CPT levels, an additional analysis of interaction effects was conducted with students with CPT scores in the 1st and 4th quartiles. This allowed procedure completion rates in extremely different groups could be observed and compared.

Chi square tests were used to observe the difference in choices made by students who had been assigned to the choice condition. Measured items included the modality in which the student went through the majority of the tutorial as well as the modality in which the student started the tutorial. The alpha value for these tests was .05.

The results of these analyses are presented in Chapter 4.
CHAPTER 4:

RESULTS

The results of this study for each hypothesis are presented below. Each of the hypotheses was tested at an alpha value of .05, where rejecting the null hypothesis by chance might occur 1 in 20 times. Due to the nature of this study, this was felt to be a satisfactory level for the questions at hand. The results are presented in order of the hypothesis that they were predicted to support. Additional results of interest that may be considered supportive of the treatment conditions in ways that are not directly related to the main hypotheses are presented as part of the discussion in chapter 5.

Effect of Presentation Modality on Number of Procedures Correctly Completed

The first hypothesis of this study concerned the effect of narration vs. text-based presentation on the number of times the process was completed. It stated that students who learned a procedure from narrated rather than textually presented multimedia software would demonstrate procedural fluency by performing the procedure correctly more often in a fixed amount of time. Because the time allowed was held constant in this study, this hypothesis predicted that more procedure completions would be found for the listening modality than for the reading modality. Table 1 below indicates the mean numbers of labels produced by participants in each of the three treatment conditions.

<table>
<thead>
<tr>
<th>Software Used</th>
<th>N</th>
<th>Mean Number of Labels Produced</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice Mode (CM)</td>
<td>23</td>
<td>3.78</td>
<td>4.067</td>
</tr>
<tr>
<td>Listening Mode (LM)</td>
<td>29</td>
<td>3.48</td>
<td>2.935</td>
</tr>
<tr>
<td>Reading Mode (RM)</td>
<td>27</td>
<td>2.37</td>
<td>3.127</td>
</tr>
</tbody>
</table>
Label production information was discarded for students who began the production phase of the study and then closed the program so that there was no accurate record of their time. The means of the numbers of labels produced appear to favor the hypothesis, although this appearance could be due entirely to chance. Table 2, the analysis of variance for Table 1, shows that there was no significant difference between treatments in how they impacted the label production.

<table>
<thead>
<tr>
<th></th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labels Completed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Between Groups</td>
<td>28.701</td>
<td>2</td>
<td>14.351</td>
<td>1.269</td>
<td>.287</td>
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<tr>
<td>Within Groups</td>
<td>859.451</td>
<td>76</td>
<td>11.309</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>888.152</td>
<td>78</td>
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</tbody>
</table>

The results shown in Table 2 indicate no significant difference that can be attributed to the treatments when considering the whole sampled population.

Effect of Presentation Modality on Number of Procedures Correctly Completed by Low-CPT Students

The second hypothesis states that among low reading ability learners, the effect of learning from narration will be more pronounced than it will be for high reading ability learners. Reading ability was measured using the CPT, which was administered to students who applied to the community college and did not furnish scores from other college entrance examinations. In light of previously mentioned research indicating the strong correlations between the CPT and other established tests of reading ability, substitution of readily available CPT scores for direct reading scores seemed justified. Where other college entrance examination scores had been furnished, equivalent CPT scores were obtained by using standardized conversion tables for those students who submitted scores from either the ACT or SAT examination. Because the college entrance
scores provided the best available approximation to reading scores, the hypothesis was tested as if it proposed that the listening modality treatment would be more effective than the reading modality treatment for those students with low college entrance scores than for those with high scores. Two alternative grouping procedures - a median split and a quartile split - were used for establishing participant CPT score categories. This allowed for effects to be observed over the whole measured population as well as over isolated extremes. Effects of the treatment conditions on different groups in the population were calculated by a comparison of means and analysis of variance. Table 3 shows the effects of the treatments on the number of successful procedure completions in 15 minutes by participants both above and below the median CPT score.

Table 3: Mean number of labels produced by CPT median group and treatment

<table>
<thead>
<tr>
<th>Dependent Variable: Labels completed in 15 minutes</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low CPT Score Treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RM</td>
<td>3.07</td>
<td>3.845</td>
<td>15</td>
</tr>
<tr>
<td>LM</td>
<td>3.82</td>
<td>3.250</td>
<td>11</td>
</tr>
<tr>
<td>CM</td>
<td>2.75</td>
<td>2.435</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>3.24</td>
<td>3.303</td>
<td>34</td>
</tr>
<tr>
<td>High CPT Score Treatment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RM</td>
<td>2.00</td>
<td>1.773</td>
<td>8</td>
</tr>
<tr>
<td>LM</td>
<td>3.75</td>
<td>2.989</td>
<td>12</td>
</tr>
<tr>
<td>CM</td>
<td>4.15</td>
<td>4.845</td>
<td>13</td>
</tr>
<tr>
<td>Total</td>
<td>3.48</td>
<td>3.650</td>
<td>33</td>
</tr>
</tbody>
</table>

Because the students for whom no entrance examination scores are available and those who closed the program early were not included in the measurements, only 67 participants are included in this analysis. The analysis of variance table for this hypothesis is presented in Table 4 below.
Table 4: Analysis of Variance for Table 3

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>31.391(a)</td>
<td>5</td>
<td>6.278</td>
<td>.507</td>
<td>.770</td>
</tr>
<tr>
<td>Intercept</td>
<td>672.312</td>
<td>1</td>
<td>672.312</td>
<td>54.247</td>
<td>.000</td>
</tr>
<tr>
<td>CPT Score</td>
<td>.127</td>
<td>1</td>
<td>.127</td>
<td>.010</td>
<td>.920</td>
</tr>
<tr>
<td>Treatment</td>
<td>18.048</td>
<td>2</td>
<td>9.024</td>
<td>.728</td>
<td>.487</td>
</tr>
<tr>
<td>CPT Score * Treatment</td>
<td>15.661</td>
<td>2</td>
<td>7.830</td>
<td>.632</td>
<td>.535</td>
</tr>
<tr>
<td>Error</td>
<td>756.012</td>
<td>61</td>
<td>12.394</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1543.000</td>
<td>67</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>787.403</td>
<td>66</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(a) R Squared = .040 (Adjusted R Squared = -.039)

The differences between group means for the treatments shown in Table 3 appear to indicate that the choice of treatment conditions is somewhat more useful in the high rather than the low CPT median group. The higher CPT median group also seemed to get little benefit from the reading modality (RM) treatment. The statistical analysis shown in Table 4, however, indicates no significant differences among treatments.

Table 5 shows the effects of the treatments on the number of successful of procedure completions by participants with CPT scores in only the 1\textsuperscript{st} and 4\textsuperscript{th} quartiles of reported scores. The first quartile of scores represents scores CPT scores less than or equal to 56. The 4\textsuperscript{th} quartile includes scores greater than or equal to 87. Scores between these two were removed from the samples so that the included scores represented extremely different levels of college preparedness as measured by the CPT test.
Table 5: Mean number of labels completed in 15 minutes by CPT highest and lowest quartiles

<table>
<thead>
<tr>
<th>Dependent Variable: Labels Completed in 15 Minutes</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>treatment RM Quartile of CPT score 1</td>
<td>1.63</td>
<td>2.066</td>
<td>8</td>
</tr>
<tr>
<td>4</td>
<td>3.00</td>
<td>1.414</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>1.90</td>
<td>1.969</td>
<td>10</td>
</tr>
<tr>
<td>LM Quartile of CPT score 1</td>
<td>3.50</td>
<td>2.168</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>4.50</td>
<td>3.271</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>4.00</td>
<td>2.697</td>
<td>12</td>
</tr>
<tr>
<td>CM Quartile of CPT score 1</td>
<td>1.75</td>
<td>1.500</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>5.00</td>
<td>5.249</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>4.07</td>
<td>4.682</td>
<td>14</td>
</tr>
<tr>
<td>Total Quartile of CPT score 1</td>
<td>2.28</td>
<td>2.081</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>4.61</td>
<td>4.272</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>3.44</td>
<td>3.517</td>
<td>36</td>
</tr>
</tbody>
</table>

The analysis of variance table for this hypothesis is presented in Table 6 below.

