The Effect of Lecture Support Media on Software Skills Learning

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THE EFFECT OF LECTURE SUPPORT MEDIA ON SOFTWARE SKILLS LEARNING

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A Dissertation submitted to the College of Music in partial fulfillment of the requirements for the degree of Doctor of Philosophy

Degree Awarded:
Fall Semester, 2007
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The following is dedicated to my family,
especially my mother and father,
    Cheryl and Terry
whose love and support is the reason I am who I am.
    To my wife,
    Mary Elizabeth
who, during this project, has helped me
    re-define unconditional love.
    Also, to Tommy G. Cruff,
my favorite uncle who models an
    unwavering love of Academia and the Arts.
ACKNOWLEDGEMENTS

I would like to acknowledge the work and dedication of my major professors: First, Jack Taylor whose patience and kindness is unequivocal; and, second, Stephen Kelly for adopting an orphan and providing thoughtful and enthusiastic mentoring. Also, I would like to acknowledge each of my committee members: Clifford K. Madsen, Patrick Meighan, and Michael Allen. Additionally, I would like to express a debt of gratitude to all of the individuals, past and present, who have put their time and effort into creating the College of Music and its extraordinary learning environment. It is truly a special place.

I would also like to acknowledge Eddie R. Smith whose lifelong mentorship has been a positive influence beyond measure.
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ABSTRACT

The purpose of this study was to compare learning, and transfer of learning, outcomes as affected by two types of lecture support both designed to teach computer skills within a music classroom. One type of lecture support was computer-based and the other was paper-based. This comparison utilized two sets of data. The first set consisted of a test of prior knowledge and posttest. The second set was comprised of data from attitudinal and demographic surveys. The sample \((N = 61)\), when divided by age, contained 41 high school age participants and 20 college-age participants. The participants were divided into six groups. There were two college-age groups, and four high school age groups. Three of the groups \((n = 30)\) received paper-based lecture support media and the other three \((n = 31)\) received computer-based lecture support media.

Statistical comparisons were made using posttest scores with a test of prior knowledge as a covariant. Testing (ANCOVA) demonstrated a significant difference in posttest scores in several comparisons. The participants who experienced the computer-based multimedia as lecture support significantly outperformed those receiving paper-based multimedia both in composite posttest scores and in near transfer scores. Also, the college-age participants scored significantly higher than the high school age participants. There were significant correlations between years of study and posttest scores, and high school age participants scored significantly better when they worked alone at the computer.

This study demonstrated that computer-based multimedia, when used to train music software skills, is a viable instructional tool, and in this experimental situation produced significantly better results than paper-based media. Results demonstrate that educators can create their own computer-based multimedia that may produce equal or better learning outcomes than paper-based media.
CHAPTER 1

INTRODUCTION

“During the past ten years, teachers have significantly increased their use of multimedia technology to enrich the learning environment in secondary schools” (Fenton, 1998, p.27). This expanding use of technology in the classroom varies nationwide and usually rests on a school’s financial abilities and the preparation of practicing teachers (Mark 1996). Ten years after the previous statements were made; a continuing escalation of technological development is making computer related skills an essential tool for the student and teacher in everyday educational processes. As a result of this, educators are finding it necessary to teach courses in the use of software specific to their subject areas. Spearman (2000) writes “Exploring the use of the computer and technology in the many aspects of the music experience in undergraduate and graduate courses is perhaps one of the most beneficial avenues for the future of music teacher education” (p. 162). Faced with the newness of this instructional situation and its need to continually pursue rapid developments, the relevant question is which technology is best suited to support the training of software users. Largely due to the growth in its capabilities, and continued reduction in cost, the personal computer is becoming more and more capable of serving these instructional needs and providing highly individualized support.

Prior to the introduction of the personal computer (PC) in 1976, computer aided instruction (CAI) was carried out within the university setting and was characterized by studies in feasibility, development and implementation of new software (Liske, 1999). This research was confined to large mainframe computer systems and was not applicable to widespread classroom use. In 1976, the Apple I was introduced, and in 1981, IBM released its first personal computer. The introduction of the PC (IBM personal computer) was followed shortly by the release and subsequent refinement of the Microsoft operating system known as Windows. What followed was an accelerated period of development that led to cost reductions of hardware and software, a widespread acceptance and use of the PC in homes and schools, and the emergence of a body of research in CAI within the fields of general education and music.
Contemporary computer technology continues to advance at a rapid rate. The field of educational research has not been able to thoroughly investigate how the results of recent and rapid advances in technology can be best applied in the classroom. In Solomon’s early writing about the field of educational media he asserted, “the field was generally atheoretical and far behind contemporary advances in psychological research” (Solomon, 1979, p. xvii). Interestingly, Solomon wrote this remark before the widespread use of the PC. He was referring to research surrounding educational media technologies such as the filmstrip, television, and early videotape. Since then, technology has increased its rate of development and it is unlikely that research has kept up with the advancements.

Thirteen years later, Higgins (1992) also referred to the research community’s inability to keep up with the rapid development of technology. Speaking specifically about music technology research, he found general weaknesses in (a) research design, (b) treatment length, (c) researcher expertise, (d) the quality of the treatment, (e) and the overuse of comparative studies instead of designs more suited to protect validity. Additionally, Higgins concluded that: Major changes in technological tools occur in decreasing time intervals, and the apparent inability of the educational system to incorporate them compounds the research problem. Because of these rapid changes, many researchers today are opting to participate in the development of new technologies, experimenting with the possibilities of these devises, rather than conducting research on the effects of pedagogical applications (p. 490).

Advances in technology and new methods for the distribution of information continue to be the focus of educational research studies and media comparisons. These studies are also the center of considerable debate. In 1983, Clark wrote a remark that may be one of the most quoted excerpts related to the use of educational media and technologies. He wrote, “… Media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes changes in our nutrition” (p. 445). Clark structures his argument with statements that support the idea that the instructional design used within the media presentation may have influence, but that when choosing between modes of delivery that can accomplish similar goals, it may be a question of cost and learning effectiveness. Dealing with the same idea, Mayer (2001) wrote, “I found no substantive differences on test performance for students who received an explanation presented via animation and narration versus students who received an explanation of the same system using illustrations and text” (p.70).
MIDI

Liske (1999) referred to two important areas of technological development that influenced research in music education. “The first, multimedia, relied on improvements in microcomputer’s processing power and speed, and its ability to control devices such as compact disks and video disks. Additionally, the development of the Musical Instrument Digital Interface (MIDI) protocol gave the microcomputer the ability to play and manipulate digitized musical sounds in a highly sophisticated manner” (p. 6). MIDI creates the means for entering data from a keyboard into notation software, it allows the aural skills student to enter responses to drill related software, and it allows multimedia presentations to send commands to computer-based sound cards or external synthesizers. Additionally, it allows the student to improvise while triggering a variety of sounds produced by electronic means.

Currently, the National Standards for music education include a reference to the use of MIDI in the classroom. Within the 9-12 heading, under achievement standard 4b, the standard recommends that, “Students arrange pieces for voices or instruments other than those for which the pieces were written in ways that preserve or enhance the expressive effect of the music.” The assessment strategy related to this achievement standard suggests that students arrange existing music for an ensemble of “…synthesizers or other MIDI-controlled instruments…” (http://www.menc.org/publication/books/performance_standards/9-12.html). Also, the accreditation agency for schools of music within the United States (the National Association of Schools of Music (NASM)) has addressed technology in music degree programs as: “Students must acquire the ability to use technologies current to their area of specialization” (NASM: Handbook 2007-2008, p. 85).

In response to advancing technologies, the National Standards, and NASM requirements, universities have called for the implementation or expansion of courses that teach basic technology skills and an introduction to the use of widely accepted software. In the university music classroom, the two largest areas of application occur in music notation software and software related to computer-aided instruction as applied toward aural skills training (Deal & Taylor, 1997). Deal and Taylor also maintained that there is a trend of increasing use of multimedia course materials within music appreciation courses and courses containing music analysis.
Transfer

In response to rapidly changing technologies, new courses must be created and old courses must be updated. It is during this process that educators who teach the use of software run headlong into questions directly related to the transfer of learning. Which software should be taught? How should the information be delivered? Does guided practice on one application transfer readily to the use of another? Today, largely because of MIDI sequencing’s growing popularity, there are literally dozens of software applications available that may or may not be appropriate for the classroom. This appropriateness is largely centered on the need to have what is learned in the classroom transfer to the software that the student finally uses away from the classroom and following the learning experience. This study is primary interested in the structure and delivery of media that is used to help teach students how to use software, and whether or not these structures can affect transfer of learning.

It can be assumed that, as a result of market forces and the expense of product support, the software giants are expending considerable resources to develop a system of user interfaces that maximize transfer between applications. It is to their benefit to produce user interfaces that ease user frustrations when learning to use a new software tool. “A fundamental transfer of learning task confronting education today is the need to improve computer competency…. Complicating this issue is the problem of having to deal with multiple hardware architectures, operating systems, and user interfaces. But, with the trend of moving toward common user interfaces based on graphics such as Microsoft Windows, transfer of learning is accelerated” (Haskell, 2001 p. 24). With a few minutes of exploration it is not hard to discover the structural similarities between major software platforms. The pull down menus, the exploding and layered “window” views, and the location of the title of the currently active software is all provided within a consistent standard, even among competing companies. These remarkable similarities seem to point directly to the theories of Edward Thorndike, the pioneer of transfer research.

Thorndike dedicated thirty years of research in a successful effort to discredit the doctrine of formal discipline. This doctrine was widely accepted at the turn of the twentieth century and had roots as far back as Aristotle’s time. The doctrine of formal discipline upheld the theory that exercising the mind like a muscle improved an individual’s mental abilities in broad categories such as reasoning, attention and observation. The underpinning of this theory was a concept of general transfer. A proponent of the idea of formal discipline and general transfer might surmise
that extensive work within the field of mathematical theory would strengthen ones ability to solve problems in the area of architectural design. Before Thorndike began his study of transfer, it was generally accepted that transfer of learning was broad in scope and sometimes crossed domains (Singley & Anderson, 1989). Thorndike’s work did indicate that the doctrine of formal discipline was incorrect. His work showed that transfer occurs in a much narrower scope than previously believed, and did not readily transfer between domains (Singley & Anderson, 1989). The result of Thorndike’s work was his theory of identical elements: “One mental function or activity improves others in so far and because they are in part identical with it, because it contains elements common to them. Addition improves multiplication because multiplication is largely addition; knowledge of Latin gives increased ability to learn French because many of the facts learned in one case are needed in the other” (Thorndike, 1906 p. 243). In his theory, Thorndike was willing to concede to the idea of transfer to the extent that there must be identifiable identical elements of stimulus-response within the transfer encounter, and that the degree of transfer rested solely on the extent to which two learning situations were identical.

Singley and Anderson (1989) provide us with a modern adaptation of Thorndike’s theory of identical elements. Having had the benefit of considering more recent cognitive theories, they propose that cognitive skill is acquired, stored, and used as a “production,” and these productions are stored and used within systems of productions. A production may be defined as a set of condition-action rules that interact with working memory. Singley and Anderson maintain that these productions represent the elements that Thorndike was searching for in his identical elements theory, but that by definition, these elements are more abstract and flexible because they are “versatile and powerful computational formalisms” (p 32). Based on these ideas, Singley and Anderson proposed the ACT* theory of skill acquisition which is still very similar in nature to Thorndike’s identical elements theory. Though decades apart, the general idea contained in both theories remains that the degree to which one learning situation is similar to the next greatly affects transfer.

The importance of similarities between learning situations is illustrated not only in transfer research but in a wide variety of real world situations. Software design conventions that rely on similar screen structures are just one example of the influence this concept has on our educational lives. Educators’ who are designing courses and lecture support media have a need...
for research based strategies that can aid in using technology in act of teaching technology while also increasing transfer of learning.

**Lecture Support**

Barring the discovery of a new science which allows teachers to inject stimulus and information directly into the human nervous system, educators will continue to deliver information to their students in a limited number of ways. Aside from direct verbal communication, the most common method used to present information in the classroom is paper-based. Through the use of textbooks, worksheets, study guides, and other unbound paper materials teachers have been improving their students learning experiences for centuries. More recently, the use of filmstrips, audio recordings, overhead projectors, opaque projectors, 16mm movie projectors, televisions, and video cassette recorders have added a variety of ways to present information to students. And, most recently, the advent of the personal computer (PC) and its accompanying software, compact disks (CDs), and digital video disks (DVDs) has added to the existing variety of technologies from which to choose. However, the types of information delivered remain very similar for all of these educational tools. For example, information delivered by filmstrip or digital video includes many of the same components: Spoken word, printed text, graphics, illustrations, photographs, moving images, and animations. All are readily available to the modern classroom in one form or another. Technology will advance but the most basic methods of engaging the human senses are not likely to change radically any time soon.

Lee and Owens (2000) group the five senses into four approaches that can be utilized in the presentation of educational media:

1. **Visual:** presenting instruction using anything the learners can see. Visual instruction includes what is seen such as video, graphics, animation, and written text.
2. **Auditory:** presenting instruction using anything the learners can hear.
3. **Olfactory:** presenting instruction using anything the learners can smell or taste.
4. **Tactile or kinesthetic:** presenting instruction using anything students can touch or manipulate.

All of these presentation modes, excluding the olfactory, can be utilized without difficulty within the MIDI classroom. The modern PC can supply all visual and auditory delivery methods simultaneously. In addition, the tactile mode is accessed through the use of the
computer keyboard as well as the musical keyboard, which provides both tactile and auditory experiences. Alexander (1999) indicates that in order to increase the likelihood of transfer, teachers should visit centralized concepts in a variety of educational situations. This is something that a technology rich music classroom can aptly support through its various modes of presentation.

However, an abundance of presentation modes and easily accessible technologies does not necessarily dictate an efficient or successful learning experience. Research indicates that there are structures within the media itself that can be utilized to make multimedia more effective for the learner; and most importantly, while we strive for a variety of experiences within the classroom setting, the simultaneous presentation of various sensory modes within the presentation is not necessarily better. Mayer (2001) outlines seven principles based on a cognitive theory of learning that can pilot the successful creation of effective multimedia. His principles are supported by more than thirty studies conducted by he and his colleagues.

Mayer’s cognitive theory of learning is based on work by Paivio (1986) and contains three essential assumptions. First, learners process information through separate channels, one for visual information and one for auditory; and second, these channels have a limit to the amount of information that can be processed during any period of time. Lastly, “Humans engage in active learning by attending to relevant incoming information, organizing selected information into coherent mental representations, and integrating mental representations with other knowledge” (2001, p. 44). Supporting his theory of learning, Mayer lists seven principles for multimedia design (see page 26 of the Review of Literature for a complete list).

A key idea for understanding Mayer’s principles is that learners’ individual processing channels can be overloaded. Overloading reduces the learner’s ability to select relevant information and integrate it with selected information coming from the other channel, and this causes a break in the link to the final assimilation of new information with old, and the formation of long-term memory. Also, in Mayer’s model of mental processing, the auditory channel is responsible for the interpretation of meaning from words either printed or spoken. For example, if a student sees a projected graphic that is accompanied by text and narration, the visual channel is interpreting the text and the graphic while the auditory channel is also processing the narration. Therefore, once the visual channel deciphers the text, it sends that information to the auditory channel to process meaning. Thus the processing channels are forced to do double duty, and this
double duty affects learning in an adverse way. The idea of limited processing within each channel lies as a foundation to Mayer’s multimedia design principles. As an educator designs media for his or her classroom, the interaction and structure of the components (audio and visual) within the design is an important concern, and for the researcher involved in a comparison study, it is essential to represent each type of media in its most effective format.

**Purpose of the Study**

Music technology educators who teach MIDI principles and software usage are concerned with a number of issues including: (a) teaching MIDI skills while preparing students for the best possible transfer of skills to other MIDI software applications, (b) providing the most appropriate MIDI software based on accessibility and transfer of skills to other applications, and (c) choosing the lecture support material format which fosters the most effective learning. This study investigated the use of screen camera software and its application within a course teaching basic MIDI sequencing skills. It also investigated the application of current multimedia design principles (Mayer, 2001) within the domain of music software education and transfer of learning between software applications.