Table 6: Analysis of variance for Table 5

<table>
<thead>
<tr>
<th>Dependent Variable: Labels Completed in 15 Minutes</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source Corrected Model</td>
<td>69.264(a)</td>
<td>5</td>
<td>13.853</td>
<td>1.143</td>
<td>.360</td>
</tr>
<tr>
<td>Intercept</td>
<td>286.923</td>
<td>1</td>
<td>286.923</td>
<td>23.672</td>
<td>.000</td>
</tr>
<tr>
<td>Treatment</td>
<td>11.896</td>
<td>2</td>
<td>5.948</td>
<td>.491</td>
<td>.617</td>
</tr>
<tr>
<td>CPT_Quartile</td>
<td>24.184</td>
<td>1</td>
<td>24.184</td>
<td>1.995</td>
<td>.168</td>
</tr>
<tr>
<td>Treatment * CPT_Quartile</td>
<td>8.065</td>
<td>2</td>
<td>4.032</td>
<td>.333</td>
<td>.720</td>
</tr>
<tr>
<td>Error</td>
<td>363.625</td>
<td>30</td>
<td>12.121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>860.000</td>
<td>36</td>
<td>12.121</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corrected Total</td>
<td>432.889</td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a R Squared = .160 (Adjusted R Squared = .020)

The means of procedure completion rates appear to be quite different between 1st and 4th quartiles for students from the choice of modality (CM) group. An interaction between treatment versions and CPT quartile group, however, was not significant. The analysis of variance shown in Table 6 indicates that most of the apparent difference in means of successful procedure completions can be attributed to the CPT quartile instead of the treatment. Effects of the treatments on number of successful procedure completions between the 1st and 4th quartile students were not shown to be significantly different.
Effect of CPT Entrance Test Score Level on Choice of Learning Modality

The third hypothesis of this study was that when given a choice between presentation modalities, students from low readiness groups (as indicated by low CPT scores) would choose the listening modality for presentation of information. Two design features of the products supported testing of this hypothesis. The first of these was the presence of a choice modality (CM) version of the tutorial software. The other was the automatic tracking and reporting of user choices that was built into this version of the product.

There were 22 students assigned to the choice treatment. Of these, CPT scores were reported for 20. Of the 20 scores reported, 10 of those randomly assigned to the CM treatment were from the 4th quartile. While this is an unusual distribution of treatments to participants, a chi-square test of this phenomenon indicated that it was not significant. But as a result of this unusual distribution of participants, the median of CPT scores includes only the 4th quartile as the above median group and the first three quartiles as the below median group. With sample sizes as low as 4 in the lower three quartiles, analysis of results related to choices made by participants in the CM group are limited to a median split.

Two choices made by CM participants are relevant to this hypothesis. One is the initial choice of modality. The other is the choice of which modality to use most of the time. Because the software allowed students to switch between presentation modalities whenever they wished to do so, it was possible for the majority choice to differ from the initial choice. The number of choices made by each group is shown in Table 7.
Table 7: Choices made by CM participants by CPT median split

<table>
<thead>
<tr>
<th>Median Group</th>
<th>N</th>
<th>Chose LM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initially chose LM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>high</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>Majority of screens in LM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>high</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

A Pearson Chi-Square statistic was calculated to examine the relationship between the choices students made and their relative CPT score. This statistic is reported in Table 8 below.

Table 8: Chi-Square analysis of initial choice and choice of majority of screens by CPT median split

<table>
<thead>
<tr>
<th></th>
<th>Chi-Square</th>
<th>DF</th>
<th>P Value (2 tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial choice *</td>
<td>3.200</td>
<td>1</td>
<td>.0736</td>
</tr>
<tr>
<td>CPT_Median</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Majority choice *</td>
<td>3.200</td>
<td>1</td>
<td>.0736</td>
</tr>
<tr>
<td>CPT_Median</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The total number of participants assigned to this treatment condition is too small to allow for examination of the choice of treatment by quartile to be meaningful. Students with CPT scores below the median chose the listening modality more often than did students with CPT scores above the median. This result, however, is not statistically significant for the two-tailed test of significance, which is called for when data about the modality preferences of both low and high readers is included, as it was in this analysis.
CHAPTER 5:

DISCUSSION

The discussion chapter is divided into five sections. The first section summarizes the findings of the study and explains how they relate to existing literature. If some specific factors may have influenced any of the findings, they are discussed here as well. Each research question is examined in terms of what is said about it by the findings. The limitations of the study are reviewed in the second section along with proposals for additional research that addresses them. A third section examines additional findings observed in the course of conducting this study. This is followed by a discussion of the findings of this study and their significance for the design of educational multimedia software. Finally, there is a section describing future research that may follow from or add to the results of this study.

Summary of Findings

The rank order of means for the rate of performing a learned procedure was the choice of modality (CM), the listening modality (LM), and then the reading modality (RM). Despite this rank order, the ability to perform the learned procedure as a result of hearing its steps described was not found to be significantly better or worse than the ability to perform it after reading through the same set of steps. The student populations included community college students on both conventional and remedial tracks so that a wide variety of reading levels could be observed. However, no significant advantage was found in favor of the listening modality (LM) treatment on the ability to perform procedures and steps involved in the procedures by students whose reading scores were either above or below the median reading level. Even in the light of further analysis that
included a post hoc breakdown by CPT score quartile, there remained no significant advantage of the listening modality. Low reading students who participated in the study did not show a significant tendency to choose the LM version of the software. While they might have been able to avoid the potential for reading difficulty associated with a choice of the RM version, there was no clear desire to take advantage of the choice offered.

**Relation of Results to Literature Regarding the Advantages of Learning from Audio**

The finding of no significant difference attributable to the modality of the presentation of a tutorial for a procedure echoes similar findings from earlier experimental research (Barron & Atkins (1994), Barron & Kysilka (1993), Beccue, Vila, & Whitley (2001), Quealy & Langan-Fox (1998), Shih & Alessi, 1996). Of these, only the Shih & Alessi study investigated a condition in which narration completely replaced the onscreen text. They found no difference in pre-test to post-test gain that could be associated with the removal of text. Their target audience of college seniors was a group that could be described as having a longstanding record of successful reading experiences. The present study, in looking at a group of students whose college entry placement scores had resulted in recommendations for reading enhancement, dealt with a population more likely to see auditory presentation as beneficial. This study did not, however, find a significant effect in proficiency with the learned task that could be explained by the difference in treatments.