The purpose of this study was to compare learning, and transfer of learning, outcomes as affected by two types of lecture support both designed to teach computer skills within a music classroom. The first type of lecture support material was a paper-based tutorial for using MIDI software. The second was a computer-based multimedia video tutorial for using MIDI software. This comparison utilized two sets of data collected in this study: (a) descriptive data from attitudinal and demographic surveys, and (b) a test of the subject’s prior knowledge and a posttest. Posttest scores contained scores from subjects’ performance on two MIDI applications and one not so closely related application, digital audio.

The first method of lecture support was paper-based. It included both text and graphics. It was created by the researcher using a word processor and by extracting color graphics directly from the MIDI software being taught. This set of materials was presented to the participants in an entirely paper-based format. The content was organized in such a manner that it required no student interaction with the computer, but because it utilized integrated text and graphics, it is considered to be multimedia in nature (see Appendix B). The second method of lecture support was accessed by subjects using the computer and was created by the researcher using screen-camera software. Screen-camera software is used to record the screen during the use of a
software application while simultaneously recording narration and sounds from the software. The result is a narrated video of the screen action including mouse movements and all interactions with the software. This video media can be played back on the computer screen and controlled by the student viewing the material. Both types of media can be considered multimedia because they combine the use of images and text either through printed words or narration.

The methods of lecture support to be investigated were selected partially because of their ease of use, and also because they can be based on design principles and software applications which are easily understood, accessible, and, are already widely used. The screen camera software utilized in this study requires little training to learn, and the word processing software used to produce the paper based media was Microsoft Word, which is a word processor that is widely used. The selected guiding principles surrounding the construction of effective multimedia presentations, as outlined by Mayer (2001), are straightforward and easy to understand.

**Importance of the Study**

Currently, there are no studies that have investigated the use of multimedia for lecture-support in a music classroom where software process learning is the primary goal of the instruction. Indeed, there are a number of researchers who have concentrated on research that investigates computers, multimedia, and learning; however, their work is not connected to the field of music or MIDI applications. They are primarily concerned with computer-aided instruction in the absence of a human component, thus creating a situation in which the multimedia stands alone in the instructional design. This study was designed to investigate the effectiveness of two types of media used as lecture support in a music technology classroom. This comparison will provide information toward the refinement of future research directly related to multimedia utilized within the field of music as well as help educators make decisions leading to more efficient instruction. It may also provide insight to multimedia structures and their strengths and weaknesses in the classroom.

**Research Questions**

The study sought to answer the following questions:

1. Which form of lecture support, computer or paper based, will produce the highest gains in learning as measured by an initial test of prior skills and a post-test?
2. Which form of lecture support, computer or paper-based, will produce the highest scores when subjects are tested on a software application that is closely related to but different than the one used in training?

3. Which form of lecture support, computer or paper-based, will produce the highest scores on a software application that is different and distantly related to the one used in training?

4. Will there be a difference in learning between college-age participants and high school age subjects?

5. Will prior computer experience correlate with scores on the post-test?

6. Will there be a difference in learning between high school students who share a computer and those who don’t?

7. Will there be a difference in exit attitude between types of lecture support media?

**Null Hypothesis**

1. There will not be a significant difference in post-test scores between modes of lecture support when subjects are tested within the software application used for training.

2. There will not be a significant difference in posttest scores between modes of lecture support when subjects are tested on a different, but closely related, software application.

3. There will not be a significant difference in posttest scores between modes of lecture support when subjects are tested on a distantly related software application.

4. There will not be a significant difference in posttest scoring between the high school age population and the college-age population.

5. There will not be a correlation between prior computer experience and posttest scoring.

6. There will not be a significant difference between high school students who share computers and those who don’t.

7. There will be no significant difference in exit attitude between types of lecture support media.

**Limitations of the Study**

This study was limited to the analysis of data collected from self-selected volunteers of high school and college age. The study was conducted at Florida State University during the
summer of 2002. High school age volunteers were accepted from the surrounding area high schools and the University’s summer music camp sessions. Students accepted as participants in the study had a basic knowledge of Windows operating system and the ability to read music as well as find notes on a synthesizer keyboard. A majority of the college-age participants were music majors. Important differences may be found between this sample and other populations as a result of student motivation, teacher effect, and size of the seminar group. Also, the students who participated during the summer school sessions were not randomly selected for each group because of logistical problems caused by the music camp schedule. Therefore, the high school aged results are based on a partial convenience sample. The size and type of the population used for this study does not meet requirements for generalization to samples of other populations, so discussion related to the results of this study should not be generalized to other populations without appropriate prudence.

A design flaw of this study might be located in the design of the media itself. One would be inclined to ask whether or not each type of media used was presented in its strongest format. To help reduce error within this part of the design, Mayer’s (2001) principles were applied. These principles address both printed text and multimedia designs and represent extensive research into the individual design elements that create effect multimedia. Before either is more thoroughly investigated within the music technology classroom, it must first be ascertained whether computer-based multimedia is at least equivalent to the traditional paper-based method of presentation, and whether or not learning can be made more effective and efficient through its use.

Definitions

Application—is a software program, or group of programs, that is designed for end users in the consumer market. Word for Windows is an Application. Microsoft Office is a group of applications.

CD-ROM—is an optical disk that can be used to store information in digital format. The information is in a read-only format; once it is recorded on the disk it cannot be changed. Each disk can store up to 640 MB of information. The information is read from the disk using a highly focused beam of laser light (Hefzallah, 1999).
Interactive—presentations or software that accept human input. The input of data or executable commands defines interactivity. A program or presentation that is not interactive would play from start to finish without human intervention.

Lecture support—supplemental instructional material designed to aid the learner in the acquisition of new skill related directly to the principles expressed in lecture-based instruction. In this study lecture support refers to either printed materials or those presented through the use of a personal computer.

MIDI Trigger—an electronic device that senses player manipulations of performance tools and converts the physical event into a transmittable MIDI code. It is usually used in conjunction with a MIDI drum module or other supporting electronic devices.

Multimedia—the presentation of material for learning in two or more formats simultaneously. For example, a text that supplies a graph and accompanying text could be considered multimedia, or a slide show presented with narration would be considered to be multimedia (Mayer, 2001). Today the term has become more closely associated with computer environments and the World Wide Web (Hefzallah, 1999).

Musical Instrument Digital Interface—(MIDI), the protocol language that allows electronic components to communicate between various models and brands of computer systems. The original protocol was created to allow synthesizers to interconnect; however, today it has a much more wide spread use, including such applications as interactive art installations and stage lighting control.

Screen Camera—Lotus ScreenCam (1998) is a Screen Capture/Presentation Graphics Utility that allows the user to record movies of screen activity on Microsoft Windows systems. Each movie includes all mouse-pointer movements and other screen events, and optionally, voice-over narration or captions. This can be played back on a computer monitor as a movie, saved in a file, or linked to another application.

Computer Mediated Multimedia—the use of computers to present text, graphics, video, animation, and sound in an integrated way. Until the early 1990s, multimedia applications were uncommon due to the expensive hardware required. With increases in performance and decreases in price, however, multimedia is now commonplace. Nearly all PCs are capable of displaying video, although the quality of the presentation depends on the power of the computer's video adapter and CPU.
Transfer of learning—occurs when knowledge acquired in one situation is applied to a different, novel situation. Several researchers have defined transfer. Singley and Anderson (1989) describe it as “how knowledge acquired in one situation applies (or fails to apply) in other situations” (p. 1), and Cormier and Hagman (1987) describe it as “whenever prior-learned knowledges and skills affect the way in which new knowledges and skills are learned and performed” (p. 1).

User interface—is the point of interaction between a computer user and a computer application. This interface may be based on a set of commands or a structured set of menus.
CHAPTER 2

REVIEW OF LITERATURE

Media, and its use for instructional purposes, has been a subject of interest and research since the advent of textbook illustrations. More readily available films, video and computer software has led to investigations seeking the most efficient and cost-effective way to deliver information and to facilitate learning (Clark & Solomon, 1986). With the proliferation of computer assisted multimedia technologies, educators and researchers have predicted that media based learning will be noticeably affected, making education more efficient and interesting (Clark & Solomon, 1986). Whereas multimedia has received widespread consumer acceptance, materials produced and marketed for educational use are often designed poorly, lack theoretical underpinnings, and fail to support their educational value with empirical data (Trautwein & Werner, 2001). However, in the field of educational research, multimedia and its design as an efficient instructional tool is being investigated in a wide variety of contexts.

In the following chapter, themes relating to the current study will be discussed in relationship to literature and research studies. The discussion will include research and scholarly writing in the following topics: History of multimedia and hypermedia, Musical Instrument Digital Interface (MIDI), multimedia instructional design principles, the role of cooperative learning in computer based instruction, approaches to software instruction and its transfer of skills, and a survey of educational transfer.
The term hypermedia gets its origin from the term hypertext, which is attributed to Vannevar Bush. In 1946 in the article “As We May Think,” Bush proposed that a storage device be created that allowed a person to interact with all of human knowledge. The key to this device was its ability to freely link any passage of text to any other in a creative network. Although the possibility of linking all of human knowledge has not yet come into the realm of immediate possibilities, hypertext linking is now possible on an extremely large scale as the result of contemporary computer software, databases, and the World Wide Web. As computer processor power increases, so does our ability to link, store, and retrieve a variety of media. Hypermedia research tends to focus on the structure through which information is presented, and the degree to which its design affects students’ achievement. It is usually structurally complex and is designed to provide a specific type of navigational environment. In this environment, a self-directed learner may freely explore information presented in a variety of modes and in a nonlinear order (Hefzallah, 1999). The presentation segments that make up the hypermedia environment may contain the basic components of a multimedia presentation.

Wang (1995) created what is known as a constructive and cognitive-flexible hypermedia-learning environment (CC-FHLE) for the purpose of enhancing the transfer of classroom management skills from pre-service teacher education to the classroom practice. He reported that the environment enhanced cognitive flexibility, teacher recognition of appropriate skills, and transfer to the classroom when the learning process corresponded to constructivist principles. Bell (1998) also investigated the effectiveness of computer-aided training in the instruction of classroom management skills. Her study centered on elementary physical education classes and utilized a computer-based environment. Her learning environment was created in a linear mode including: introduction, tutorial, review test, and self-exploration sections. Findings in Bell’s study indicated that learning from the computer environment did transfer into the classroom and was one of the contributing factors influencing the participants’ classroom management skills.

Nicaise and Crane (1999) conducted a qualitative study in which graduate students participated in a technology course while learning educational theories. The students spent a semester learning appropriate technology for the purpose of authoring a chapter in a World Wide Web based book about educational theory. Interestingly, the students reported a high sense of satisfaction regarding the amount learned during the course. This was contrasted by final
projects that were, as a majority, less than satisfactory in content, containing misconceptions, and lacking organization.

Henderson, Klemes, and Eshet (2000) used a hypermedia science environment created for the purpose of supporting classroom curricula. The software, Message in a Fossil, created a learning environment with game-like interactions. The students were able to excavate virtual archeological sites and use the fossil evidence to create museum displays related to what they had found. Reported results indicate improved skills in the areas of basic recall, higher level thinking skills, strategies, and the students’ use of related scientific vocabulary.

Mann (1997) sought to differentiate between modes of delivery within a hypermedia environment. Using a researcher-designed multimedia presentation created to teach drug awareness in urban schools, he investigated the effectiveness of text, sound, and sound in combination with text, as delivery methods. The highest levels of learning occurred in the environment where recorded text only was presented as sound; and students exposed to the text, and text with sound environment reported displeasure with extensive amounts of reading from the computer screen. This study shows results similar to several multimedia studies (Mayer & Moreno, 1998; Mousavi, Low, & Sweller, 1995; Moreno & Mayer, 1999; Kalyuga, Chandler, & Sweller 1999). Except for Mann (1997), the previous studies were structured to investigate the effect of hypermedia environment and its potential to facilitate learning. However, little attention was given to the precise structure and content of the instructional media. It is important to be able to identify what components and specific design elements structured within the media affect students’ learning outcomes.

Research in Multimedia & Music

Education research in the fields of multimedia and music fall into two distinct categories. The first utilizes multimedia delivery systems in the form of a presentation that may or may not be delivered in an interactive learning environment. The second category contains computer-aided instructional software that utilizes multimedia presentations to provide practice exercises for the development of musical skills.

Renwick and Walker (1992) created an extensive multimedia re-creation of Schenker’s analytical essay “Brahms: Variations und Fuge uber ein Thema von G. F. Handel, op. 24.” The final project included graphs incorporating Schenker’s analysis with the original score that were then aligned to MIDI sequences and CD audio recordings of the musical performance. The CD
also included textual information relating to Schenkerian analysis, a glossary of terms, and an interactive graphic display that allows flexible presentation of the levels of analysis and the scored music. Innis (1996) created a multimedia presentation using Adobe Photoshop and Adobe Premier software. The visual presentation accompanies the audio performance of Saint-Saens’ *Le cygne* from *Le carnaval des animaux* as arranged for two pianos. Two versions of the visual portion of the multimedia project were created. One incorporated abstract images while the other utilized realistic visual representations of the musical content. Gyorgy Kroo, acting as the managing editor guided the creation of “Bella Bartok, 1881-1945: Multimedia CD-ROM.” This project contains close to one hundred fifty segments of audio and visual recordings of performances by Bartok and world-renowned performers. Chad Kirby (1998) created a multimedia addition of *The Modern Trombone* written by Stuart Dempster. The resulting project contains the original text and recordings as well as new video and audio performance examples created and digitized specifically for inclusion in the CD-ROM.

In each of the previous examples, extensive work and time was invested in the creation of the multimedia presentations. However, little or no attention was given to the instructional design of the presentation or the effects of individual components within each segment of the presentation. To this point, none have been used in the collection of research data pertaining to the effectiveness of the design of the final product.

In the category of computer-aided instruction, Benson (1998) investigated the effects of sequenced disk, video, and multimedia computer software on the performance achievement and attitude of group piano students. The treatment groups were assessed in performance variables including: rhythmic accuracy, musicianship, and note accuracy. There was no significant difference between treatment groups; however, an attitude survey did assess that the students who received the multimedia treatment perceived less difficulty in their practice sessions. Notably, Benson’s study had a very small sample size, with four participants in each of the four design groups. Choi (1996) created and implemented an interactive multimedia tutor for the purpose of investigating its effects on instrumental discrimination skills and attitudes of clarinet students. This study indicated that regular use of interactive multimedia could improve the skills of young instrumental students and positively affect their attitudes. A similar study investigated the effect of interactive multimedia on the achievement of young saxophone students. Orman (1998) used a control group design in which the treatment group used a music-training program.
for eight to fifteen minutes of their daily band class. Written and video taped performances indicated that the experimental group achieved significantly higher scores than the control group on all administered tests.

**Research Related to Music & MIDI**

Although no studies exist that deal with the training of participants in the use of MIDI software and technology, there are several studies that utilize MIDI as a tool to collect data. Woody (1999) used MIDI performance files to demonstrate performances with varied dynamic expressions (musically inappropriate and appropriate). The performances were played using a Yamaha Disklavier, an acoustic piano fitted with automation mechanics that is capable of playing MIDI files. Participants were asked to describe their observations of the played sequence and then, through performance, duplicate it. The MIDI recordings of these performances allowed the researcher to index the dynamic content of each participant’s performances. Only when participants had previously indicated in their written observations that they noticed dynamic variations, were the participants found to consistently duplicate the performance examples. Busse (1998) used MIDI technology and software to record, analyze, and recreate several jazz piano examples in two groups, one derived from live performances and the other created using software-based styles and representative traditional notation. Seven examples were created, four were derived from live expert performances recorded in a MIDI file and three were generated using software parameters. Forty-two experts in jazz keyboard then performed the examples. Compared measurements of note placement at the down and up beat and velocities produced significant differences between the experts performances of the mechanical recreations and the examples derived from actual performances. Also, listeners were able to distinguish between the live performance and software-generated types.

In a study of developmental improvisation skills in children, Brophy (1999) utilized a MIDI-triggered Orff alto xylophone to record 840 melodic improvisations created by children age six to twelve. The MIDI technology allowed the researcher to analyze the performances based on rhythmic content and improvisational structure. Analysis of the recorded performance data showed that children’s improvisations change significantly with age, and may be independent of mallet ability. Although these studies show extensive use of MIDI technology and software, there is little or no other research that has been conducted in the domain of music
software training, or more specifically, in the area of teaching MIDI sequencing and its related software.