Because both text and narration deliver information to a learner in verbal form, the different versions of the program might be expected to increase the load of what Paivio (1979) called the verbal channel by the same amount. In terms of cognitive load, no difference between software versions would have been predicted for most populations. In the population under test however, a low reading level was predicted to create an advantage for the listening modality because of a previous record, among participants, of having encountered impedance to acquisition in the verbal channel when the information was presented as text. That this did not occur in the present study may be explained several ways. One possible explanation is that the students in this population were generally not good at acquiring information in the verbal channel at all. Another
explanation is that the design of the program, by leaving menus and navigation dependent on text, did not effectively remove enough of the text encountered in the learning situation to make the difference clear. In its attempt to completely replace text with its spoken equivalent, this study went beyond the Rehaag & Szabo (1995) study that found no significant difference attributable to the addition of redundant audio. Although it was not demonstrated in the present study, it is still reasonable to suggest that low readers will benefit more from auditorily presented information than high readers because they are able to overcome reading difficulty. But the lack of a conclusive result in this study indicates that although auditory presentation provides the ability to overcome difficulty with reading, it is not sufficient to guarantee that verbal difficulties of a more general nature will also be overcome.

Relation of Results to Literature Regarding Low Reading Populations

This study found that low-reading students did not become more proficient with a learned procedure presented in narrated rather than textual form. An earlier study by Gretes & Green (1994) of low-reading adult learners, conducted in adult basic education (ABE) sections of a North Carolina Community College, found a significant improvement in adult literacy increases with the Reading to Educate and Develop Yourself (READY) program. Their results compared favorably with a control group in a conventional section of the class. Narrated presentation was a part of the formula for the success of the READY program, but was not considered in isolation from other features built into the program. In addition to the narrated presentation, other improvements included focusing on subject matter that was meaningful to adult learners. The result of their study was an average 1.1 grade equivalence of improvement in an 11-week program. By isolating the change to narration only and seeing no significant difference, the present study indicates that it is likely that most of the improvement attributed to the READY study may have been a result of other changes.

Another study that might be thought to relate to a low-reading population is the Mousavi, Low, & Sweller (1995) study in which an auditory and illustrated presentation of a geometry procedure to 8th grade students resulted in significantly better proficiency
with problem solving than the same presentation in textual and illustrated form. The current study's finding of no significant difference in the proficiency with which a learned computer procedure is applied is similar to the earlier study in investigating procedural proficiency as well as the replacement of text with its audio equivalent. One difference between the studies, however, is that the current study set out to investigate a population of low-reading adults rather than 8th grade learners. The CPT scores of the participants in the current study indicated that most had advanced in reading skill beyond that of the 8th grade students tested in the Mousavi, Low, and Sweller study. Therefore, the participants in this study may have had higher initial reading scores and less advantage for the auditory presentation than the participants in the Mousavi, Low, and Sweller study.

An additional explanation may be attributed to the text not being challenging for the population that was being tested. Several passages were taken from the reading modality version of the software and analyzed by an automatic Flesch-Kincaid reading level measure provided inside Microsoft Word. This revealed that the text version of the software was written to be appropriate for an average reading level of grade 6.5. This design feature of the software may have enabled low readers within the measured population to succeed with learning to perform the procedure because they were at a reading level above this point. Of 59 students whose CPT scores were available without converting from other scores, only 13 scored below 55. At some other colleges without open admissions policy, this is the minimum score required for admission, and corresponds to a TABE level A grade equivalent of 8.4 (Northwest Wisconsin Technical College, 2004). This indicates that a sizable majority of the participants were unlikely to be challenged by the text with which they were presented.

**Relation of Results to Literature Regarding Choices Made by Low Readers**

Participants in the CM treatment group chose the reading and listening modalities evenly overall. While no clear majority of students either above or below median CPT scores chose either modality, those below the median preferred listening (LM) while those above the median preferred reading (RM). The difference between these preferences was not significant. The hypothesis of this study that low reading students
would choose to learn from a narrated set of instructions was not confirmed. A finding of no significant difference in choices between low-reading and high-reading groups could be explained in several ways. One of these was that with the design of the experiment such that only one third of the participants were randomly assigned to a condition in which a choice was made available, not enough data was collected. Another was that the average reading level was not low enough for students to sense an advantage by learning from the narrated version.

A previous study by Frey and Simonson (1993) found a significant tendency for students with a high reading learning style to choose the combination of visual information and textual description far more often than visual information with a narrated description. Their study, conducted among college undergraduate students in two junior level courses, made no attempt to find the opposite choice on the low end of the reading spectrum. While they concluded that, based on student choices, it was important to include a combination of visual and verbal information to teach about the visually oriented subject matter of historical costume, they did not design their study as a direct comparison between visual-textual and visual-narrated combinations. And they made no attempt to extend their findings to populations where reading as a preference was not as likely to be entrenched.

It is also possible that the choice was not made with a strong sense of needing to pick up details of the procedure. In a pilot study leading to the current study, a selected group of college undergraduate education majors was given only the CM version of the material used in the present study. Their choices were monitored at two points - one when they began the learning process and the other when they were presented with the task and given the opportunity to review. Although 14 of 31 students could complete the task without the need for further review, of those who used the reviewing option, 14 of 17 did most of the reviewing by listening to rather than reading the description of the procedure (Solomon, 2004). Chi-square analysis of this result indicates that this tendency to choose the listening modality for reviewing is significant (p < .05). An explanation offered for this is that reviewing with the task started is a higher pressure situation than going through a presentation. In this situation, it is possible that students may choose to listen in order to be able to capture speech nuances that would not be available in textual form.
Limitations of the Study

Conclusions drawn from the results of this study are limited in several ways. The use of college entrance examination scores required an inference that reading ability was a major influence on the scores students received. Personal communication with counselors at the community college involved indicated that, in addition to reading ability, the CPT score is also based on a measurement of critical thinking ability. Whether there is a high enough portion of reading level measured by the CPT to infer an effect of reading level based on CPT level is subject to question. Regardless of the exact contents of the CPT, a significant correlation measurement of .247 (p<.05) between CPT scores and label production rates in this study indicates that the CPT is predictive of success with learning experiences like that presented in the project. In addition, the practice of using the CPT for the purpose of assigning students into reading enhancement sections indicates that a decision was made by college administrators that the CPT scores are related to reading level. Nonetheless, a direct measure of reading without the additional measures incorporated into the CPT would have helped substantiate claims made in the present study about reading level as a characteristic of the participants.

Another area that limits the likelihood of being able to see a significant difference between the LM and RM versions of the software was that there was a demand for reading skills to be used while dealing with menus and navigation procedures for use of the software. The procedure taught - a process for using PowerPoint software, mandated at least a minimal use of text because of the way the software was designed. PowerPoint relies extensively on textual presentation of menu choices. Further reduction of the reliance on text could have been achieved by auditorily providing learners with information about shortcuts so that menu reading could be avoided. While this adds to cognitive load during the learning process, its results may have been similar to the advantages experienced by Fitch & Kramer (1994) in which a fully auditory interface resulted in superior learner proficiency with the simulated anesthesiology procedures demonstrated. In the present study, however, even the memorization of keyboard
shortcuts would not remove text-based user interactions such as naming and selecting sounds.

Available time, data collection procedures, and software design issues also may have had impact on the results obtained, as explained below.

**Available Time**

Based on a pilot study conducted with undergraduate students, it was predicted that one half hour would be needed for students to complete the activities in this study. In most cases, this was enough time. Because the tutorial portion of the project was completed without a time limit, some students required more time than anticipated to complete the project. Several student participants inquired about the amount of time that the project would require and were told that they should plan on over a half-hour. Those who took the most time going through the tutorial (The most time measured was 23 minutes.) were pressured to get to classes. In the present study, there was no reason to expect that longer student learning times would be associated with any of the treatments. So pressure to get to class may be inferred to be evenly distributed because of the randomization of the assigned treatments. While there were differences in available hardware at the six testing stations (Four of the computers operated faster than the other two.), these had little impact on the time taken to complete study related activities.

**Data Collection**

Two problem areas had an impact on the ability to collect data from the project. One was that students sometimes began the production phase of the project and then shut off the reviewing program which, inadvertently, turned off the associated timer. In cases where this happened, data involving rates of label production and sound recording was discarded. This occurred in 9 cases. Data about the choices students made was retained. The other problem with data collection was that for some students in a community college environment, no entrance score had been recorded. While data from these students could be used in the general comparison of modalities, the lack of available entrance exam scores prevented performance by these students from being used in portions of the study concerned with entrance exam median and quartile levels. The
policy of the community college of admitting transfer students with no entrance exam requirements resulted in transfer students not being counted in median and quartile counts. The use of a standardized measure of reading ability would have removed the need to consult records of entrance examination scores and allowed more of the available participants to have their performances included in all parts of the study. Including this as a measure, however, would have increased the time demand on participants, while introducing questions about the validity of instruments used for the measure of reading level.

**Software Design**

A possible factor that bears on the validity of the results obtained was that the listening modality (LM) version of the software used continued to maintain reliance on text for some of the instruction. The amount of text presented to participants was greatly reduced, but still present in various parts of the user interface. Further instructions that could have reduced the amount of onscreen text could have been presented in narrated form, but this would have required memorization of more material by LM participants which was not requested of participants of the RM group. In order to keep the level of effort required of participants as equal as possible between versions, the listening modality version was designed with text available in menus, on buttons, in the user interface, and in pop-up windows incorporated in the simulation of PowerPoint. In addition, the introductory survey taken by users was conducted in text form, regardless of the treatment groups into which the participants were assigned. This may have had a slight priming effect on how well the verbal channel was prepared ahead of time to acquire information in text form. Hopefully, this priming effect was neutralized by the requirement that all participants wear headphones and test the audio level at the beginning of the program.

**Influence of Specific Environmental Factors**

Information from participants was collected over three consecutive days using six computers equipped with headsets all located at one large table in the center of a conference room. It was observed that when students began the project while other
students were recording sounds, they tended to be less confused about the idea that they were to record sounds at some point in the project. While this may have influenced student performance in individual cases, the influence of another “talking” student when a student first arrived was not controllable and was probably distributed randomly among the participants. No more than six students were in the room at any time. There were slight differences in the computers used to conduct the study, but none that would affect the way students responded to the treatments.

### Analysis of Additional Variables

#### Number of Sounds Recorded

Because the creation of a label is a multi-step complex task, data was collected for the completion of sound recordings, which was an early step of the label making procedure. Overall 106 sounds were recorded by participants but were not included in the label counts because of other reasons that the labels were not successfully completed. A difference in proficiency with only part of the procedure, if it were related to the treatment condition, could be taken as a positive effect attributable to the treatment. Recording of sounds was the only other action by participants counted as a sub-process and treated as a dependent variable. Table 9 below indicates the numbers of sounds recorded by treatment groups in fifteen minutes. Table 10 indicates the number of sounds that students with above median and below median CPT scores recorded in fifteen minutes.

<table>
<thead>
<tr>
<th>Sounds Recorded (Sounds)</th>
<th>Software Used</th>
<th>N</th>
<th>Performance mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Choice Mode (CM)</td>
<td>23</td>
<td>5.61</td>
<td>4.882</td>
</tr>
<tr>
<td></td>
<td>Listening Mode (LM)</td>
<td>29</td>
<td>4.66</td>
<td>3.210</td>
</tr>
<tr>
<td></td>
<td>Reading Mode (RM)</td>
<td>27</td>
<td>3.63</td>
<td>3.341</td>
</tr>
</tbody>
</table>
Table 10: Mean number of sounds recorded in 15 minutes by CPT median split and treatment

<table>
<thead>
<tr>
<th>Sounds Recorded in 15 Minutes</th>
<th>N</th>
<th>Mean</th>
<th>Std. Error</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower Bound</td>
</tr>
<tr>
<td>CPT Score is below median</td>
<td>RM</td>
<td>15</td>
<td>4.733</td>
<td>2.719</td>
</tr>
<tr>
<td></td>
<td>LM</td>
<td>11</td>
<td>4.000</td>
<td>1.647</td>
</tr>
<tr>
<td></td>
<td>CM</td>
<td>8</td>
<td>4.625</td>
<td>1.866</td>
</tr>
<tr>
<td>CPT score is above median</td>
<td>RM</td>
<td>8</td>
<td>3.000</td>
<td>.241</td>
</tr>
<tr>
<td></td>
<td>LM</td>
<td>12</td>
<td>5.833</td>
<td>3.581</td>
</tr>
<tr>
<td></td>
<td>CM</td>
<td>13</td>
<td>6.231</td>
<td>4.067</td>
</tr>
</tbody>
</table>

No significant differences in student performance related to this variable were noted. As a result, no further discussion of the number of sounds recorded will be included in this discussion.

**Time to learn**

The amount of time participants spent completing the tutorial was recorded. This was not a specific focus of this study. However, a difference in student performance in this area would indicate a difference in learning efficiency that may be taken into consideration in software design decisions.

Time spent in the tutorial was analyzed as a dependent variable. The mean time spent in the tutorial by participants in the choice modality (CM) treatment group was significantly less than that spent by participants in the other two groups. Table 11 shows the means of times spent completing the tutorial by participants in different treatment groups.

Table 11: Time in tutorial by treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>Time (minutes) in Tutorial</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice Mode (CM)</td>
<td>22</td>
<td>8.14</td>
<td>3.314</td>
</tr>
</tbody>
</table>
The analysis of variance table for the data above, shown in Table 12 below, shows that the difference between how much time participants in the different treatment groups spend completing the tutorial is significant.

### Table 12: Analysis of variance for Table 11

<table>
<thead>
<tr>
<th>Time in Tutorial</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>69.213</td>
<td>2</td>
<td>34.606</td>
<td>3.476</td>
<td>.036</td>
</tr>
<tr>
<td>Within Groups</td>
<td>696.869</td>
<td>70</td>
<td>9.955</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>766.082</td>
<td>72</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This suggests that providing a choice of tutorial treatments to students encourages them to select the mode in which they learn most efficiently. A significant inverse correlation (Spearman's rho = .277, p<.05) was found between the amount of time spent in the tutorial and the rate of label completion suggesting that computer experience, which would likely improve a student's time in learning in a computer-based environment could have influenced this finding. Program experience level was compared with the tutorial completion times and found not to be a significant influence on the time spent in the tutorial (F = 1.400, p = .273). While experience in the program was influential in reducing the time it took for participants to complete the tutorial, a Pearson Chi-Square test of the distribution of participants' program experience indicated that it was distributed evenly in the three treatment groups. (Chi-Square = 1.774, Asympt. Sig. = .939).

Therefore, the effect of the CM treatment on time to complete the tutorial cannot reasonably be attributed to uneven distribution of experience with the program. One advantage of the choice modality with regard to tutorial completion time is that low readers have an option of avoiding reading difficulty by choosing to listen to the presentation of information and then proceeding through the presentation at a speed set by the narrator. On the other hand, high readers are able to benefit from the faster maximum acquisition speed associated with a non-temporal presentation mode. Shih & Alessi (1996) recognize an advantage for text in its flexible processing rate. For students who
read well, choice makes this flexibility into a benefit. The results for high readers shown in Table 13 below show this to be the case with this study as well.