**Multimedia Design for Meaningful Learning, Retention, and Transfer**

Richard E. Mayer is one of the leading researchers investigating the effects of intentional multimedia design principles on effective knowledge acquisition (Reed, 2006). Mayer’s research-based design principles identify the aspects of multimedia instructional messages that promote learning. Learning that occurs from a multimedia message is the result of two cognitive processing systems, the verbal and visual. Mayer explains, “The rationale for multimedia presentations – that is, presenting material in words and pictures – is that it takes advantage of humans’ full capacity for processing information. When we present material only in the verbal mode, we are ignoring the potential contribution of our capacity to also process materials in the visual mode” (Mayer, 2001, p. 4).

Mayer’s research in these modes of processing is based on the work of three major theorists: Paivio, Baddeley, and Sweller (Reed, 2006). Paivio is best known for his dual code theory. He argued that there are two major ways that humans elaborate on a subject during the learning process: Visual and verbal memory codes. Several of Mayer’s design principles are closely associated with both Paivio’s dual-code theory and Baddeley’s working memory model, which “assumes humans have separate information processing channels for auditory and visual processing” (Mayer, 2001 p.7). A student relies on either (or both) of these encoding strategies when assimilating, storing, and recalling information. The verbal encoding can either be phonological or semantic (Pavio 1975, as cited by Reed 2006). The visual code is pictorial imagery that reflects the meaning of the verbal code. When both codes work together to represent a concept, the memory will be stronger than when a single code represents a piece of information on its own (McCown, Driscoll, and Roop, 1996; Reed, 2006).

Baddeley describes the auditory processing as a “phonological loop” and visual processing like a “visual-spatial sketch pad” (Baddeley, 1992 p. 556 as cited by Mousavi, Low, and Sweller 1995). Both Pavio’s and Baddeley’s auditory and visual processing theories have influenced Mayer’s multimedia design principles. By emphasizing the right combination of instructional content in the separate but interdependent verbal and visual channels of processing, Mayer uses the capability of multimedia in both the verbal material (narration and sounds) and
the visual material (on-screen text, imagery, and animation) to optimize the learner’s opportunity to process information (Mayer, 2001).

Another important theoretical underpinning for Mayer’s investigation of the design principles of multimedia is Sweller’s cognitive load theory (Mayer, 2001; Reed, 2006). Cognitive load theory assumes that each channel has a limited capacity for processing information and thus can be overloaded (Chandler & Sweller, 1991, 1996; Mayer, 2001). Chandler and Sweller’s research investigates how demands on cognitive processing can overwhelm the short-term memory (Reed, 2006).

Richard Mayer’s (and colleagues) research in multimedia learning has investigated the way the design of instructional media can affect optimal cognition in learners. The effects of computer and paper-based multimedia on learning and transfer of learning has shown that many factors (belonging to either the learner or the instructional media) can effect the learner’s achievement.

**Mayer’s Seven Principles of Design for Instructional Multimedia**

The following section is a list of the multimedia design principles followed by a summary of related research by Mayer and others that connects factors influencing how students learn with multimedia instruction. These design principles serve as recommendations for educators who recognize that “not all multimedia messages are equally effective” (Mayer, 2001, p. 187) and who are interested in designing multimedia instruction for optimal cognition.

Mayer has identified the following seven principles for the design of instructional multimedia messages:

**Multimedia Principle:** Students learn better form words and pictures than from words alone.

**Spatial Contiguity Principle:** Students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.

**Temporal Contiguity Principle:** Students learn better when corresponding words and pictures are presented simultaneously rather than successively.

**Coherence Principle:** Students learn better when extraneous words, pictures, and sounds are excluded rather than included.
Modality Principle: Students learn better from animation and narration than from animation and on-screen text.

Redundancy Principle: Students learn better from animation and narration than from animation, narration, and on-screen text.

Individual Differences Principle: Design effects are stronger for low-knowledge learners than for high-knowledge learners and for high-spatial learners rather than for low-spatial learners (Mayer, 2001 p. 184).

Multimedia principle

Mayer’s vision of meaningful learning as a result of well-designed instructional multimedia is one that begins with his first research-based design principle, “Student’s learn better from words and pictures than from words alone” (Mayer, 2001, p.184). In nine different experiments over four years, (Mayer & Anderson 1991; 1992; Mayer & Gallini 1990; Mayer 1989) retention and transfer test scores were compared for students learning from text and illustrations and text alone. The participants in the multi-representation group (learning from words in combination with pictures) showed a 23% median improvement over the single representation - text only groups (Mayer 1997; 2001).

Graphics and illustration are widely used in textbooks and instructional multimedia. Tables, graphs, diagrams, drawings or photographs can play an important role in the way a student acquires schema and integrates new knowledge with prior knowledge. Visual examples integrated with relevant text in dual modes of presentation can mean making the most of working memory and reducing cognitive load (Mousavi, Low, & Sweller 1995). When used together, visual and verbal explanations combined in multimedia instruction lead to enhanced student understanding. Mayer (1997) reports on eight experiments completed by him and his colleagues over a three-year period. The findings show that combined visual and verbal instructional messages led to “75% more creative solutions to transfer problems than did students who received the explanation presented only in verbal form” (p. 8).

It is important to note that the multimedia effect is not limited to computer-delivered multimedia, nor is instruction always enhanced by dynamic multimedia. Mayer, Hegarty, Mayer, & Campbell (2005) found that students in the static illustrations combined with printed text group scored significantly better on retention and transfer tests than participants in the
animated multimedia (computer-based) group. “Trying to make a presentation less effortful and more interesting through the use of computer-generated animation led to worse test performance on four of eight comparisons and no significant difference on the others” (Mayer, Hegarty, et al. 2005, p. 264). Well-designed multimedia is not always computer-mediated, it can also be paper-based (Mayer, Hegarty, et al., 2005; Harp & Mayer, 1998).

**Auditory and Visual Contiguity**

The Temporal Contiguity Principle states that, “Students learn better when corresponding words and pictures are presented simultaneously rather than successively” (Mayer, 2001, p. 184). Bagget (1984) conducted a study in which participants ($N = 336$) were randomly assigned to fourteen different groups. All groups viewed films with narration that was out of sync (temporal overlaps) with the visual images. Seven variations of temporal overlap were used in the treatment: Visual images were presented 21, 14, or 7 seconds ahead of the audio narration, visuals and narration were in sync, and visuals were presented 21, 14, or 7 seconds after the narration. One half of the groups were tested immediately following the treatment and the other half were tested seven days after the treatment. Scores were the highest for two groups who were tested immediately after the treatment—the synchrony group and the group whose film presented the visuals seven seconds before narration. The same two groups scored highest when the retention group was tested after a seven-day delay. Presenting the visual information 21, 14, or even 7 seconds after the narration led to significantly reduced retention scores. Bagget identified the key finding of the study, “When visuals precede narration by up to 7 seconds, recall is as good as when visuals and narration are in synchrony. In a dual-presentation, the narration should shortly follow, or be in synchrony with, the visual image; it should not precede it” (1984, p. 415).

**Spatial and Temporal Contiguity**

Mayer’s spatial contiguity principle states that, “Students learn better when corresponding words and pictures are presented near, rather than far, from each other on the page or screen” (Mayer, 2001, p. 184). Mayer’s principles of spatial and temporal contiguity are closely related to Sweller’s split attention effect. The split attention effect occurs when instructional text and images (as in a textbook) require learners to divide their attention between multiple sources of information (Chandler & Sweller 1991; 1996; Kalyuga, Chandler & Sweller
When a learner is engaged in mental integration of separated text and diagrams prior to being able to understand the presented concept, a split attention effect can impede learning. “Mentally integrating multiple sources of information results in less effective acquisition of information than if learners are presented the same material in a physically integrated form” (Mousavi, Low, and Sweller 1995). Several studies have investigated how the presentation of text and images in mixed rather than single modes can improve retention and/or transfer by reducing cognitive load. In one study, (Mayer, Moreno, Boire & Vagge, 1999) students scored better on retention and transfer tests when they were presented with instructional multimedia that was designed in such a way that allowed them to hold both visual and verbal information in their working memory simultaneously. Instructional materials should be designed to integrate diagrams with explanatory text rather than present them separately (Mayer 2001).

**Redundancy Principle**

This principle states that, “Students learn better from animation and narration than from animation, narration, and on-screen text” (Mayer 2001, p. 147). When learners are presented with corresponding text near or integrated with diagrams, the split attention effect is reduced which then frees up working memory and reduces cognitive load. However, when part of the visual, text, or audio information is unnecessarily repeated, a redundancy effect can be seen and the cognitive load is increased (Chandler & Sweller 1991; Mayer, Heiser & Lonn, 2001).

In a series of three experiments by Kalyuga, Chandler, and Sweller (1998) the split attention and redundancy effects were investigated to learn how cognitive load influences learning when participants have varying degrees of prior knowledge. It was hypothesized that in the same way that isolation of text and diagram information can cause cognitive overload, redundancy can cause overload when integrated textual information is needlessly repeated in a diagram or example.

The distinction between the split-attention and redundancy effects hinges on the distinction between sources of information that are intelligible in isolation and those that are not. If a diagram and the concepts or functions it represents are sufficiently self-contained and intelligible in isolation, then any text explaining the diagram is redundant and should be omitted in order to reduce cognitive load. Alternatively, if the concepts or functions of a diagram are not intelligible in isolation, then the diagram will require additional, possibly textual, information.
In this case, to reduce cognitive load, that additional information should be integrated with the diagram. These situations represent the two extremes of a continuum of intermediate states in which the text is partly redundant (Kalyuga, Chandler, and Sweller 1998).

**Individual Differences Principle**

“Design effects are stronger for low-knowledge learners than for high-knowledge learners and for high-spatial learners rather than for low-spatial learners” (Mayer 2001). Several different types of individual learner qualities have been studied to determine the extent to which learners may vary in their response to multimedia instruction: Learner’s level of expertise (Kalyuga, Chandler & Sweller, 1998); verbalizer or visualizer cognitive style (Massa & Mayer, 2006); cognitive style, gender, and prior knowledge (Grimley 2007); field articulation, conceptual style, and gender (Grabinger, 1993).

The study of cognitive load, split attention, and redundancy is made even more interesting when considering learners with varying levels of expertise. Textual explanations that were once essential to the novice learner may become redundant when an expert learner is working on acquiring more advanced concepts and has greater prior knowledge. Kalyuga, Chandler & Sweller (1998) conducted an experiment which was designed to investigate split attention (integrated diagram and text, separate diagram and text, and diagram only) effect on novice trainees (N=26) who were first year apprentices, all learning three new electrical circuitry and switching concepts. All of the instruction in the three experiments was presented in a computer-based multimedia format. Participant test performance in the first experiment indicated that the text-diagram integrated format was superior to the split source format and the diagram only format. For the novice learner, an integrated text diagram model was a better presentation format.

The second experiment also compared three different instructional formats (diagram only, integrated diagram and text, and separate diagram and text). The participants (n=33) were first year electrical apprentices in their second month of training with some limited knowledge of electrical circuitry. The researchers found that the participants had not yet reached a level of expertise that would make the integrated textual explanations and the diagrams redundant. At this intermediate level of expertise, the understanding of information in the diagram-only group
was significantly higher than the diagram only group in the first experiment in which the participants were true beginners.

For experiment three, the final experiment in Kalyuga, Chandler, and Sweller’s (1998) study, the same participants from experiment two were used. It was hypothesized that after additional training the participants would reach a higher level of expertise and eventually test scores would show a preference for the diagram only format. The participants were divided into two groups (diagram only and integrated-diagram-and-text). Learners in the first (diagram-only) group supported the hypothesis in all manners of assessment. They outperformed the diagram-text group on the fault identification test as well as the multiple response circuit operations test. The participants in the first group also rated the diagram only presentation as lower in cognitive load than the diagram-text group in a subjective rating survey. These results indicate that level of expertise could play an important role in split attention and redundancy effects. When learners are near the expert level in a content area, basic textual information might be redundant in an integrated diagram and result in an unnecessarily high cognitive load. On the other hand, the explanatory textual information integrated in a diagram may be necessary for a novice learner to gain understanding of a new concept.

Moreno and Mayer (1999) point out that if the participants had been more experienced in the content area of the multimedia presentation, the results of their study which investigated contiguity and modality effects on learners (see the Modality section, for a more complete description) were likely to be very different. All of the participants in their 1999 study had little experience or prior knowledge. “If presenting verbal information in an auditory mode allows students to increase their effective working memory capacity, low-experience students who lack a mental model the instructional material would be the ones to benefit the most from having more cognitive resources available” (Moreno & Mayer, 1999, p. 367).

Grimley (2007) set out to investigate how text/illustration and narration/illustration multimedia design affects student learning when varying individual differences, namely, cognitive style, gender, and prior knowledge are measured. Ninety-one 10 and 11 year-old students served as participants for this study. It had two treatment groups, illustration with accompanying text, and illustration with simultaneous narration and no text. Comprehension scores were compared between the two conditions and cognitive styles (holist/analytic style and verbal/imagery style), gender and prior knowledge (as indicated by SAT scores). Several results
are notable. Students who identified as holist style learners scored significantly higher on the recall questions than the students who were analytic learners. Female analytics performed significantly lower than all other groups. The greatest improvements from the illustration and text to the illustration and narration were among male holists and female analytics. Perhaps the most widely useful finding from this study is that low knowledge verbalizers scored significantly higher in the illustration/narration than the same low knowledge verbalizers in the illustration/text group. This finding lends support to work by other researchers who suggest that multimedia (diagram and integrated text) is an ideal mode of instruction for learners with a low level of expertise (Kalyuga et al., 1998).

Massa and Mayer (2006) posed the question, “Should multimedia instruction accommodate verbalizer-visualizer cognitive style?” Should instructional multimedia be designed differently for students who learn better through visual methods of instruction (visualizers) and for students who learn better through verbal modes (verbalizers)? Massa and Mayer aptly point out that the idea of unique visual / verbal learner qualities are “deeply engrained in the folklore of educational practice” which makes this research question all the more relevant for designers of instructional multimedia (2006, p. 321). Fifty-two participants were divided into a pictorial or text group. The researchers used 11 instruments to measure cognitive style, learning preference, and spatial ability. Richardson’s (1977, as cited by Massa and Mayer 2006) 15-item Verbalizer-Visualizer Questionnaire (self-report) was also used. It was found that it is in fact possible to use a combination of instruments to determine a verbalizer or visualizer tendency. The self-reported answers on the questionnaire were consistent with user behavior in that verbalizers showed more reliance on pictorial help menus and visualizers showed more reliance on verbal help in the multimedia. However, no support was found for the hypothesis that visual and verbal learners learn better from different modes of multimedia instruction. Two replication experiments and the examination of 51 interactions across all three experiments yielded no significant results to support differentiated multimedia for verbalizers and visualizers. These results are consistent with Mayer’s first design principle – the multimedia principle which states that students learn better from words and pictures than from words alone (Mayer 1997, 2001).
Modality Principle

“Students learn better from animation and narration than from animation and on-screen text” (Mayer, 2001 p. 134). The Modality principle calls for multimedia instruction that is presented with audio narration in place of on screen text. Researchers who have recently investigated how the modality effect influences multimedia learning include Brunken, Plass, & Leutner (2004); Moreno & Mayer (1998, 1999); Mousavi, Low & Sweller (1995); Tabbers, Martens, & Merrienboer (2004); Veronkias (2005); and Mann (1997).

In a study by Mousavi, Low, and Sweller (1995) investigating presentation modality and working memory, it was found that integration of auditory and visual modes of presentation could reduce cognitive load. A series of six experiments were conducted to test the three modes of presenting worked examples for a geometry lesson. In the first experiment, 30 eighth grade participants were divided into three experimental groups: A simultaneous group, visual-visual group, and a visual-auditory group. The purpose was to investigate how diagrams and statements presented in these three modes would affect learning during a geometry presentation. Visual diagrams, verbal statements presented by audio recording, and text statements (no audio) were used. Participants in the mixed mode group (visual-auditory) solved worked examples faster than the other two groups.