**Table 13: Time in tutorial by CPT median split and treatment**

<table>
<thead>
<tr>
<th>Time in Tutorial</th>
<th>N</th>
<th>Mean time (in minutes)</th>
<th>Std. Error</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPT Score is below median</td>
<td>Treatment RM</td>
<td>13</td>
<td>9.846</td>
<td>.789</td>
</tr>
<tr>
<td></td>
<td>LM</td>
<td>9</td>
<td>10.667</td>
<td>.948</td>
</tr>
<tr>
<td></td>
<td>CM</td>
<td>7</td>
<td>10.143</td>
<td>1.075</td>
</tr>
<tr>
<td>CPT Score is above median</td>
<td>Treatment RM</td>
<td>8</td>
<td>9.750</td>
<td>1.006</td>
</tr>
<tr>
<td></td>
<td>LM</td>
<td>11</td>
<td>9.545</td>
<td>.858</td>
</tr>
<tr>
<td></td>
<td>CM</td>
<td>13</td>
<td>7.231</td>
<td>.789</td>
</tr>
</tbody>
</table>

A significant difference (F = 4.05, p < .05) was found in favor of the choice modality when compared with the listening modality for above median CPT score participants. For students who read poorly, reading is often inflexible and slow. Choice could present an opportunity to avoid learning being impeded by slow rates of information acquisition that poor readers associate with reading. In this study, however, choice was not seen to be advantageous for students with below median CPT scores.

A 1995 study conducted by Rehaag and Szabo found that the inclusion of audio slowed down the speed with which high readers completed lessons. This study found a similar result in which high reading participants offered a choice of presentation modality completed the tutorial in significantly less time than those assigned to listen to the procedure's instructions. In the Rehaag and Szabo study, this loss was offset with a gain in the proficiency with which the high readers solved similar and transfer problems, in effect, offsetting the time lost listening to audio with an increase in efficiency with which a learned procedure was used. This study did not find significance for this effect.

**Cases of failure to grasp the procedure**
Another phenomenon observed while analyzing the results was that for students in the RM treatment group, a larger than expected number scored zero. This meant that there was a high likelihood that students were more likely to fail to succeed with the procedure demonstrated when they had been assigned to a text-based presentation. Of the seventeen students who completed the study but were unable to complete any labels, ten had experienced the RM treatment. A binomial test of this phenomenon against the expected value of .33 (28 of 85) showed that the possibility of this distribution of zero scores occurring by chance was less than .05. It seems then, that for the population of this study, being assigned to the reading modality significantly increases the likelihood of failure. Table 14 shows the results of the binomial analysis.

**Table 14: Binomial Analysis of Distribution of Zero Scores by treatment**

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Number of Zeroes</th>
<th>Proportion of Total</th>
<th>Proportion of Zeroes</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Modality</td>
<td>10</td>
<td>.33</td>
<td>.61</td>
<td>.025</td>
</tr>
<tr>
<td>Listening Modality</td>
<td>3</td>
<td>.39</td>
<td>.18</td>
<td>.055</td>
</tr>
<tr>
<td>Choice Modality</td>
<td>4</td>
<td>.28</td>
<td>.21</td>
<td>.460</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
</tbody>
</table>

The high proportion of zeroes by students assigned to the RM treatment appears unlikely to be the result of chance.

**Importance for Educational Multimedia Software Design**

Very little sound is used in educational software (Bishop, 2000). Like other studies in which media forms are compared, no significant improvement in the rate at which learned processes are performed was seen to be associated with the auditory presentation condition. An advantage in the time to complete the tutorial was, however, seen for the choice modality. This could be expected because it offers a nearly fixed-time path through the procedure for students who might have struggled with reading while allowing strong readers to take advantage of this relative strength. Although the benefit of making a choice available was not shown conclusively in this study, the rank order of performance means, in which the CM treatment students had the highest mean score of
any group indicates that no harm is done to the learning process by making the choice of modalities available. Thus, on the strength of the results shown here, there is little reason not to make a narrated presentation available as an option for procedure learning.

Any improvement in student performance that could be associated with making narration available rather than relying on a text-only presentation leads to some recommendations for the design of educational software. Reasons the text modality dominates instructional software include technological barriers and a belief that the ability to learn from text is more efficient than the ability to learn from narration. And findings such as that of Holmes (1985) that found significant differences in reading comprehension scores for participants in favor of the silent reading mode on inferential questions and detail questions are interpreted as evidence of the overall superiority for reading as a learning medium. But design based on the greater efficiency of learning by reading too often limits its definition of learning to improvements of verbal capabilities. This ignores findings like those of Mann (1995) or the same study by Holmes (1985) indicating that gist learning improves with a shift of stimulus to the auditory modality. Beccue, Vila, and Whitley (2001) suggest that the incorporation of new technologies in instruction needs to be researched before extensive commitments of time, money, or other resources are made. But changes in technology lead others like Bishop and Cates (2001b) to note a decline in the amount of time, money, and resources that need to be committed before sound can be included.

Universal Design for Learning (UDL), a standard proposed by Rose and Meyer (2002), calls for instructional materials to be developed in multiple modalities with learners given the option of selecting how information will be presented. Such a scheme would make educational software more usable for those with disabilities as well as allowing learners to select presentations in their strongest learning modalities. Implementing their recommendation could be achieved with little extra time added to existing software development time for most products. The switchability feature of the CM software version used in this study was created with only several hours of additional development time after the RM and LM versions of the software had been created. While the CM treatment's most notable effect in this study was in the area of time reduction
rather than improved student performance, if it improves accessibility and makes an educational product easier to use, this investment is worth the effort.

Far more difficult than actually producing audio clips while using the RM version as a script for the LM version is deciding on how the text is to be replaced. If, for example, there are three paragraphs of text on a screen, is it appropriate to create one clip that includes all the text, three that are divided by paragraphs, or more divided by sentences? Gibbons and Fairweather (1998) recommend short repeatable audio messages presented in sequence with individual clips initiated by overt actions of the user. They claim that this approach allows time for reflection about what is said and lets the student decide how much time is used for reflection between listening to clips. This study followed this advice, and limited clips to approximately ten seconds in length. There was no decline observed in high CPT score student performance associated with the LM version. This may be taken as evidence that this design strategy is a way to avoid the effects of poorly constructed audio. It could also allow product revisions to be made without requiring the replacement of large numbers of clips.

Aarntzen (1993) suggests that sound supports the process of increasing involvement by drawing and holding attention, complementing visual information, minimizing information that must be present on screen, and increasing motivation. Norman (1990) suggested that interfaces need to use as few items that may need interpretation as possible. He went on to suggest that if sound is used as part of a computer's interface, it must have very distinct and clearly interpretable sounds. In educational software, the presentation of information to the learner is part of the interface between the learner and the software. As such, the avoidance of ambiguity needs to be considered when sound is used. Nocente (1995) was aided in the avoidance of ambiguity by the presence of a professional narrator. The narrator in the LM version software used in the present study made a point of concentrating on clarity and diction while recording audio clips. No notes or complaints were received that would indicate that any of the spoken instructions or content was not clearly understood. But a clear and natural voice is an asset to the comprehensibility of the audio clips.

Rose and Meyer (2002), in their recommendations for the universal design of learning (UDL) product standards caution that the purpose for which the software is being
used must be considered in the choices of modalities made available. If the purpose of the software is to provide reading practice, for instance, inclusion of spoken audio in any form may be counter-productive. While the possibility of making a choice of narration available in multimedia instructional software may have a positive effect on learning of procedures, the decision to include it must be made on knowledge of its intended audience and purpose. While the computer is capable of delivering messages in spoken form, the decision to do so must be made on the prospect of improving student learning more than on the current state of media capabilities.