Mayer and Moreno (1999) set out to clarify the contiguity and modality principles and isolate their respective effects learners’ retention, transfer, and matching ability. Experiment one affirmed the notion that multimedia presentations with verbal material presented auditorily as speech narration is more beneficial than on-screen text. In a follow up experiment (experiment two, 1999) Mayer and Moreno further tested the superiority of concurrent narration and animation over on-screen text and animations. In their discussion, they acknowledge the confusion when comparing the contiguity and modality principles and past tendencies on the part of researchers to label them in the general terms of split-attention effect (Mayer and Moreno, 1998). Instead, the researchers recommend that future research begin distinguishing between several different specific effects, especially the spatial-contiguity effect, temporal-contiguity effect, and the modality effect.
Personalization Effect

In recent years Mayer has initiated a related strand of research in multimedia learning to investigate the effect of learner interest. The human voice as narration in multimedia can have a personalization effect (Mayer 2003; 2004) which serves to capture the interest of the learner. In a study by Mayer, Fennell, Farmer and Campbell (2004), participants ($N = 62$) were assigned to two groups (personalized and non-personalized narration) to examine the effect of a change in the style of narration. Both groups heard narration accompanying a multimedia presentation about the human respiratory system. The two groups were different in one way. The personalized group’s narration used the word “your” to replace the word “the” twelve times. For example, the personalized group heard the phrase “your lungs” in place of “the lungs” when learning how the respiratory system works. In experiment one, 62 participants were exposed to either the personalized or the non-personalized version of the multimedia. The participants were assessed on retention and five problem solving transfer questions. The retention score was not significantly different between the two treatment groups. However, participants in the personalized group scored significantly higher on the problem based transfer questions than the non-personalized narration group. It is interesting that simply replacing the word “the” with the word “your” twelve different times in the audio narration of a multimedia presentation could have such an effect on learner transfer.

Seductive Details and the Coherence Principle

“Students learn better when extraneous words, pictures, and sounds are excluded rather than included” (Mayer, 2001, p. 184). The coherence principle recommends that all of the “extras” be removed from instructional multimedia. These extras, or seductive details, may include illustrations, animations, sound effects, music, or other information that is interesting to the learner but is not directly related to the core content of the instruction. The seductive details effect is seen when interesting but irrelevant information in an instructional message impedes learning. An instructor might intentionally present seductive details for the purpose of increasing learner interest without realizing that these interesting but extraneous elements could cause students to develop inappropriate schema surrounding a topic (Harp & Mayer, 1998). Or, seductive details may appear in a multimedia presentation rather thoughtlessly, like a decoration, perhaps in the form of an animated clip art image in a PowerPoint presentation slide.
“Technology offers ‘bells and whistles’ that seem to have great potential but often take the lead and interfere with instructional design. Indeed, if misapplied, the software enhancements could actually befuddle the learning process” (Knupfer & Clark, 1996 as cited by Beccue, Vila, & Whitley, 2001, p. 51). When computer mediated multimedia is being employed in the classroom there is a risk that the “bells and whistles” of new technologies could become seductive details.

Harp and Mayer (1998) suggest that the seductive details effect has three possible theoretical explanations: Learner distraction, disruption, and diversion. Seductive details may be a (a) distraction from important information, (b) a disruption in the processing of chaining together important conceptual sequences, or (c) a diversion from constructing the appropriate mental models of the most important ideas (1998, p. 415). These three terms and their emphasis on the process of acquiring new knowledge is related to the generative theory of multimedia learning (Mayer, 1997) which points to a learner’s engagement in three basic processes: (a) Selecting relevant material, (b) organizing a coherent structure for learning, and (c) integrating and building connections with prior knowledge. Seductive details have the potential to jeopardize the integrity of these processes.

In experiment one (Harp & Mayer, 1998), participants ($N = 81$) were divided into four groups (2x2 design). All students were presented with paper booklets, which described the formation of lightning. Half of the students read a booklet about lightning that included an extra 150 words of seductive details. These extraneous details were all related to the dangers and risks of lightning strikes. For example, swimmers and golfers are excellent targets for lightning strikes. The other half read a booklet without seductive details. All students who read the seductive details version of the booklet recalled significantly fewer important ideas and scored significantly lower on recall and problem solving questions than the group with no seductive details. This result supports the assumption that seductive details impede the learner’s ability to recall the most relevant lesson content and complete problem solving questions for an assessment.

The same experiment by Harp and Mayer (1998) investigated how presenting important pieces of information as highlighted or underlined text might dilute the seductive details effect by cueing the most relevant concepts in the science lesson. It was thought that signaling might also help the learner organize and sequence sets of information. However, results on recall and problem solving tests did not show significantly different scores for participants who were in the
highlighted or underlined seductive details group. In other words, signaling did not counteract the effect of seductive details. However, in experiment four (1998), it was found that the placement of seductive details at the end of an instructional booklet allowed students to learn the most important information first without being diverted by the seductive details. Placing seductive details at the beginning of the lesson served to create a diversion away from the appropriate schemas for which understanding the science lesson might be constructed. When seductive details are presented at the beginning of a lesson it may cause learners to construct inappropriate schemas for organizing concepts they are about to learn.

**Auditory Load**

In another study, Moreno and Mayer (Experiment 1, 2000) investigated how irrelevant sounds and background music added to varying types of instructional multimedia affects retention, transfer, and matching scores. Participants ($N = 75$) were divided into four groups: (a) narration group, (b) narration and environmental sounds group, (c) narration and music group, and (d) narration and environmental sounds plus music group. The narration and environmental sounds plus music group scored lower than each of the other groups on the assessments. The second lowest scoring group was the narration and music group. The other two groups (a) narration and (b) narration environmental sounds had comparable scores. For these two groups, the background music was not putting an unnecessary load on their phonological capacity. This study shows support for an auditory load theory. More information presented in auditory mode leads to less learner understanding. “These results are consistent with coherence theory—the idea that auditory adjuncts can overload working memory—and inconsistent with arousal theory—the idea that auditory adjuncts motivate the learner to pay more attention to all incoming materials” (Moreno & Mayer, 2000, p. 124). Moreno and Mayer (2000) point out that these results are different from findings reported by Harp & Mayer (1998). Both studies were investigating coherence effect. Moreno and Mayer attribute their results to an overload in auditory working memory while Harp and Mayer suggest that seductive details seem to lead learners to assimilate information into inappropriate schemas.

Like Moreno & Mayer (2000), Brunken, Plass, & Leutner (2004) designed their research to examine the effect of background music on multimedia learning. However, their results differed, in that “the auditory cognitive requirements of background music alone did not differ
from the auditory cognitive requirements of the materials without any auditory stimuli”
(Brunken, Plass, & Leutner, 2004, p. 129). One major difference between the two studies is that
Brunken et al. measured the total load of background music when presented alone. Moreno and
Mayer’s measurement allowed for a demonstration of “heavier” auditory load by measuring
background music, sounds, and narration (Brunken, Plass, & Leutner, 2004).

**Cooperative Learning and Computer-Based Instruction**

Comparative studies have investigated small work groups versus individual computer-
based instruction (CBI) and their effect on achievement, retention, efficiency and attitude.
Posttest scores from several studies (Carrier & Sales, 1987; Makuch & et al., 1992; Shlechter,
1990; Whyte, Knirk, Casey, & Willard, 1991) show that small group versus individual computer
instruction demonstrates no significant difference on learner outcome. Other studies found that
despite the lack of evidence that grouped participants perform better on tests, they may
experience a high level of efficiency, (Schlecter, 1990) and improved attitude (Bishop-Clark,
Courte, & Howard, 2006).

**CBI: Cooperative Learning and Achievement**

Hooper (1992) found that 5\textsuperscript{th} and 6\textsuperscript{th} graders’ (N=115) achievement improved when
students were grouped in dyads compared to those who worked individually. The participants in
Hooper’s study were also grouped according to high and average ability levels. Both ability
groups completed the mathematics CBI more effectively than participants who worked alone. It
was also found that achievement scores were highest for homogeneously matched high-ability
level groups and lowest for homogenously matched average-ability groups.

Thirty-six college juniors were participants in a study by Carrier and Sales (1987) with
two treatment groups designed to investigate the effect of paired versus individual work when
participants were engaged in a computer assisted mathematics lesson. Participants in both
treatment groups (paired groups and individuals at computer workstations) were tested
individually with the same posttest. One week later the posttest was administered again as a
measure of retention. It was found that students who worked in pairs did not score higher on the
achievement or retention test than students who worked individually.

Whyte et al. (1991) found no difference on posttest scores when comparing college-age
participants (N= 86) who worked in pairs with those who worked individually on a computer
assisted instructional lesson. However, when paired groups were compared, students who were grouped by cognitive learning style show significantly higher scores than pairs of students who shared the same learning style. The interactive effect of two different cognitive learning styles, categorized as ‘field dependent’ and ‘field independent’ gave students an advantage. Pairs that consisted of one independent learner and one dependent learner achieved significantly higher on the posttest than pairs of two dependent learners.

A meta-analysis (Susman, 1998) investigating thirty-six studies from 1980-1998, demonstrated that merely pairing students together at a computer work station is not enough to incite increased achievement. In fact, students who are paired together at a computer are not necessarily even engaged in true cooperative learning (Stahl, 2005; Susman, 1998). Susman states in the discussion of her meta-analyses, “This review shows that placing students in a group does not assure interaction or achievement. We need to go beyond only including instructions to ‘work together’ to develop and use more appropriate and extensive training to produce greater interaction and achievement” (p.316).

Gerry Stahl is part of a group of theorists who insist that Computer-Supported Collaborative Learning (CSCL), drawing upon the foundations of such disciplines as anthropology, sociology, linguistics, and communication sciences; should be carefully distinguished from previous forms of instructional technology research which pays most attention to behaviorist and psychological methods of experimentation. CSCL, as described by Stahl (2005), is primarily concerned with language and the social context of learning. Furthermore, in his view, collaborative learning should be focused on building group knowledge and shared meanings that exceed the knowledge of the group's individual members (Stahl, 2005). Stahl propounds that the essential question for researchers concerned with CSCL is as follows: “Can sets of students be transformed into groups that learn collaboratively in ways that encourage the emergence of collaborative group cognition in a significant sense?” (2005, p.85).

**CBI: Cooperative learning and instructional/economical efficiency**

Although the number of computers in schools is growing, often there are more students than computers, requiring students to work in pairs or small groups. Students in typical classroom situations are frequently paired to work together at a computer when there are not enough workstations for each student (Shlechter, 1990). While the studies that were reviewed
did not show an overall increased achievement as a result of students working together during computer-based instruction, paired computer use did not decrease performance either (Carrier & Sales, 1987). "Where there is an insufficient number of computers for individual use, adults can use CAI cooperatively in pairs without a negative effect on learning (Makuch & et al., 1992).” Some of the benefits of cooperative learning (aside from increased student achievement) could include increased efficiency. When instructor, computer, and time resources are considered as indicators of instructional effectiveness, paired computer usage could increase efficiency.

Makuch et al. (1992) found no difference in achievement of paired students and students who worked alone. However, it was noted that students who worked in pairs took longer to complete the training exercise. Makuch attributes the increased time spent by the paired group to the fact that participants in the paired group “were instructed to discuss with their partner their material that they did not understand and to come to agreement before practice sessions” (p. 206).

Contrary to Makuch et al., Schlecter (1990) found that students working individually asked for assistance from the proctor thirty-seven times compared to just two requests from students who were working in the group condition. He also found that students in the group condition were more time-efficient. In fact, participants who worked on the computer training exercise individually took an average of thirty-three minutes longer to complete the lesson. In his discussion of the study, Schlecter equates the improved resource efficiency (demand for proctor assistance, and the 1:4 computer to participant ratio in the group condition) and time efficiency (time required to complete computer lesson) to an overall improved cost efficiency when computer aided instruction is delivered to a small group of participants working together at a single workstation and cooperative learning occurs.

Stephenson (1992) measured the effect of student-instructor interaction on paired versus individual study in a computer-based training. It was found that the effect of student-instructor interaction was greater for individuals using a computer-based training than pairs of students working on the same training. The same instructor interaction was less influential for students who were studying in pairs. Stephenson states, “A dyad partner can provide the feedback, support, and social facilitation usually provided by the instructor in a more traditional classroom setting” (1992, p. 25). Several studies show that cooperative learning has the potential to
increase the instructional efficiency of computer based instruction (Carrier & Sales, 1987; Hooper, 1992; Shlechter, 1990; Whyte et al., 1991).

CBI: Cooperative learning, attitude and enjoyment

Some researchers find promise for increasing attitude and enjoyment by pairing students together. Bishop-Clark et al. (2006) found that students who were partnered with another student reported more enjoyment than students working individually at the same programming task. Students who were working individually actually showed a decline in enjoyment from pretest to posttest. Perhaps some of this enjoyment could be linked to the opportunity to socialize. Increased discussion among groups may be linked to an enhanced enjoyment but it may also include conversation that is off topic. One study (Carrier & Sales, 1987) made note of increased off-task behavior demonstrated by members of paired groups: “Nearly one quarter of the verbal interactions among members of a pair did not relate to the task itself” (p. 16). However, Hooper (1992) found that time-on-task results for individuals and groups were not statistically different.

Despite great expectations, cooperative computer-based instruction research has not demonstrated that students learning at the computer in groups achieve significantly more than those working alone (Carrier & Sales, 1987; Makuch & et al., 1992; Shlechter, 1990; Whyte et al., 1991). Researchers continue to investigate what combination of instructional strategies will lead to greater achievement for grouped students, and what other factors (such as efficiency and attitude) may indicate the value of cooperative learning for designers of computer-based instructional media.

Software Instruction and Programming

Research in the field of computer software generally falls into two categories. The first investigates instruction related to the use of software in practical applications. The second category investigates learning computer programming and its effect on cognitive abilities, specifically problem solving skills.

David Bebell (1988) conducted a study involving Logo, a computer programming language designed for children, and problem-solving heuristics instruction. Bebell used two control groups and one treatment group in a convenience population taken from third grade classrooms. He analyzed pretest and posttest results attained through the Ross Test of Higher Cognitive Processes. The treatment group showed significantly higher scores in the tested areas
of analysis, synthesis, and evaluation. The results achieved by Bebell seem to be supported by a study conducted by Bernardo and Morris (1994). Bernardo and Morris used existing populations within a high school to test the effects of training students in the use of the BASIC programming language on mathematical modeling skills. Based on results taken from teacher-designed testing, there were no significant differences found between groups in mathematical modeling or procedural comprehension. However, the group that was taught BASIC scored significantly higher in the area of verbal problem solving compared to those with groups having no computer literacy and computer literacy group with no programming training. “The significant positive effect on the verbal problem-solving process in the present study reinforces the findings of Clements (1987) at the elementary level and Palumbo and Reed (1991) at the high school level” (Bernardo & Morris, 1994, p. 532).

Pursuing the theory that learning to program using a computer language can have transfer effects on students’ problem solving, Jang (1991) conducted a study that attempted to isolate the effects of the instruction of a single concept within computer programming learning. He used two groups, each received identical training except for one concept, the nested loop. Students in the treatment group who were taught the nested loop concept, scored significantly higher on the transfer posttest when analogous problems were tested within other domains. Also, the degree to which the students learned the nested loop concept was positively related to the amount of transfer found in the posttest.

**Approaches to Software Instruction**

Martin-Michiellot & Mendelsohn (2000) conducted a study in which participants (N=30) were to learn the basics of a CAD software program using three different types of manuals/help material. The design of the manual was based on research in cognitive load theory (Chandler & Sweller, 1991; 1996). The participants were divided into three groups: (a) a conventional text-only manual and the computer, (b) a manual design using juxtaposed screen capture images but no computer, and (c) a manual with integrated screen images but no computer. No significant difference was found between the written and practical computer test scores of the three groups. However groups b and c who were using a manual with juxtaposed or integrated screen images learned twice as fast as the participants using the conventional manual. This study suggests that for faster learning, a paper-based computer software training manual should include integrated instructive text and images derived from screen capture.
There are a number of research projects that have been designed to investigate instructional methods of teaching new software applications and their affects on transfer to other software applications. In industry, there are three basic approaches that are used for software training, (a) behavior modeling, (b) one-to-one coaching, and (c) tutorials that are computer based (Colaco, 1998). A less frequently used method involves self-training or exploratory training. In this type of study, participants are placed in a learning situation with as little coaching as is deemed practical for the individual learning situations. Sander and Richard (1997) used this method to investigate the role of the analogical transfer of participants’ existing knowledge when engaged in ‘learn by doing’ word processing. Through a series of six experiments, the researchers’ results indicated that learners use analogy in general domains. Domains selected for transfer are, at first, related directly to the object’s surface features, followed by a movement to more general fields of knowledge. Sander and Richard illustrated that their participants first utilized knowledge of the typewriter and its possible functions, then the processes associated with writing, and lastly the manipulation of physical objects.

Studies that fall within Colaco’s (1998) three groups are much more common; within the area of behavioral modeling there are a number of studies that utilize a pretest, treatment, and posttest design with control to investigate software process learning and the transfer of skills: Olsen, 1997; Sander & Richard, 1997; Robinson, 1991; and Hill, 1990. In these studies participants are given instruction on the use of software and then tested for learning, and in some cases transfer of knowledge. Robinson (1991) studied the relationship between prior exposure and task proficiency to learning an unfamiliar word processing program. Her study indicated that exposure time does not necessarily translate to proficiency and that the training effect overshadows positive and negative transfer from previous learning. Posttest scores between participants with a high level of previous exposure to word processing were also significantly higher than those who had a low level of previous experience.

Olsen (1997) studied the use of a conceptual framework and created a teaching strategy that influenced the treatment group to de-contextualize their learning from the software on which they did their training. Using the transfer pretest as a covariate, the treatment group showed significantly different scores on the transfer test than the skills test.

In a qualitative study, Hill investigated participants’ perceptions when they were trained on one type of software and then asked to complete tasks on a slightly different program. The
participants expressed (a) frustration, (b) a need for visual cueing, (c) loss of control, (d) a need for quality documentation, and (e) time to comprehend the differences between programs. Notably, Hill, Olsen and Robinson utilized similar but different word processing programs to investigate transfer of process learning.

**Transfer**

The beginning of transfer research is most often accredited to Thorndike and Woodworth in 1901. However, Bell (1998) points out that William James conducted a transfer study as early as 1890. James investigated the effects of memory training on the memorization of poetry. He did not find transfer. It was a decade later that E. L. Thorndike began researching transfer in a way that has profoundly influenced the research world’s view of educational training and transfer.

At the time of Thorndike’s research, in the early 1900’s, the predominant theory of transfer was linked to what John Locke defined as the doctrine of formal discipline. The doctrine was passed down through centuries of educational practice and solidified in ancient Greek society, Aristotle was a notable influence. The idea of formal discipline describes the mind as a muscle. Rigorous exercise (study) in one subject, such as geometry, leads to intellectual growth in all other areas that are related to math, from formulating theorems to architectural design. The belief that focused study on a few specific disciplines can develop the whole intellect led the Greeks to create the trivium and quadrivium, which are the foundations of the modern core curriculum. The idea of the mind as a muscle, or formal discipline, can be called a theory of “general transfer” (Singley & Anderson, 1989).

Thorndike’s research, in direct conflict with the idea of general transfer, was a “program extending some thirty years to show that transfer was much narrower in scope than would be predicted by the doctrine of formal discipline” (Singley & Anderson, p. 3, 1989). The result of Thorndike’s work was his theory of identical elements: “One mental function or activity improves others in so far and because they are in part identical with it, because it contains elements common to them. Addition improves multiplication because multiplication is largely addition; Knowledge of Latin gives increased ability to learn French because many of the facts learned in one case are needed in the other” (Thorndike, 1906 p. 243). In his theory, Thorndike was willing to concede to the idea of transfer only to the extent that there must be identifiable identical elements of stimuli within the transfer encounter, and that the degree of transfer would
rest solely on the extent to which two learning situations were identical. He was working entirely from a stimulus-response perspective of cognition, even going so far as to claim that a human who encounters two identical learning situations would react exactly the same in each situation simply because the stimulus is identical and the learner utilizes the same neurological collection of responses. Critics maintain that Thorndike’s theory falls short because of its inability to address learner adaptation and because he fails to successfully define “identical elements” (Singley & Anderson, 1989). “Though Thorndike’s theory has been criticized, it is regarded as pivotal for two reasons: first, it challenged the theory of formal discipline; and second, it has greatly increased the interest in the study of transfer...” (Hill, 1998, p. 68)

Even though Thorndike’s work was widely criticized and fell from favor in the middle of the century, transfer research and its resulting theories from the last thirty years are in some ways returning to the identical elements theory originally proposed by Thorndike. Haslerud (1972) reports that researchers Hildegard and Bower (1966) believed that the current theories could be reduced to an equivalent of Thorndike’s identical elements theory or to stimulus-response generalization. The one theory of the time that they refused to include in their generalization was the Gestalt theory. This theory held that organisms learn relationships and not specific responses to stimuli. Hildegard and Bower indicated that through the early nineteen-seventies transfer theories largely relate back to Thorndike’s original ideas about transfer.

In addition, the end of the twentieth century contains the theories of Singley and Anderson (1989). Anderson (1983) created a theory of skill acquisition that was given the label ACT*. Together, they maintain that the ACT* theory is a “modern version of Thorndike’s theory of identical elements” (Singley and Anderson, 1989, p.32). The ACT* theory is based on the use of production systems as representations of cognitive processes. “In its basic formulation, a production system consists of a set of condition-action rules… and a working memory” (p.30). Importantly, productions are allowed to interact with declarative memory structures, which are used to encode factual information. Within this theory, transfer is said to occur in direct relationship to the amount of overlap, or similarity, that one production has to another. Productions are described as powerful and versatile tools that can be used to define cognitive processes that occur externally as well as internally, thus going beyond observable response to stimuli. Singley and Anderson (1989) maintain that it is the use of productions to
represent cognitive processes that would have provided Thorndike with the ability to successfully define “identical” and create a more comprehensive theory of transfer.

Thorndike’s theory of identical elements even pervades the most extensive training programs within the United States Military. Currently, the military spends billions of dollars from its annual budget to continually upgrade the quality of its training simulations. In 2001, STRICOM, the army’s division that handles simulation training, had a budget of $645 million dollars. In 2003, the United States Army and Air force combined to award a 1.1 billion dollar contract that would outsource the production of simulation training for just three different types of aircraft. Whether the military is conducting basic flight training, nuclear control room training, or complex combat missions, the goal remains to create a situation that is as close to real as possible without risking lives and equipment while improving speed of training, effectiveness and cost efficiency. It may be argued that the design researchers are searching for, and creating, identical elements. NASA creates huge underwater environments that serve as an element within a training environment used to simulate zero gravity missions. The astronauts practice processes in full life-support suits with machinery and tools identical to what they will encounter on the mission.

Baudhuinn (1987) writes, “Device [simulator] designers believe, however, that a highly realistic training environment is required for the training stimuli to acquire meaning, where the trainee does not have to work hard at visualizing the connection between the training stimuli and goal oriented behavior” (p. 218). Designers work to create stimuli that are as real as possible in order to reduce the cognitive load of the trainees. Researchers working with the concept of cognitive load surmise that working memory has limitations and can be easily overloaded thus reducing learning. In conjunction, ineffective instructional activities are those that create or require extraneous cognitive activities needlessly impacting the limited scope of the learner’s working memory (Mousavi, Low, & Sweller, 1995). Once again the discussion returns to identical elements and the learner’s ability to make immediate connections from training to real world situations without having to unnecessarily expend cognitive resources.

Multiple Definitions of Transfer

Researchers’ definitions of transfer, although worded differently from one another, carry in their meaning undeniable similarities. Cormier and Hagman (1987) describe transfer as “whenever prior-learned knowledge and skills affect the way in which new knowledge and skills
are learned and performed” (p. 1). Singley and Anderson (1989) state, “The study of transfer is the study of how knowledge acquired in one situation applies (or fails to apply) in other situations” (p. 1). Very similarly, Alexander and Murphy define transfer as “the process of using knowledge acquired in one situation in some new or novel situation” (1999, p. 561). Mayer (1999) writes that “problem solving transfer occurs when a student is able to use what was learned to solve problems that are different from those presented during instruction” (p. 612). Most recently, Haskell (2001) defines transfer as “our use of past learning when learning something new and the application of that learning to both similar and new situations” (p. 1).

Although these researchers present very similar definitions of transfer, they tend to differ in the way they define how closely related the original learning is to the situation and subject matter within which the event of transfer takes place. Haslerud (1972) draws distinction between degrees of transfer by labeling transfer that occurs between very similar situations as literal transfer, and transfer that occurs between distantly related situations as creative transfer. Cormier & Hagman (1987) report that Gagné (1970) defined the relationships between transfer situations by using the terms “lateral” and “vertical.” Lateral transfer refers to situations that are related by the level of complexity of the situation. If knowledge or skills transfer to a situation of similar complexity it can be considered lateral in nature. Knowledge that transfers to a situation that is more complex in its structure is said to be vertical in nature. Singley & Anderson (1989) adopted Gagné’s terminology for their work, and Haskell (2001) chose a slightly different approach. “Near” and “far” transfer become the center of Haskell’s continuum. Near transfer “refers to when previous knowledge is transferred to new situations that are closely similar, but not identical” (p. 29). This would be similar to Haslerud’s literal transfer and Gagne’s lateral transfer. Far transfer, as defined by Haskell, “refers to applying learning to situations that are quite dissimilar to the original learning” (p.30). Because this doesn’t account for complexity, it does not directly relate to Gagné’s vertical transfer but falls closer to Haslerud and his definition of creative transfer. Also related to Haslerud’s definition of creative transfer is the additional level of complexity that Haskell describes as displacement or creative transfer. This refers to transferring learning in a way that the previous learning, and its interaction with the new learning, result in an entirely new concept (2001). This would be similar to Haslerud’s most creative transfer.
Research related to the study of these definitions ranges from the creation and testing of synthetic clinical tasks, to training and testing participants within real-life situations. This study is directly related to those experiments that train software skills, which make up the bulk of software related research.

**Summary**

In conclusion, this review of literature has described the current research related to the history of multimedia and hypermedia, MIDI, multimedia instructional design principles, the role of cooperative learning in computer based instruction, approaches to software instruction and its transfer of skills, and a survey of educational transfer. These themes are related to the current study which will investigate which of two types of multimedia (the first a computer-based screen video with narration and the other a paper-based handout) will be most effective as lecture support materials for teaching MIDI software. Transfer to related software will also be investigated.
CHAPTER 3

METHOD

Purpose of the Study

The purpose of this study was to compare learning, and transfer of learning, outcomes as affected by two types of lecture support both designed to teach computer skills within a music classroom. This comparison will be conducted using three sets of collected data: (a) a test of prior knowledge and posttest, (b) descriptive data from attitudinal and demographic surveys, and (c) posttest scores from participants’ performances on two applications of closely related software. A test of prior knowledge/posttest design was created using two age classifications, college and high school. Within each age classification one group was given lecture support media in the form of a paper-based handout and the other was given lecture support using a computer-based multimedia presentation. Within the high school aged groups a further division was made and half of the students worked in pairs while at the computers, and the other half worked alone. All participants were tested individually. The dependent variables of the test of prior knowledge and the posttest were addressed relative to the following independent variables: computer-based lecture support verses paper-based lecture support, college age verses high school age, and in the high school age group, shared computer usage verses working alone.

Also, correlations are sought between the posttest scoring and both prior computer experience and each participant’s attitude toward the experience as represented by data collected in the demographic survey and the attitudinal exit survey.

Description of the Sample

Self-selecting volunteers were solicited from local high schools, the university community, and The Florida State University international summer music camps. Volunteers were allowed to participate if (a) they had basic Windows related file management skills, (b) could read music, and (c) find keys corresponding to note names on a musical keyboard.

The study began with a total of 67 participants participating and concluded with 61 participants of whom 20 were college-age participants and 41 high school age participants.
Mortality was caused by several factors. Four high school age participants were eliminated, two due to single absences from treatment sessions, one missed the posttest, and one was discovered not to be fluent in written English. The high school age absences were caused by extra summer camp activities that interfered with one or more treatment sessions. In the college-age population two participants were eliminated. One participant did not return after the second treatment and a second participant missed the posttest.

The college-age participants were divided into two groups. In the first group 10 participants received paper-based lecture support, and in the second group 10 participants received computer-based lecture support. There were four high school aged groups. Two received paper-based lecture support and two received computer-based support. Additionally, one group from each type of lecture support worked in pairs while seated at the computers. High school aged groups receiving computer-based lecture support contained 10 participants practicing in pairs and 11 participants working alone. High school groups receiving paper-based lecture support contained 10 participants working in pairs and 10 participants working alone.

**Materials and Equipment**

**Hardware**

All treatments were administered within the same computer lab located within the College of Music at The Florida State University. The computer lab contains ten workstations and musical keyboards. The computers are desktop models utilizing one 3.5 “ floppy drive and one CD ROM drive. The computers are divided into two groups. Five computers contain Pentium 4 processors running and 66 MHz, and the other five contain Pentium 4 processors running at 133Mhz. Each contains 128 MB of RAM. The slower processors run Microsoft’s operating system Windows 95 and the faster processors run on Windows 98.

The musical keyboards are five Korg N5Rs and five Korg M1s. They are connected directly to the computers using serial interfaces. The NS5 keyboards were used for both input and output of musical information during the use of the primary MIDI sequencing software (Cakewalk Home Studio 9 (1999)), and the test software (Anvil Studio MIDI sequencer). The Korg M1 keyboards were only used for MIDI input into the computer system and an additional sound module (Korg NS5R) was used as an output source for MIDI file playback. The headphone output from the computers’ sound cards was used for the delivery of audio during the presentation of the computer-based lecture support and during post testing on the digital audio
software (Audacity). Otherwise the students listened directly to the output from either the NS5 keyboard or the NS5R sound module.

Additional equipment used for the creation of the audio portion of the computer-based lecture support was: (a) a Shure SM81 condenser microphone, (b) a Stewart phantom power supply, (c) a Tascam 1508 mixer, and (d) a Korg 03/W sound module. The microphone signal and audio output from the sound module were mixed in stereo using the Tascam audio mixer and then returned to the “audio in” on the computer’s sound card for the purpose of recording audio during the creation of the computer-based lecture support media.

Software

Three software applications were used during treatment and testing. The first was Cakewalk Home Studio 9 (1999). It was used during treatment and was the primary software used in post testing. Two other applications used in the study were Audacity (Mozoni, 2002) and Anvil Studio MIDI sequencer (Willow Software, 2002). Both of these applications were used only during the posttest. At the time of the post testing the participants had no prior experience with them. Audacity is designed to record and edit multi-track digital audio and Anvil Studio is a MIDI sequencer.

The university’s computer lab utilizes the sequencing software Cakewalk Home Studio 9 (1999). Cakewalk was chosen both as the software foundation for the treatments and the primary section of the posttest because it meets all of the project’s instructional needs, and the researcher has considerable previous experience with this software. The software chosen for the transfer portion of the posttest was selected on the basis of basic capabilities, cost, accessibility, and functionality in the lab. Several MIDI sequencing and digital audio programs were tested in the lab before a decision was made to use Anvil Studio MIDI sequencer and Audacity.

Microsoft Word and Lotus Screen Cam (1998) software were used to produce the lecture support media. Microsoft Word was used in conjunction with Windows’ print screen capabilities to create the paper-based handouts (see Appendix B) that are similar to modern textbooks in that they are rich with color graphics and are structured to call attention to key items within the text. The “print screen” button on the computer keyboard was used to capture images of the software while it was in key states. These images were then placed within the instructional text, and graphics comprised of red circles and arrows were added to direct the reader’s attention directly
from the text to the part of the software graphic that was being explained. This is known as signaling as related to multimedia research conducted by Mautone & Mayer (2001). Also, each graphic was placed as close to the text that it related to as possible. The construction of this media was based on Mayer’s (2001) multimedia principles numbers: 1, 2, and 4 (see section on Mayer’s Seven Principles of Design for Instructional Multimedia in Chapter 2).

Lotus Screen Cam (1998) was used to create the computer-based multimedia by recording the visual processes and audio created by the MIDI software as well as the researcher’s narration during instructional demonstration sequences. This combination resulted in a self-standing playable file that could be accessed on each computer. This software’s output is very similar to pre-recorded videotape, and allows the viewer to watch the presentation from beginning to end or select smaller sections of the presentation for playback. The software record settings for recording in the Lotus (1998) screen camera software were as follows: (a) movie area –800x600 pixels; (b) color depth – true color 32 bit; and (c) soundtrack –11 kHz, 16 bits, stereo.