**Recommendations for Future Research**

The results of any one study cannot adequately address the issue of whether the time and expense required for adding audio to computer based training is justified. This study is consistent with previous research on the replacement of text with sound for the presentation of a procedure to be learned. While differing from many studies in the completeness of text removal, it found no significant difference attributable to the inclusion of narration. Although the intention of this study was to focus on a low reading population, the population chosen, consisting mostly of remedial track community college students, may have been sufficiently advanced that the advantages of a narrated demonstration did not have sufficient impact or attractiveness for an effect to be seen. Because most participants entered the study with a high enough grade reading level to fully comprehend the material when it was presented as text, the text presentation did not impede understanding of the procedures. A replication of this study with students from grades 6 or 7 is more likely to find that the narrated presentation is more clearly comprehended and followed by the students. The overall procedure for conducting the study would require modification that takes the required reading level of the material into account first and then selects a group nearer to that level.

The present study also made no attempt to restrict the time available for students to complete the tutorial portion of the software. Had such a restriction been in place, there may have been a greater likelihood of observing an advantage favoring the narrated over the text based version. If narration has an effect of reducing cognitive load, it is possible
that narration would be most effective with students with poorer reading skills when class
time or computer time is severely limited due to uncontrollable factors (e.g., limited
access to lab computers, student comes to class late, class starts late, etc.). In other words,
the increased cognitive load that may be attributable to external pressure to complete the
lesson quickly could be reduced when narration takes the place of reading. Designing a
study that restricts time yet insures equivalent exposure to the material in different
treatment conditions would be a challenge, but would help show the way narration could
have an impact on cognitive load for poor readers.

Another area of concern in the design of the present study is the use of the CPT as
a measure of reading level. Counselors at the community college where the study was
conducted expressed an opinion, based on their contact with the test, that, while its scores
may correlate highly with reading level, they were not strictly confined to serving this
purpose. Replacement of CPT scores with a straightforward measure of reading level
would allow reading to be represented more accurately in the data while providing a score
that reflects current skill rather than skill at the time of admittance. A change of the
study's design to accommodate an actual reading score is unlikely to have an impact on
the overall outcome. The CPT was used in the present study as a measure of reading
because scores were readily available even though its measurement of reading skill is
indirect. There is no reason, however, to believe that its indirect nature would have had
any effect on the study's validity. While a more direct reading measurement may have a
slight effect on the values attained as reading scores, another variation in the design may
be to change the measured characteristic from reading level to verbal ability level.
Because the goal of the study is to see whether a change to auditory presentation
facilitates verbal acquisition in cases where poor reading skill impedes acquisition in the
verbal channel, finding a population that could be characterized as highly verbal with low
reading ability may give a better result.

Among the best of results attributed to instruction in auditory form, the study of
anesthesiology technique (Fitch & Kramer, 1994) stands out for its demonstration of the
benefit of auditory media. In their study, the subject matter dealt with techniques that
would regularly be employed in a context other than that of using a computer program. In
the current study, the learned task was one in which a computer program was expected to
be used. The personal computer in most of its interfaces relies extensively on the visual presentation of information, normally taking the form of text (Raman, 1997). Further study of using audio to increase the naturalness of the way instructions are given while simulating non-computer tasks may disclose benefits for the use of audio.

Yet another variation on this study may move it in the direction of the Gretes & Green (1994) study that saw significant differences in reading level improvement only after several months of a combination of interventions. If, instead of one tutorial about one process, a series of tutorials about multiple processes would allow more time for an effect, if there is one that is related to time, to occur.

The results of a pilot study conducted in preparation for this study (Solomon, 2004) indicated that when reviewing was available in either modality, students who reviewed had a high preference for the listening modality. The existence of this preference leads to several questions. It may have been the case that students were looking for the greatest amount of information and chose to include the vocal inflections of the narrated presentations. An alternative explanation proposed by students, however, was that the popularity of the narrated version stemmed from its location on the left side of the page - a position seen first by most American students. Seeing the phenomenon persist after switching positions would remove this possibility, and would be an easy to produce follow up to the present study.

The Bishop and Cates (2001a) study that was one of the inspirations for the present study, noted a lack of research that supports the use of sound despite its apparent usefulness for gaining attentions and providing second channel redundancy. This study focused on narration, but left music and natural sound as auditory phenomena that are still largely unexplored. The capacity to use music and natural sound to create emotional reactions is known. Some room may well exist for further studies that explore what emotional settings can be induced in order to help students learn.
CHAPTER 6:

CONCLUSION

This study began with the recognition that although current technology makes it easy to include sound in educational multimedia software, that most software was designed to present information to learners in visually presented text form. According to Bishop (2000), although sound has the capacity to increase learner immersion in learning experiences, the use of sound has been impeded by designers' preconceptions and limited theoretical understanding. Previous technological impediments may have been removed, but the designers of educational software are reluctant to break with tried and proven processes for creating instruction without evidence of the benefits of trying to take a new path. This study has been an attempt to address this reluctance by conducting research about an area in which the inclusion of sound holds promise - that of the presentation of information regarding a procedure.

To see whether any benefit could result from the replacement of text with spoken narration, different versions of a software tutorial needed to be created that would differ only in this one characteristic. Once it was developed, its effect was studied on community college students with both low and high college entrance scores. One finding of this study was that providing a choice of modality had a greater impact on the time it took to learn a procedure among students with entrance scores above the median score obtained in the study. This result was statistically significant, and may be taken as revealing a trend pointing to the value of providing choices for this group. For students with scores above the median reading score, then, imposing a listening modality appears detrimental to their learning efficiency - the time it takes them to conclude the tutorial -when compared with providing them an option of having the same material presented to
them as onscreen text. The additional finding that among students who do not successfully acquire the ability to perform a procedure after a tutorial are concentrated in the reading modality group also helps make the case for the inclusion of a narrated alternative in software designed to teach procedures to this population of students.

Despite the lack of conclusive findings in the present implementing audio elements into CBT may still have a positive impact on procedural learning. The idea of universal design - a concept borrowed from architecture, points to the ways that small improvements that enhance experiences for small portions of a population of users, have unexpected payoffs. While text is the dominant modality in schools, its dominance serves only the students who are good at using it. But for those who do not use text well, learning software can compensate and accommodate. Universally designed learning products can offer different modalities and recognize that these may or may not be chosen by particular learners at particular times. As long as the instructional goal is not confused with a reading improvement goal, the flexibility of allowing learners to choose from alternative media forms offers hope that they can match their learning strengths.
APPENDIX A

SOFTWARE SCREENS

Initial Screens Common to Both Modalities

1. Starting Screen

Welcome to the research project
You are reading this from a file that has been placed on your computer. You are working with the red version of this program. Some notepaper and a set of quotations on paper will accompany this program. If your notepaper is not colored red, please write the word "red" at the top of each page you use.

Please continue this introduction to the project by clicking the "Next" button in the button bar below.

2. Checking the Sound Level

Sound Check Before Project
Instructions
As soon as you click the "Start Sound" button, you will hear sound in your headphones. A button will appear that asks if you hear it. If you hear sound, click the button. Otherwise call a lab attendant or supervisor for help.

3. Project Overview

Instructions
You will be asked to complete the tasks involved in the project in a prescribed sequence. Please do not vary the sequence or jump ahead with the tasks. The main sequence in which you will experience the events of this project are:
A) Complete a survey about your PowerPoint experience.
B) Complete the presentation of instructions in this program.
C) Work in PowerPoint for 15 minutes to complete as many "talking labels" as you can.

Please continue this introduction to the project by clicking the "Next" button in the button bar below.

4. Survey about PowerPoint

How recently did you first learn to work with PowerPoint?