The verbal content contained in the computer based lecture support and the paper-based support was kept as identical as was practical. Also, the instructional content was identical in order of presentation. The only differences that existed were those that were necessary because of the nature of the presentation media. In the computer-based lecture support the narrator could say, “Listen as the sound pans from left to right.” This was impossible to recreate within the paper-based media so a graphic was created to visually demonstrate the effects of panning between the left and right audio channel. Careful attention was given to Mayer’s (2001) multimedia principles in order to create each type of media so that it represented the most effective design possible given the tools available to the researcher.

**Dependent Variables**

The instruments were researcher designed and applied at four times during the experiment. Each participant completed a survey of prior experience, a test of prior knowledge, a posttest, and a post-attitudinal survey.

The test of prior knowledge (see Appendix C) was created based on the assumption that a traditional pretest would fail to yield a high degree of discrimination. Because of the unique structure of MIDI sequencing software the first steps necessary to set up a track for recording and the terminology used within the menu systems are not intuitive and have little structure
similar to other types of applications. It was reasoned that a pretest would discriminate between those who had sequencing experience and those who had none; however, within the group that had no prior experience pretest scores would be largely close to zero. Therefore, a paper-based test was devised that would test various levels of understanding within the participant domain but was administered to the participants while they were seated at a desk. This was different than the posttest that was administered at the computers and required the participants to actually use the software to produce specific results. The test of prior knowledge contained questions of a general nature about MIDI and MIDI sequencing as well as questions specifically relating the use of Cakewalk Home Studio 9 (1999).

The posttest (see Appendix C) was administered at the computer and contains three sections. It requires each participant to complete exercises using the three software applications Cakewalk Home Studio 9 (1999), Audacity, and Anvil Studio MIDI sequencer. The files used during the posttest were researcher created and pre-loaded on a 3.5” floppy disk for each participant. As the participants worked through the test questions they made edits to the pre-loaded files and then re-stored them to the floppy drive. The first section tested process knowledge using Home Studio 9, the second section tested transfer to the Anvil Studio MIDI sequencer software with which the participants had no prior experience. The third section of the posttest tested transfer of learning to Audacity, a digital audio software that the participants had not used during the treatments. Participants were timed in each section. They were allowed 20 minutes for the first section and 15 minutes for each of the last two sections. In order to control for order effect, two forms of the test were created that varied only by the order in which the participants were tested on the final two sections of the posttest. Half of the participants encountered the secondary MIDI software first, and the other half encountered the digital audio software first.

Within each section of the posttest the questions were placed in order from easiest to most difficult. The primary MIDI section (Cakewalk) and the transfer MIDI section (Anvil Studio MIDI sequencer) were constructed to apply two levels of testing. The first centered on skills identical to the ones taught through the support media. The second was centered on skills similar to those taught in the support media, and involved problem solving. This test design was based on the test designs used by Mayer (2001) and his colleagues.
Surveys

The test of prior knowledge (see Appendix C) was designed using Robinson’s (1991) survey as a model. It contains fifteen questions with the addition of name, age, GPA, and whether or not the participant is a music major. An attempt was made to identify participants’ prior computer experience from several different perspectives: (a) usage, (b) number of computer applications regularly used, (c) previous software training, and (d) work related computer use.

The attitudinal survey (see Appendix D) was created and edited under the supervision of an experienced descriptive researcher and contained questions that specifically targeted attitude in relation to: (a) the support media, (b) the direct instruction, (c) and feelings of success or accomplishment. The first 15 questions utilized a five-step Likert scale, and the last three questions were free response questions that asked how previous knowledge affected the participant’s experience, and what types of emotions were elicited by the transfer tasks in the posttest.

Procedure

Group Assignment and Test Administration

Within the study there were two age groups utilized, college and high school. These two groups were divided to a total of six different groupings. The college-age participants were divided into two groups. One received computer-based lecture support and the other received paper-based lecture support. The high school age groups were divided into four types of groups. Half of the high school age participants received paper-based lecture support and half received computer-based lecture support. Additionally, within the high school aged group whose participants received computer-based support, half worked in pairs while seated at the computers and half worked alone. The same division was made within the high school aged group receiving paper-based support. In all groups, except the high school age population of summer camp students, participants were randomly assigned to either computer-based lecture support or paper-based lecture support. Because of summer camp course scheduling, the summer camp population became a convenience sample and those students who wanted to participate were placed into two groups, as their camp schedules would allow. One group received paper-based lecture support and the other received computer-based lecture support. Within each of the music camp groups, 10 students were randomly selected to share a computer. In all groups, other than
the music camp groups, group size ranged from 3 to 6 depending on the number of participants who were available each week. The treatments were conducted in the early afternoon and the early evening. The type of group was alternated between the two time slots in order to evenly distribute both paper-based and computer-based groups between the two treatment times.

The test of prior knowledge was administered during the first session of the experiment. It followed the instructor’s formal introduction to the study and the collection of consent forms. It was administered before any discussion was conducted that directly related to the treatments. Participants were limited to twenty minutes for the completion of the test.

The posttest was administered in two forms in order to control for order effect. The difference between the two forms is located in the sequence that the participants encountered the transfer software. Form A and Form B were alternated between workstations in order to produce an equal number of participants between the two forms. Also, the classroom is arranged so that the computer workstations face the wall and circle the room on three sides. Because the students were facing a wall and away from the center of the room, this method of alternated test forms provided for visual/auditory isolation as the participants completed the posttest.

**Independent Variables**

Participants were asked to participate in five sessions with a length of one hour. The first session was used to (a) collect consent forms, (b) complete the test of prior knowledge, (c) administer the survey of prior experience, and (d) to provide a brief history of music and computing as it relates to a MIDI lab. The next three sessions were structured using a common instructional model. This model contains: (a) presentation of information, (b) demonstration, (c) practice (guided and unguided), and (d) assessment (Rothwell & Kazanas, 1998, Alessi & Trollip, 2001). Each session contained a sequence of direct instruction based on the principles underlying the software processes that would be immediately taught in the media, instruction from the media about software usage, and guided practice. In this case, all of instructional design components are present. During the treatments the instructor provided information, and the lecture support media provided demonstration. The instructor provided guided practice in the form of structured exercises; and assessment, in the form of a posttest, is suspended until after the three treatments have been conducted. Following the three treatment sessions, the fifth session consisted of post testing and the administration of the attitudinal survey.
The structure of each treatment was controlled for time. The first twenty minutes of each treatment session was filled with direct instruction. During direct instruction the underlying concepts about MIDI files and the types of processes used for editing MIDI files were illustrated. There was no discussion as to how to carry out specific tasks while using the software. Direct instruction was followed by fifteen minutes with the lecture support media. Participants who were given the paper-based media were asked to read at their desk and then move to the computer. Participants who received computer-based media moved to the computers directly following direct instruction. After the media was read or viewed, twenty-five minutes were given for guided and un-guided practice. During guided practice, participants were given tasks that specifically related to the processes described in the most recent lecture support media presentation. Once these tasks were completed participants were permitted to perform un-guided practice and were encouraged to record and edit MIDI music that suited their preference. Participant’s questions about software usage that occurred during practice time were directed back to the lecture support media only if the answer could be found in the material’s content. Otherwise the instructor provided appropriate coaching toward the discovery of an answer. Also, during the practice portions of the treatments those participants who were sharing computers were asked to change command of the computer keyboard and mouse about every seven minutes.

Careful attention was given to the researcher lectures. Every attempt was made to keep the lectures as identical as possible without forcing the lecturer to read from a script. This was done with a high level of confidence because content of the lectures contained information that had been presented by the researched to similar age groups for eight years previous to the treatment sessions. Also, all information regarding specific software processes were purposefully left out of the instructor’s presented information in order to isolate any effect created by the different types of lecture support media. The two types of lecture support media provided all of the software process information that was presented to the participants; however, during the problem solving portion of the test, it is expected that the participants would combine the principled learning from the direct instruction with media based process learning. Since the lectures were identical it can be assumed that differences in posttest scoring would be the result of the differences in the lecture support media and or prior software experience.
Treatment of the Data

The test of prior knowledge was a multiple-choice paper-based test that contained twenty-five questions and the posttest was of computer-based test containing thirty-five editing or problem solving tasks. These tests were scored by the researcher using a system that awarded one point per correct answer on the test of prior knowledge; and, during the posttest scoring one point was awarded for each successful edit performed on a computer file and each correct free response.

The posttest questions required participants to open MIDI and digital audio files, that were previously placed on a 3.5” floppy disk, and then make edits to those files. Some responses in the problem solving sections of the test required written responses. These responses were typed into comment text boxes contained within the MIDI or digital audio file and saved alongside the edits as they were created. See posttest questions number 7, 8, and 12 in Appendix C. Several of the written responses contained ignorant language that was used to describe software processes and key concepts. The researcher and two colleagues evaluated the vague questions. Each answer was discussed until a consensus was reached and then points were awarded accordingly. In order to score the posttest, each file was extracted to the researcher’s computer and examined individually from within the software that was used to create and save the file. All scoring was conducted at the end of the study and after every treatment session had been completed.
CHAPTER 4

RESULTS

The purpose of this study was to compare learning, and transfer of learning, outcomes as affected by two types of lecture support both designed to teach computer skills within a music classroom. One type of lecture support was computer-based and the other was paper-based. This comparison utilized two sets of data. The first set consisted of a test of prior knowledge and posttest. Data from attitudinal and demographic surveys comprised the second set. SPSS for Windows version 10.0.5 was used for all statistical analysis.

The sample \( (N = 61) \), when divided by age, contained 41 high school age participants and 20 college-age participants. Table 1 contains descriptive data pertaining to the sample as divided by age group.

Table 1

<table>
<thead>
<tr>
<th></th>
<th>Average age</th>
<th>Male/Female</th>
<th>% of daily computer use</th>
<th>Mean years of computer usage</th>
<th>Mean grade point average</th>
<th>Number of Apple users</th>
</tr>
</thead>
<tbody>
<tr>
<td>High School Age ( (n = 41) )</td>
<td>15.68</td>
<td>22/19</td>
<td>71%</td>
<td>7.05</td>
<td>3.66</td>
<td>2</td>
</tr>
<tr>
<td>College Age ( (n = 20) )</td>
<td>20.85</td>
<td>7/13</td>
<td>85%</td>
<td>10.86</td>
<td>3.34</td>
<td>0</td>
</tr>
</tbody>
</table>
The participants that completed the study were divided into six groups. There were two college-age groups, and four high school age groups. Three of the groups \((n = 30)\) received paper-based lecture support media and the other three \((n = 31)\) received computer-based lecture support media. Table 2 shows the tabulation of participant totals for each treatment group.

Table 2

<table>
<thead>
<tr>
<th>Media</th>
<th>College Age Worked Alone</th>
<th>High School Age Worked Alone</th>
<th>High School Age Worked in Pairs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Computer</td>
<td>10</td>
<td>11</td>
<td>10</td>
</tr>
</tbody>
</table>

Sample Results

A full set of the test scores utilized in the following statistical testing is located in Appendix E. Prior to conducting the subsequent ANCOVA tests, a test of homogeneity was conducted. Levene’s Test of Equality of Variances was used to compare all six of experimental groups \((F = 1.254; F [(0.05, 5, 61)]; p > .05)\). The null hypothesis states that the error of variance of the dependent variable is equal across groups, and was not rejected. In addition to the test of homogeneity, a scatter plot was created in order to visually check for outlying scores that may affect the accuracy of the ANCOVA analysis. Figure 1 is a scatter plot created using the test of prior knowledge and the composite posttest scores as X and Y coordinates. The plot represents a pattern that is close to a normal population distribution. It also demonstrates a weak linear relationship between participants scoring on both tests. None of the plots were identified as outliers with enough influence to affect the homogeneity of the sample. Therefore, no participants were omitted from statistical analysis as a result of the visual inspection. Also, plots that landed on identical locations were displayed in the color red. This explains why only fourteen college-age plots are displayed instead of twenty.
Figure 1. Scatter Plot of Participant Test Results

*Note.* College-age participants are plotted in green and high school age in red.

A histogram of the test of prior knowledge and the composite posttest scores is represented in Figures 2 and 3.

Figure 2. Test of prior knowledge score distribution (N)

*Note.* Std. Dev = 3.16, Mean = 10.1, N = 61
Null Hypothesis 1

*There will not be a significant difference in posttest scores between modes of lecture support when participants are tested within the software application used for training.*

The statistical comparison used two groups: (a) contained all participants who received lecture support from the computer based media, and (b) contained all participants who received lecture support from paper based media. The dependent variable used for analysis of covariance (ANCOVA) was the composite posttest scores and the covariant was the test of prior knowledge. Significant differences were found ($F = 12.91; \ F [(0.05, 2, 61)]; p < .05$) between the comparison groups. The test score means for the computer-based group moved from 10.00 to 12.42 and the means for the paper-based group moved from 10.32 to 11.77 (see Table 3). The group receiving computer support media as a treatment demonstrated a higher gain between scores than the group receiving paper based support. The difference between the means of the posttest and the test of prior knowledge is significant when comparing computer-based media to paper-based media. Therefore, null hypothesis 1 was rejected. Descriptive statistics for the null hypothesis are displayed in Table 3, and Table 4 for contains the ANCOVA results.
Table 3
Descriptive Statistics For Null Hypothesis 1: Comparing Posttest Composite Scores by Media Type

<table>
<thead>
<tr>
<th>Media Type</th>
<th>Post test Mean</th>
<th>Median</th>
<th>Mode</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>12.42</td>
<td>27</td>
<td>28</td>
<td>5.17</td>
</tr>
<tr>
<td>Paper</td>
<td>11.77</td>
<td>26</td>
<td>28</td>
<td>4.91</td>
</tr>
</tbody>
</table>

Test of Prior

<table>
<thead>
<tr>
<th>Media Type</th>
<th>Post Test Mean</th>
<th>Median</th>
<th>Mode</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>10.00</td>
<td>10</td>
<td>10, 11</td>
<td>3.38</td>
</tr>
<tr>
<td>Paper</td>
<td>10.32</td>
<td>9</td>
<td>9</td>
<td>2.94</td>
</tr>
</tbody>
</table>

Table 4
ANCOVA Results of Computer Based Media Compared to Paper Based Media

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>207.46</td>
<td>2</td>
<td>103.73</td>
<td>12.91</td>
<td>.000</td>
</tr>
</tbody>
</table>

* P < .05

There were two types of questions within the posttest, those questions that directly related to the media-based instruction and those questions that did not relate directly to the media-based instruction and required problem solving. Mayer (2001) utilizes problem solving following instruction as a test for transfer. A posttest score was created utilizing only those questions that did not relate to the media-based instruction; and, an additional ANCOVA was conducted based on this score. Questions used from the posttest were (a) question 6, (part a. only), (b) question 7, (c) question 8, (d) question 11 (part b. only), and (e) question 12.

The statistical comparison used two groups: (a) contained all participants who received lecture support from the computer based media, and (b) contained all participants who received lecture support from paper based media. The dependent variable used for analysis of covariance
(ANCOVA) was the posttest scores and the covariant was the test of prior knowledge. Significant differences were found ($F = 11.82; F[(.05, 2, 61)]; p < .05$) between the comparison groups. The test score mean for the computer-based group was 3.00 and the mean for the paper-based group was 2.93 (see Table 5). The group receiving computer support media as a treatment demonstrated higher scores than the group receiving paper based support. The difference between the means of the contrived posttest score is significant when comparing computer-based media to paper-based media. Therefore, null hypothesis 1 was also rejected for this test. Descriptive statistics for the null hypothesis are displayed in Table 5, and Table 6 for contains the ANCOVA results.

Table 5
Descriptive Statistics for Null Hypothesis 1: Comparing Contrived Posttest Scores by Media Type

<table>
<thead>
<tr>
<th>Post test</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>3.00</td>
<td>2</td>
<td>2</td>
<td>2.24</td>
</tr>
<tr>
<td>Paper</td>
<td>2.93</td>
<td>3</td>
<td>5</td>
<td>2.10</td>
</tr>
</tbody>
</table>

Test of Prior

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>10.00</td>
<td>10</td>
<td>10, 11</td>
<td>3.38</td>
</tr>
<tr>
<td>Paper</td>
<td>10.32</td>
<td>9</td>
<td>9</td>
<td>2.94</td>
</tr>
</tbody>
</table>

Table 6
ANCOVA Results of Computer Based Media Compared to Paper Based Media Using Contrived Posttest Scores

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>80.47</td>
<td>2</td>
<td>40.24</td>
<td>11.82</td>
<td>.000</td>
</tr>
</tbody>
</table>

* $P < .05$
Null Hypothesis 2

*There will not be a significant difference in posttest scores between modes of lecture support when participants are tested on a different but closely related software application.*

The comparison was conducted using two groups: (a) contained all participants who received lecture support from the computer-based media, and b) contained all participants who received lecture support from paper-based media. The dependent variable was the MIDI transfer portion of the posttest and the covariant was the test of prior knowledge. Significant differences were found between the comparison groups using the MDI transfer score as the dependent variable and the test of prior knowledge as the covariant (p < .05). The mean score for the computer-based group moved from 8.00 to 10.00 and the mean for the paper based group moved from 8.00 to 10.32 (see Table 7). The group using computer-based support media demonstrated a higher gain between scores than the group receiving paper-based support. The change between the means of the posttest and the test of prior knowledge is significant as tested using an ANCOVA ($F = 5.99; F[(.05, 2, 61)]; p < .05$). Therefore, null hypothesis 2 was rejected. Table 8 contains the ANCOVA results from the comparison of computer-based lecture support and paper-based lecture support.

Table 7
Descriptive Statistics for Null Hypothesis 2: Comparing MIDI Transfer Scores by Media Type

<table>
<thead>
<tr>
<th>Post Test</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>1.59</td>
</tr>
<tr>
<td>Paper</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>1.68</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test of Prior</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>10.00</td>
<td>10</td>
<td>10, 11</td>
<td>3.38</td>
</tr>
<tr>
<td>Paper</td>
<td>10.32</td>
<td>9</td>
<td>9</td>
<td>2.94</td>
</tr>
</tbody>
</table>
Table 8

ANCOVA Results of Computer Based Media Compared to Paper Based Media on MIDI Transfer

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>27.21</td>
<td>2</td>
<td>13.60</td>
<td>5.99</td>
<td>.004</td>
</tr>
</tbody>
</table>

* P < .05

Null Hypothesis 3

There will not be a significant difference in posttest scores between modes of lecture support when participants are tested on a distantly related software application.

The comparison was conducted using two groups: (a) contained all participants who received lecture support from the computer-based media, and (b) contained all participants who received lecture support from paper-based media. Descriptive statistics for the digital audio section of the posttest are displayed in the top half of Table 9. The dependent variable was the digital audio transfer portion of the posttest and the covariant was the test of prior knowledge. The ANCOVA test demonstrated no significant difference between the groups (F = 2.75; F[(.05, 2, 61)]; p > .05). Therefore, null hypothesis 3 was not rejected. The results of the ANCOVA are located in Table 10.

Table 9

Descriptive Statistics for Null Hypothesis 3: Comparing Digital Audio Transfer Scores by Media Type

<table>
<thead>
<tr>
<th>Post Test</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>1.05</td>
</tr>
<tr>
<td>Paper</td>
<td>6</td>
<td>5</td>
<td>5, 6</td>
<td>0.97</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test of Prior</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td>10.00</td>
<td>10</td>
<td>10, 11</td>
<td>3.38</td>
</tr>
<tr>
<td>Paper</td>
<td>10.32</td>
<td>9</td>
<td>9</td>
<td>2.94</td>
</tr>
</tbody>
</table>
Table 10

ANCOVA Results of Computer Based Media Compared to Paper Based Media on Digital Audio Transfer

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>5.29</td>
<td>2</td>
<td>2.643</td>
<td>2.75</td>
<td>.072</td>
</tr>
</tbody>
</table>

* P > .05

Null Hypothesis 4

*There will not be a significant difference in posttest scores between the high school age population and the college-age population.*

This comparison was conducted using the entire sample divided into two groups. Posttest scoring was compared between college-age participants and high school age participants. Descriptive statistics related to age-based grouping are contained within Table 11. The composite posttest score was used as the dependent variable with the test of prior knowledge as the covariant. The ANCOVA (see Table 12) demonstrated a significant difference between the two groups ($F = 16.14; F[(.05, 2, 61)]; p < .05$). The college-age group had the greater change in mean score, changing from 12.40 to 28.90. The high school age group had a change of 9.00 to 23.80. Therefore, null hypothesis 4 was rejected.

Table 11

Descriptive Statistics for Null Hypothesis 4: Comparing Scores by Age Group

<table>
<thead>
<tr>
<th>Post Test</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>College</td>
<td>28.9</td>
<td>29.5</td>
<td>28, 30, 31</td>
<td>3.92</td>
</tr>
<tr>
<td>High School</td>
<td>23.80</td>
<td>24</td>
<td>23, 27, 28</td>
<td>4.66</td>
</tr>
</tbody>
</table>

Test of Prior

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>College</td>
<td>12.40</td>
<td>13</td>
<td>13, 14</td>
<td>2.76</td>
</tr>
<tr>
<td>High School</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>2.74</td>
</tr>
</tbody>
</table>
Table 12
ANCOVA Results of College Age Compared to High School Age Post Testing

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>27.21</td>
<td>2</td>
<td>13.60</td>
<td>5.99</td>
<td>.004</td>
</tr>
</tbody>
</table>

* P < .05

**Null Hypothesis 5**

*There will not be a correlation between prior computer experience and posttest scores.*

Two Pearson correlation tests were used to test for a relationship between prior computer use and posttest scoring. The first test used the posttest composite, and from the demographic survey, the participants’ estimated number of hours per week that they use computers. The first test did not yield a significant correlation and the null was not rejected (see Table 13).

Table 13
Pearson Correlation Between Hours per Week of Use and Post Test Scores

<table>
<thead>
<tr>
<th>Post Test Composite</th>
<th>Pearson Correlation</th>
<th>Sig. (2-tailed)</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours per Week of Computer Use</td>
<td>Pearson Correlation</td>
<td>.106</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Sig. (2 tailed)</td>
<td>.420</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

The second correlation was tested between the post test composite scores and the participants’ estimated number of years of computer use. This comparison yielded a significant correlation at alpha 0.01 and null hypothesis 5 was rejected (see Table 14).
Table 14

Pearson Correlation Between Years of Computer Use and Post Test Scoring

<table>
<thead>
<tr>
<th></th>
<th>Post Test Composite</th>
<th>Hours per week</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post Test Composite</strong></td>
<td>Pearson Correlation</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>61</td>
</tr>
<tr>
<td><strong>Years of Computer Use</strong></td>
<td>Pearson Correlation</td>
<td>.343(***)</td>
</tr>
<tr>
<td></td>
<td>Sig. (2 tailed)</td>
<td>.009</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>57</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).

**Null Hypothesis 6**

*There will not be a significant difference between scores of high school students who share a computer and those who don't.*

This comparison was conducted using two groups: (a) contained high school age participants who worked alone at the computers during instruction and practice, and (b) contained participants who shared a computer. The dependent variable used was the composite post test scores and the covariant was the test of prior knowledge. Significant differences were found between the comparison groups using the composite posttest score as the dependent variable and the test of prior knowledge as the covariant (p > .05). The mean score for the group that worked alone moved from 9.52 to 25.00 and the mean for the group that shared moved from 8.45 to 25.00. Descriptive data for the comparison is contained in Table 15. The group of students working individually on computers demonstrated a higher gain between mean scores than the pairs of students sharing a computer. The change in the difference between the means of the posttest and the test of prior knowledge is significant as tested using an ANCOVA ($F = 3.29; F[(.05, 2, 61)]; p < .05$). Therefore, null hypothesis 6 was rejected. ANCOVA results are located in Table 16.
Table 15
Descriptive Statistics for Null Hypothesis 6

<table>
<thead>
<tr>
<th></th>
<th>Post Test</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS Alone</td>
<td>25.00</td>
<td>26</td>
<td>27</td>
<td>4.60</td>
<td></td>
</tr>
<tr>
<td>HS Pairs</td>
<td>22.55</td>
<td>23</td>
<td>20, 23, 28</td>
<td>4.50</td>
<td></td>
</tr>
</tbody>
</table>

Test of Prior

<table>
<thead>
<tr>
<th></th>
<th>HS Alone</th>
<th>9.52</th>
<th>10</th>
<th>7</th>
<th>2.73</th>
</tr>
</thead>
<tbody>
<tr>
<td>HS Pairs</td>
<td>8.45</td>
<td>9</td>
<td>9</td>
<td>2.70</td>
<td></td>
</tr>
</tbody>
</table>

Table 16
ANCOVA Results of Computer Sharing Compared to Computer Used Alone

<table>
<thead>
<tr>
<th>Source</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>128.58</td>
<td>2</td>
<td>64.290</td>
<td>3.29</td>
<td>.048</td>
</tr>
</tbody>
</table>

* P < .05

Null Hypothesis 7

*There will be no significant difference in exit attitude between types of lecture support media.*

A Pearson correlation test examined the relationship between support media type and Likert scale responses from the attitudinal exit survey. The survey responses selected for this test were those questions in the exit survey that directly referred to the lecture support media. The participant’s responses from the selected questions were summed for the purposes of the statistical testing. The survey data used for this comparison is located in Appendix F. The test indicated that there was not a significant correlation between the two variables. Therefore, the null was not rejected. The results of the Pearson correlation test are located in Table 17.
### Table 17
**Pearson Correlation Between Media Type and Attitude**

<table>
<thead>
<tr>
<th></th>
<th>Media type</th>
<th>Survey Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Media Type</strong></td>
<td>Pearson Correlation</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>.</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>61</td>
</tr>
<tr>
<td><strong>Survey Responses</strong></td>
<td>Pearson Correlation</td>
<td>.052</td>
</tr>
<tr>
<td></td>
<td>Sig. (2 tailed)</td>
<td>.695</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>60</td>
</tr>
</tbody>
</table>
CHAPTER 5

DISCUSSION

Summary of the Study

The purpose of this study was to compare learning, and transfer of learning, outcomes as affected by two types of lecture support both designed to teach computer skills within a music classroom. Participants were trained to use MIDI sequencing software in two treatment groups. Posttest results from the two treatment groups were compared. Two types of lecture-support media, which served as software instruction to the college and high school age participants ($N = 61$), were presented as either paper-based multimedia or computer-based multimedia. ANCOVA results indicated significant differences in several group comparisons. When tested on the MIDI software, participants who received computer-based multimedia lecture support scored significantly higher than participants who received paper-based multimedia lecture support. Also, participants who received computer-based multimedia lecture support scored significantly higher than participants who received paper-based multimedia when they were tested on transfer software that was similar to the software from the treatments. No significant difference was demonstrated between groups when tested on transfer software that was “not so” similar.

Differences between age groups were found. College-age students scored significantly higher on the posttest than high school age participants, and in conjunction, college-age participants also reported the highest average number of years using computers. In addition, significant correlations occurred between the entire samples’ reported years of computer use and posttest scoring.

One half of the high school age participants shared computers in pairs during the treatments and but were tested individually. An ANCOVA analysis identified a significant difference between high school age participants who shared a computer and participants who did not. The participants who received treatments while working alone scored significantly higher than did those who shared computers in pairs.
Discussion

The purpose of this study was to compare two types of lecture-support media that was intended to teach computer skills within a computer-based music classroom. The treatments were structured to demonstrate whether there was a difference in learning between participants who received instruction about MIDI sequencing software from a paper-based lecture support format and participants who received the same instructional content from a computer-based lecture support format. Additional purposes of the study were to (a) examine the effect of lecture-support media type (paper or computer-based) on transfer of learned skills to other software, (b) investigate a possible media-based age effect between high school age and college-age participants, (c) compare learning outcomes between high school age participants who shared computers and those who worked alone, (d) ascertain possible correlations between prior computer usage and posttest scoring, and (e) investigate a possible correlation between participant attitude at exit and lecture-support media type. Participants \(N = 61\) were self-selected volunteers, a convenience population taken from a summer music camp for high school age students.

Data were gathered using (a) a test of prior knowledge, (b) a posttest, (c) a demographic survey and, (d) an attitudinal exit survey. Each participant participated in three treatment sessions, and one half of the high school age participants worked in pairs while at the computers. All treatment sessions contained the same sequence of events, (a) direct instruction only about MIDI sequencing concepts, (b) multimedia based instruction only related to software skills, (c) guided practice, (d) unguided practice, and (e) closure by the researcher.

The test of prior knowledge was conducted at the participants’ desks away from the computer and post testing was done at the computer. During the posttest each participant edited and then saved a series of files on a 3.5-inch floppy disk that were later scored by the researcher. The attitudinal exit survey was administered after the posttest and was based on a five point Likert scale.

Differences Between Multimedia

The primary purpose of this study was to investigate whether or not there were differences in learning between participants who received computer-based multimedia and participants who received paper-based multimedia during software skills training. The media designed for the treatment sessions was created using research established guidelines (Mayer,
2001). Also, it was created using software that would be understandable and accessible to the average computer user/teacher. I was interested in creating an experimental situation based on media that could be created by a typical educator who was teaching within a computer-based classroom.

Statistical testing demonstrated a significant difference in posttest scores between the two media types. The comparison was made using posttest scores from the entire sample \((N = 61)\) with the test of prior knowledge as a covariant. The students who experienced the computer-based multimedia as lecture support demonstrated a higher degree of software-skills learning as indicated by the posttest scores. These results seem to support a situated learning theory. McLellan (1995) proposes that learning is more effective when it occurs in contexts that are most closely related to the settings in which the learning is actually applied. Differences in learning may have been the result of the mode and location of the media presentation. The students who viewed the computer-based media may have had stronger gains in learning because they watched the software demonstration on the computer screen while seated at the same computer they used during the practice sessions.

This study’s results demonstrate that when basic guidelines for multimedia design are followed, educators can create their own computer-based multimedia that may produce equal or better learning outcomes than a paper-based textbook or software reference manual. While attempts to generalize the results of this experiment to larger populations are inappropriate, it does appear that students who are learning to use MIDI sequencing software may learn more effectively from multimedia that presents instructional information through live-action video and narration on the computer.

Educators who teach students how to use software may benefit from the use of computer-based multimedia for several reasons. Cost, portability, and classroom management may all play a role in the decision to create and use computer-based instructional media. Computer-based multimedia has demonstrated that it can be more effective as an instructional aid than paper-based handouts. And, this educationally effective media can be created using simple guidelines based on Mayer’s (2001) research. Therefore, a technology instructor who teaches multiple software applications can confidently produce a set of materials that specifically address curricular goals. These materials are flexible, continually available for student review, and easily updatable. They can also be distributed to the students utilizing CD format, networked drives,
and the internet. All of these options come at a fraction of the cost of a textbook, set of software manuals, or paper-based media.

Additionally, multiple sections of a technology course may become easier to manage when students view a multimedia presentation. Whether viewed as a group or watched individually at work stations, this type of video presentation holds student attention for a specific amount of time, and delivers material to multiple classes in a consistent manner. As students become more familiar with the computer-based media and its controls, the teacher may also experience less distraction from students who ask easy to answer questions because the media facilitates student centered discovery. Conversely, students who are given a text-based reading assignment will finish the passage at different rates. An instructor would be forced to wait for students who have not completed the reading before progressing with the lesson.

**Transfer of Learning to Similar Software**

A portion of this study was designed to examine the possible effect of lecture-support media on transfer of learning. The posttest included questions that tested participants on a secondary software, the Anvil Studio MIDI sequencer. The participants were given no prior experience or instruction with this secondary software. Both programs are used to create and edit MIDI sequences.

In order to make the statistical comparison, two tests were conducted. In the first, the MIDI transfer portion of the posttest was used as the dependent variable and the test of prior knowledge was used as the covariant. The ANCOVA indicated that there was a significant difference between those participants who received computer-based lecture support and those who received paper-based lecture support. Participants who received lecture support in the computer-based form scored better than those who received paper-based lecture support.

In the second comparison, questions that dealt with problem solving were selected from the two MIDI sections of the test. These questions were totaled and the test of prior knowledge was used as a covariant. A significant difference was detected by the ANCOVA, and again the students who received computer-based lecture support scored significantly better than those who received paper-based media. Results from this comparison may indicate that near transfer between software can be positively affected by computer-based multimedia when it is used to deliver software-skills instruction. It may also indicate that the computer-based media produced a higher degree of understanding than
the paper-based media, which in turn lead to better transfer. Mayer (2001, p. 15) maintains that there are two types of learning, that which can only be recalled, and that which can be applied to a new situation. According to Mayer, learning that can only be recalled and not applied is generally the result of learning that took place with little cognitive engagement. Conversely, learning that can be applied to new and novel situations, as the result of more thorough understanding, is the result of highly active cognitive involvement. It is this level of cognition that generates what Mayer identifies as meaningful learning outcomes and in turn, successful transfer. Within this study, the group that received computer-based skills instruction may have generated a more functional understanding of the direct conceptual instruction as it was combined with the software skills instruction.