☐ I have never used the program before
☐ Within the last year
☐ Between one and three years ago
☐ More than three years ago

Next
5. PowerPoint Survey Continued

How well can you switch between making the slides and watching the slide show you made?

☐ I don’t understand the question.
☐ I’ve never tried to do that.
☐ I can do it easily.

Next

6. If a selection is made that someone is not familiar with switching to slide show mode.

7. Opening and closing the slide show mode is demonstrated

Close the slide show mode by selecting the embossed triangle

8.
9. After the demonstration the student is returned to the same question

10. Once they claim that they can switch between slide show mode and slide mode, they are asked to enter their score or their reference number

11. Their identification is confirmed

12. They write their identification

Screens Available in the Choice Modality

If the students were selected into the choice modality, they get to make a choice
And they are informed that they can change their mind about their choice.
Screen Comparisons Between Software Versions

**Reading Modality (RM)**

Talking Labels - Using Power Point to do the unusual

Please follow instructions usually located here

Click anywhere on the screen to continue

***Restart***  ***Prev/Next***

**Listening Modality (LM)**

Talking Labels - Using Power Point to do the unusual

Please follow instructions usually located here

Click anywhere on the screen to continue

***Restart***  ***Prev/Next***

Starting with the screen above, a series of clicks on the screen present the text. In the Reading Modality (RM) version, new text is presented one line at a time. In the Listening Modality (LM) version, the same lines as the RM version are presented by being spoken, one line at a time.

On this screen, the learner is instructed, either by onscreen text or by spoken narration, where to click on the screen to get samples of the output product.
The screens below are both title screens. The line missing from the screen on the right is spoken as narration.
Reading Modality (RM)

In the RM version, a series of clicks on the screen reveals each new sentence. In the LM version, each click on the screen results in the next sentence of narration.

Creating a sound file has three main steps
These are:
• Getting the sound file menu
• Naming your sound
• Recording your sound

The screen below is the opening screen of the first step where interaction takes the form of menus that simulate the PowerPoint program.

Listening Modality (LM)

Creating a sound file has three main steps

1st step in recording a sound: Opening the Record Sound Control Panel
After you make sure that a microphone is plugged into the computer’s sound card, PowerPoint allows you to create sound files.
**Reading Modality (RM)**

The menu of the PowerPoint program appears. An arrow indicates where on the screen the learner should click to begin to go through the menus required to activate sound recording. The hint of the screen on the right provides narration matching the text over the black bar in the screen on the left.

In the event that the learner chooses a menu other than the one called for in the procedure, a pop-up menu provides a message indicating that the learner should make another choice. Clicking OK on the pop-up menu removes the pop-up so that the user in the RM version can continue to view the instructions for this step. This can continue until the learner selects the menu described.

**Listening Modality (LM)**
Once the insert menu has been selected, it opens up in a way that simulates the way the menu behaves in the PowerPoint program. The hint in the LM version speaks the same message as that which appears just above the black button bar in the RM version.

If the learner chooses something other than the "movies and sound" menu item, the message telling them to try again appears. By clicking OK in the message box, the message disappears.

The submenu appears only after instruction to select "record sound" has appeared on the screen. The RM version continues to display the instruction on the screen. The LM version makes the instruction available as a spoken response to the "Hint" button.
If anything other than "Record Sound" is selected, the learner is informed of the difficulty. When the OK button is clicked, the message box disappears.

This is the sound recording program that has been called by the menu selections.

Naming of the sound file is accomplished as it would be done in PowerPoint.
The hint provided by the LM version matched the text that appears onscreen in the RM version.

Clicking into the sound's name box instructs the student to enter a name and then click the record button. Students are reminded that this is a simulation and that they are not yet actually creating a sound file at this point.

An animation of talking into a microphone appears on screen and will continue until the student clicks the "stop" square.
Spoken text in the LM version matches the text beneath the title in the RM version.
**Reading Modality (RM)**

Spoken text in the LM version matches the second sentence of text beneath the title in the RM version.

**Listening Modality (LM)**

Spoken text in the LM version matches the 3rd sentence of text in the RM version. The spoken hint in the LM version matches the text above the button bar in the RM version.

The Hint button of the LM version provides the same message as the text that appears between the diagram and the button bar.
The Hint button of the LM version provides the same message as the text that appears between the diagram and the button bar. The simulation of PowerPoint continues with special keys on the keyboard.

If the user was successful with the keyboard procedure described, the speaker icon will have been deleted.

The sentences below the title are revealed with four separate clicks in the RM version but are spoken in one continuous narration in the LM version.
Each of the sentences in the illustration on the left is revealed by a click on the appropriate menu or submenu item. In the version on the right, the same action narrates each sentence. The appearance of the menus follows the way they appear in PowerPoint. Hints on the right side version correspond to the printed text beneath the figure in the left-side version.

The sentences beneath the title in the RM version are spoken in the LM version. The hint contains the spoken version of the text beneath the image. The process of dragging the mouse over the area of button placement is simulated in the program.
The change in the screen is the way the PowerPoint program responds to dragging the mouse over the label area by covering the area with a button. Further instructions are given by the appearance of or speaking of additional sentences.

The sequence continues with a pop-up menu that PowerPoint automatically displays each time a button is placed on the screen.
After play sound checkbox is checked, the sentence on the left of the RM version is spoken in the LM version.

Once the drop down menu has been clicked, the instruction under the image in the RM version is spoken as the hint in the LM version.

After the correct sound is selected, the second sentence on the left of the RM version is spoken in the LM version. The instruction under the image of the RM version is available as a hint in the LM version.
The instruction to right click the button that appears in the RM version is spoken in the LM version.

The instruction in the RM version to select "format auto shapes" is spoken in the LM version. The hint in the LM version provides a spoken version of the text between the image and the black bar. The arrow pointing to the menu line that is to be clicked appears as part of the hint in the LM version.
The sentence left of the figure in the RM version is spoken in the LM version. The LM version hint speaks the text located beneath the figure while pointing to the control with an arrow.}

The text beneath the figure in the RM version is spoken as part of the hint in the LM version.

The second sentence left of the figure in the RM version is spoken in the LM version. The LM version hint speaks the text located beneath the figure while pointing to the control with an arrow.
The text beneath the figure in the RM version is spoken as part of the hint in the LM version.

The third sentence left of the figure in the RM version is spoken in the LM version. The LM version hint speaks the text located beneath the figure.

The text in the RM version is spoken in the LM version.
As the project begins, the program remains open in a reviewing mode while the student begins the PowerPoint label-making project. A timer in this program limits time in the project to 15 minutes. These reviewing options are available for students while they are producing labels.

At the conclusion of the project, the student is interrupted by a tone in the headset followed by vocal instructions to return to the main program. He or she is asked to provide an estimate of the number of labels they believe themselves to have completed. These estimates were too inaccurate to be used as data for the study.
The student is then instructed to save the file with a name that lets the version and the student's identification information be easily retrieved.

As soon as all my files are saved, I'll make sure that the CD is back in its envelope (if I used a CD) and my note paper is folded and placed back in the packet.
Students are presented with information indicating that the project is on the second slide. They are given instruction for how to get to the second slide as well as how to get to the review information. Students are asked to create the labels one at a time so that the number of times they complete the procedure can be counted more accurately.

Subject: The parts of the western saddle. 13 different parts are shown in the diagram, allowing for a maximum of 13 labels to be made for this slide. Students are instructed to make as many labels as they can on this slide in the time allowed. The method for getting to the review material is repeated at the bottom.
Thank you for your hard work!
• Please “Save as” the presentation you created.
  – Change the file’s name to your code.

This is a slide that asks the user to change the file's name while saving so that it can be collected for verification of the information that the user will provide. The request to do this is repeated twice in the tutorial program prior to the program being closed.
APPENDIX C

SCRIPTS

Scripts for Talking Labels

Cantle - The cantle is the rear seat-back on a saddle. A higher-backed saddle offers more support for the rider's back. But this comes at a loss of flexibility for the rider. So a low cantle is often found in a roping saddle or when a quick dismount is needed such as in steer wrestling.

Cinch or Girth - The front cinch is the wide strap that fits under the horse behind its front legs to hold the saddle onto the horse. Cinches are often made of materials, often mohair blends, that can be tightened snug without chafing the animal's skin.

Fender - A saddle's fenders are the wide leather plates on the side of the saddle that cover the stirrup leathers and against which the rider's legs rest. The smoothness of the fender leather affects the comfort of the rider. Rough leather allows for the rider's legs to grip the saddle, but cause chafing over a long ride.

Flank Cinch - Saddles with double rigging have a "front cinch" and a "flank cinch". On a saddle with double rigging, a keeper strap connects the flank cinch to the front cinch to prevent the flank cinch from riding back under the horse's belly. Double-rigging in saddles came about because stresses transmitted to the saddle could upend the saddle unless it was fastened in back with a flank cinch.

Flank Cinch Billet - The back flank billet is the belt and buckle apparatus that attaches the rear flank cinch when one is used. Because its purpose is only to prevent the saddle from tipping forward, it may seem easier on the horse to leave this loose. However, no more than an inch of slack should be left or it will be possible for a horse to catch a foot in rough terrain.
Fork or Swell - The fork is located on the front of the saddle and gives shape and definition to the front portion. The gullet, or bottom part of the fork, describes the under-side curvature of the front of the saddle to determine how well the saddle fits the horse. A fork that is lower and wider is said to have more swell, which provides more support.

Hobble Strap - It is very important that hobble straps are used. This will prevent the stirrup from turning over if you fall off, which could result in your foot becoming stuck, in which case you risk being dragged!

Horn - The horn was originally designed for wrapping the lariat around when roping cattle. Because it protrudes from the top of the saddle fork, it has come to be used as something steady to hold while getting on or off the horse.

Jockey - Usually the outermost layer of leather on a saddle, tied on with leather strips called strings, covering and protecting the bars, ground seat, and rigging. Depending on its construction, a saddle may have a front jockey, a seat jockey, and a back jockey.

Seat - The shaped leather mass between the seat jockey and the saddle tree which forms the contour upon which the rider sits. A quality saddle will typically have three to six carved layers of heavy leather in its ground seat.

Skirt - A large leather plate under the saddle tree which keeps the tree from resting directly on the horse's back. It acts to protect the mount from abrasion by the saddle tree bars and protects the rider from the sweat of his or her mount.

Stirrup - The stirrups were made of various hard materials, and took many different shapes as long as they could hold the rider's foot. Cowboys would use the stirrups to keep him from slipping and falling off the horse while using their hands for other things like roping cattle.

Tie Strap - Tie straps, also known as latigo, are strips of leather used to attach the jockeys (and sometimes the skirts) to a saddle tree. Excess length of the Latigo is looped through the tie strap holders so that the straps do not trail on the ground.
Dear Student,

Howard Solomon, a doctoral candidate in the College of Education under direction of Dr. Walt Wager, requests your participation in a research study at FSU entitled "The effect of presentation modes in multimedia instructional software on how well procedures are mastered by learners of different reading ability levels." The purpose of the research is to provide a comparison of student performance on a previously untried task after receiving instruction in two different forms. Your class will be involved in the study. This group is well prepared to participate in this study by previous exposure in the course to tasks similar but not identical to the task under consideration. Participants must be at least 18 years old, or have written permission of a parent or guardian, to participate in this study.

The activities for which the data will be collected involve taking a reading speed and comprehension inventory and an enhanced lesson by proceeding individually through a tutorial presentation, and producing a product using the processes learned. The activity involved, while not specifically contained within your class activities, enhances existing class skill by trying a new activity in a program previously learned. It is anticipated that approximately 60 minutes of your class time will be used in the activities involved with this study. It is understood that points leading to your course grade may be awarded for being present at the time of the study at the discretion of your instructor. Since data is being collected anonymously, there is no effect on your grade if you choose not to allow your data to be collected. Your participation will, however, contribute to our overall knowledge about design and development of multimedia educational software. The results of this research may be published, but no names or identification of participating subjects will appear in published form.

There are no foreseeable risks or discomforts if you agree to participate in this study. If you have questions about your rights as a subject/participant in this research or if you feel you have been placed at risk, you can contact the chair of the Human Subjects Committee, Institutional Review Board, through the office of the Vice President for Research, at (850) 644-8633

By signing this form, you indicate that you have read the above informed consent form and understand that you may discontinue participation at any time without loss of benefits to you. In signing this form, you are not waiving any legal claims, rights, or benefits. A copy of this consent form will be offered to you...
Subject's Signature: __________________________  Date:________________
Office of the Vice President
For Research
Tallahassee, Florida 32306-2783
(850) 644-8673 · FAX (850) 644-4392

APPENDIX E - HUMAN SUBJECTS APPROVAL LETTER

APPROVAL MEMORANDUM
Human Subjects Committee

Date: 7/1/2003

Howard Solomon
5676 Doonosbury Way
Tallahassee, FL 32303

Dept. Education Psychology

From: David Quadagno, Chair

Re: Use of Human Subjects in Research
Effects of Instructional method on quality of group project output

The forms that you submitted to this office in regard to the use of human subjects in the proposal referenced above have been reviewed by the Secretary, the Chair, and two members of the Human Subjects Committee. Your project is determined to be exempt per 45 CFR § 46.101(b) 2 and has been approved by an accelerated review process.

The Human Subjects Committee has not evaluated your proposal for scientific merit, except to weigh the risk to the human participants and the aspects of the proposal related to potential risk and benefit. This approval does not replace any departmental or other approvals, which may be required.

If the project has not been completed by 6/30/2004 you must request renewed approval for continuation of the project.

You are advised that any change in protocol in this project must be approved by resubmission of the project to the Committee for approval. Also, the principal investigator must promptly report, in writing, any unexpected problems causing risks to research subjects or others.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000446.

Cc: Dr. Walt Wager
HSC No. 2003.332
APPENDIX F - SOFTWARE SAMPLES

This appendix is part of the .pdf version of this dissertation. Software used in all treatment conditions may be viewed from this page. The following software items are available:

Listening Modality (LM) Instructional Software

Reading Modality (RM) Instructional Software

Choice Modality (CM) Instructional Software

Project to be completed

Random Selection Software
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BIOGRAPHICAL SKETCH

Howard Solomon was born in Chicago, Illinois in 1949. He received a bachelor's degree in philosophy with a minor in electrical engineering from Bradley University in 1971. In 1976, he received a master's degree in philosophy from Northern Illinois University with certification to teach.

He taught introductory philosophy classes at the College of Lake County (Illinois) between 1977 and 1981. A subsequent position as an electronics service technician with Panasonic Services Company led to a position as a technical trainer. In this position, he created product category service courses as well as creating annual product service update courses for video products.

Interest in alternative ways to provide update training led Howard to explore computer-based learning products for adult learners. To provide training to technicians, Howard taught himself several computer software development products. He was later given opportunities to learn to work with instructional software authoring products. Following his interest in instructional software development led him to the completion of a master's degree in Instructional Technology at Northern Illinois University in 1999.

In 2000, Howard enrolled in the doctoral program in Instructional Systems Design at Florida State University. He is currently a doctoral candidate and teaching assistant at Florida State University.