This study’s treatments were designed so that participants received conceptual knowledge about MIDI and the key ideas surrounding MIDI sequencing from the instructor’s lecture, and then software skills were learned from the lecture-support media. This was done in an attempt to isolate media’s affect on learning. The order of the process within each treatment was conceptual instruction first and then skills instruction. As the participants received instruction from the multimedia they were working to create functional learning outcomes that were the result of combining the two learning experiences into one working model of understanding. The two types of lecture-support media were as close to identical in content as was possible, and both were created using research based principles of design. Every attempt was made to represent each media in its best possible state. Yet, the computer-based media affected the highest degree of transferable learning. The fact that the computer-based learning was presented on the computer screen and contained video of the actual training software may have provided the participants with a more immediate understanding of the required software skills. In turn, the computer-based presentation may have allowed the learner to direct more energy to integrating the previously presented concepts with the new software skills.

**Transfer of Learning to “Not So” Similar Software**

A freeware digital-audio editor was chosen for the purpose of testing the transfer of learned skills to more distantly related software. Audacity was chosen as the secondary software to test transfer of skills because of its similarity in editing processes. The nomenclature and file types used within the software are different but key concepts remain the same. For example, both programs require a click, hold, and drag mouse action in order to select a file region before
the editing function is enabled. Because Audacity dealt with a digital audio musical file (digital audio), it was considered to be similar, but more distantly related than the MIDI sequencing software used for the near-transfer test. Hence, the software receives the label “not so” similar.

The results of the statistical analysis (ANCOVA) indicate no significant difference on performance between the participants who received paper-based media and those who received computer-based media. Further examination into “not so” near and far transfer of software skills may result in the identification of more powerful influencing factors. It would seem that, as participants get farther away from their specific training, past computer experiences are capable of extinguishing the small effects that might have been achieved through a limited number of experimental treatments. Logic would dictate that a decade of computer use, efficient or not, would have considerable effect on computer users’ habitual routines. When learning new software skills, do computer users rely on (a) trial and error, (b) help menus, (c) printed manuals, (d) assumptions based on past experiences, (e) computer aided instruction, (f) or a combination of all of the above? More research is needed to identify the most profound factors of influence on far transfer.

This result adds to the large body of research that continually demonstrates the difficulty of affecting students’ ability to produce far transfer. Implications for the educator may most clearly be represented by Haskell’s (2001) ideas surrounding transfer and training for transfer. It could be that when the media supporting our classroom lectures is designed as well as can be, it still may not have a measurable effect on our students’ ability to transfer. The results of this study and the large body of existing transfer research may be telling us to train students directly about transfer and its importance. Haskell’s writing indicates that in order to affect students’ ability to transfer we have to teach them about transfer and create an environment that values, rewards, and fosters transfer as a skill. Essentially he is saying, if you want them to transfer, teach them how to transfer and why.

**Age Related Differences in Software Skills Learning**

In order to make the comparison between high school age and college-age participants, an ANCOVA was used. The posttest composite score was used as the dependent variable. The composite score includes testing conducted on the training software, the near transfer software, and “not so” near transfer software. The test of prior knowledge was used as a covariant to control for differences in previous learning. Statistical testing revealed a significant difference
between the two age groups. The college-age participants had the most change in mean scoring from the test of prior knowledge to the posttest. Within this experimental situation, the college-age participants were able to produce a higher degree of software skills learning. This result is not unexpected. It is logical that college students are more experienced learners and that they can achieve more when working for the same amount of time as high school age students.

**Correlations to Prior Computer Use**

Two Pearson correlation tests were used to test for a relationship between prior computer use and posttest scoring. The first comparison used the posttest composite, and the participants’ estimated number of hours per week of computer use taken from the demographic survey. The second correlation was tested between the posttest composite scoring and the participants’ estimated number of years of computer use. The testing revealed no significant correlation between posttest scoring and reported weekly hours of computer use. However, there was a significant correlation detected between years of computer usage and posttest scoring. The participants who had used computers for the greater number of years also tended to score higher on the posttest composite.

Seventy-five percent of the entire sample (N = 61) reported daily computer use and there was no significant correlation between scores and daily use. However, there was a significant correlation between years of reported computer use and posttest scores. Hypothetically, if a student uses a computer daily for three years, they have had more than one thousand sessions with a computer. The college-age participants reported an average of 10.86 years of use verses the high school age participants who reported 7.05 years of use. This is an average difference in years of reported usage of 3.81 years. For those participants (75%) who reported using computers daily, the upper boundary of difference in number of exposures to a computer might be as much as one thousand three hundred uses. It seems logical that years of usage would have more effect on participants’ degree of learning and subsequent use of new software than reported daily use. However, within this experimental design, assuming a direct relationship of cause and effect between previous number of computer uses and posttest scoring would be inappropriate.

There may be any number of other contributing factors involved. It is conceivable that someone who uses a computer daily may only utilize an email program, an instant messaging application, and a word processor, while another plays games for the majority of his or her usage time. Also, two users who use identical software for an identical amount of time may have two
entirely different levels of expertise within those applications. Additional research is needed to measure participants’ level of expertise and efficiency within the software that they use most, and then make a comparison to the effect of expertise on achievement when learning new software as well as the subsequent transfer of prior learned skills.

Implications for the educator are related to the number of exposures each student receives over an extended period of time. If the goal of computer education is to produce students who learn to use software with successful transfer, educators should provide numerous encounters with the computer over an extended period of time. Although it was not tested in this study, it would be logical to also assume that each student encounter with the computer should be structured in such a way as to produce expert users with as few bad habits as possible. Interestingly, the significant correlation between test scores and years of computer use indicates that volumes of practice, probably mostly unguided, had a positive correlation to scoring. While it is unwise to apply cause and effect to a correlation, it does seem that these skills, built during years of usage, contain enough substantial and varied experience as to allow good habits to overpower bad.

**Effects of Computer Sharing on Learning**

Half of the high school age population worked in pairs during the computer-based multimedia presentation as well as during the classroom practice sessions. A statistical test was conducted using the high school age composite posttest scores as the dependent variable and the test of prior knowledge as the covariant. Significant differences were found between those participants who shared computers and those who did not. High school age participants achieved higher posttest scores in relation to their test of prior knowledge when they did not share computers during the presentation of the lecture-support media and during classroom practice session.

It is important to point out that no accommodation was made in the lesson design for those students that worked in pairs. Paired participants received the same treatments and participated in the same practice sessions. The only difference that occurred was during the practice sessions. At intervals of about seven minutes the participants were asked to change who had control over the mouse. Similarly, a meta-study investigating shared workspaces and computer-aided instruction found that pairing students at a computer work station increases
achievement only if the students are purposefully trained to engage in interaction and collaboration with their partner (Susman, 1998).

Because this study placed pairs at the computer with no instructional modifications it represents a situation of necessity that occurs within many school systems throughout the world. For many instructors it is a question of available resources (Schlecter 1990). Having too many students and too few computers creates a situation that causes teachers to compromise. Results from this study suggest that students in a paired situation will learn; however, achievement increases when students can work alone at the computer. This statement is made under the assumption that no instructional design accommodations have been made for the students working in pairs. Interestingly, this finding of unequal achievement in favor of the individuals working alone is not congruent to the body of studies that compare paired verses individual computer based instruction (Carrier and Sales, 1987; Makuch et al., 1992; Schlecter, 1990; Whyte et al., 1991).

As part of a routine, the researcher made informal and subjective notes after each treatment session. Even though these observations have not been examined in a thorough qualitative analysis, it is worth mentioning that throughout each treatment session containing paired students, there was a higher degree of student discussion and what was perceived by the researcher to be off task behavior. This observation is supported by findings reported by Carrier and Sales in 1987. They report, “Nearly one quarter of the verbal interactions among members of a pair did not relate to the task itself” (p. 16). This implies that when educators choose to use computers in a shared situation they must plan accordingly. It is to the instructor’s advantage to design the shared experience in such a way as to take advantage of the natural interaction between students who work together toward a common goal.

**Participant Attitude and Media Type**

A group of questions were selected from the attitudinal exit survey that directly referred to the lecture-support media used during the treatments. A five point scale was used and in each question a response of “5” represented the most positive choice. These selected responses were summed for each participant and then statistically compared using two groups. One group contained participants who received computer-based lecture support and another contained those who received paper-based lecture support. The entire sample was used for the comparison.
The Pearson correlation did not detect a significant relationship between lecture-support media and exit survey attitude. Interestingly, averages of Likert responses for participant groups within the study are surprisingly similar. The entire sample averaged a 4.00 on all responses while the paper-based media group averaged 3.99 and the computer-based media group averaged 3.93. Of all of the experimental groupings the participants that shared computers in pairs reported the lowest averages. Paired users who received paper-based lecture support averaged 3.95 and paired users who received computer-based support averaged 3.80 on their Likert scale responses. The differences in averages are not significant; however, it is interesting that those students who shared a computer reported the two lowest averages on the Likert scale and scored significantly lower than all other groups on the posttest. These results imply that learner attitudes may be related to computer sharing and student achievement.

The apparent lower positive attitude may also be a reflection of the treatment design and lack of choice. The treatments made no attempt to modify the experience for those who were sharing, and the pairs were randomly selected. Future study is needed to investigate the effects of lesson design on shared experience as well as student choice in partnering.

**Implications for Future Study**

This study takes an initial step toward a comprehensive evaluation of the effect of lecture-support media on learner outcomes. It has served the purpose of demonstrating that computer-based multimedia, when used to train music software skills, is a viable instructional tool, and in this experimental situation produced significantly better results than paper-based media. These results give credence to the continuation of investigations that seek to identify the most effective multimedia-design elements for teaching software within a music classroom.

While Mayer and his colleagues have produced a large body of research dealing with multimedia and its effectiveness, no studies isolate learning situations where the aural/musical component of the multimedia is essential to the learning process. A series of studies that first replicate and then extend Mayer’s work within the field of music would be necessary to further this investigation.

Electronically-based portable multimedia is becoming ubiquitous. In addition, we are currently witnessing the advent of the video-capable hand-held media device. Educators can look to a future where every student carries a small device capable of storing and delivering a variety of media. Imagine a student who carries in his or her pocket the media that supports every
class for four years of high school. Textbooks may soon be supplemented or replaced by well
designed instructional media. The need for understanding the most effective design elements of
that multimedia are paramount.
APPENDIX A

CONSENT FORM

AND

INFORMED CONSENT FORM
I freely, voluntarily, and without the element of force or coercion consent to be a participant in the research project entitled "The effect of lecture support media on music software process learning."

This research is being conducted by Scott Alan Meier, who is a Graduate Student at Florida State University. I understand the purpose of his research project is to better understand educational technology in the music classroom. I understand that if I participate in the project I will be asked questions about my past computer use, my educational history in technology, and my feelings about the seminar at its closure.

I understand I will be asked to fill out paper and pencil questionnaires, and take a pretest on paper and posttest at the computer. The total time commitment would be about six hours over three days or evenings. If I participate in the study, I will receive education in basic MIDI (Musical Instrument Digital Interface) concepts, and training in the use of MIDI sequencing software for the purpose of creating music, and be given printed information on how to set up a similar system at home.

I understand that I may be audio recorded by the researcher. The researcher will keep these tapes in a locked filing cabinet. I understand that only the researcher will have access to these tapes and that they will be destroyed by June 1, 2003. These recording will be used for the sole purpose of tracking the types of questions asked during the practice portions of the seminar, and they will not be used to identify individual participant actions.

I understand my participation is totally voluntary and I may stop participation at anytime. All my answers to the questions will be kept confidential and identified by a subject code number. My name will not appear on any of the results. No individual responses will be reported. Only group findings will be reported.

I understand there are benefits for participating in this research project. First, my own awareness about the possibilities of using a home computer for the composition and recording of original music will be enhanced. Also, I will be providing educational researchers with valuable information regarding technologies and software education within the music classroom. This knowledge can assist them in providing more effective and efficient learning situations.

I understand that my consent may be withdrawn at any time without prejudice, penalty or loss of benefits to which I am otherwise entitled. I have been given the opportunity to ask and have answered any inquiry concerning the study. Questions, if any, have been answered to my satisfaction.

I understand that I may contact Scott Meier or Dr. Jack Taylor for answers to questions about this research or my rights at the Florida State University, Center for Music Research, KMU-214, (850) 644-5786. Also, I may contact the Florida State University Institutional Review Board at (850) 644-8633.

Group results will be sent to me upon my request at the conclusion of the study.

I have read and understand this consent form.

(Participant’s Name, printed) (Participant’s Signature) (Date)
INFORMED CONSENT FORM
(For Parents or Guardians)

I have been informed that:

This research is being conducted by Scott Alan Meier, who is a Graduate Student at Florida State University. I understand the purpose of his research project is to better understand educational technology in the music classroom.

My child’s participation will involve questions about his or her past computer use, educational history in technology, and feelings about the seminar at its closure. My child will be asked to fill out two short paper and pencil questionnaires, take a pretest on paper and posttest at the computer. The total time commitment will be about six hours over three days or evenings.

The possible benefits of my child’s participation will include a) education in basic MIDI (Musical Instrument Digital Interface) concepts, b) training in the use of MIDI sequencing software for the purpose of creating music, and c) printed information on how to set up a similar system at home.

I understand that all of my child’s answers to the study’s questions will be kept confidential to the extent allowed by law, and identified by a subject code number. My name or my child’s name will not appear on any of the results. No individual responses will be reported. Only group findings will be reported.

I understand that my child may be audio recorded by the researcher. The researcher will keep these tapes in a locked filing cabinet. I understand that only the researcher will have access to these tapes and that they will be destroyed by June 1, 2003. These recording will be used for the sole purpose of tracking the types of questions asked during the guided computer practice portions of the seminar, and they will not be used to identify individual participant’s actions during the taped portion of the sessions.

I understand there are benefits for participating in this research project. First, my child’s awareness about the possibilities of using a home computer for the composition and recording of original music will be enhanced. Also, we will be providing educational researchers with valuable information regarding technologies and software education within the music classroom. This knowledge can assist them in providing more effective and efficient learning situations.

I understand that my consent may be withdrawn at any time without prejudice, penalty or loss of benefits to which my child is otherwise entitled. I understand that I will not be paid for my child’s participation. I have been given the opportunity to ask and have answered any inquiry concerning the study. Questions, if any, have been answered to my satisfaction.

I understand that I may contact Scott Meier or Dr. Jack Taylor for answers to questions about this research or my rights at Florida State University, Center for Music Research, KMU-214, (850) 644-5786. Also, I may contact the Florida State University Institutional Review Board at (850) 644-8633. Group results will be sent to me upon my request at the conclusion of the study.

I have read and understand this consent form.

________________________________________  __________________________________________  __________________________  ___________
(Participant’s Name)  (Parent’s Name, printed)  (Parent’s Signature)  (Date)
APPENDIX B

PAPER BASED MULTIMEDIA
Cakewalk Basics Session #1

Hello and welcome to Cakewalk Basics, Session #1. In this segment we will explore opening a file, tool bar manipulation, the track display, setting up tracks for use, and recording using two different modes.

Let’s get started. When you first open the Cakewalk application, a window will pop up asking you to make a file choice.

At this point, you may choose to open a project already created and saved to disk, open a recent project, or, create a new project. For this exercise let’s create a new project.

By clicking on “Create a new project” the new project file window is placed on the display. You will notice that the template “Normal” is already highlighted. Click “OK” to accept this type of file.
You are now looking at a new and empty Cakewalk work file. There are several things that I would like to point out. First, there is a set of window control buttons in the upper right hand corner of each window. Each set contains the buttons minimize, restore/maximize and close.

Until you become more familiar with the complexities of this program, please make sure that each window you work in is maximized. When the window is not maximized, the title bar divides the screen. This causes some of the screen information **not** to be displayed. You want you to be able to see everything. So, when you enter each new screen check to make sure that only one title bar is showing and that it is located at the top edge of your display. Cakewalk displays are very flexible. Each user may set the display just the way he or she likes it. By clicking and dragging on the left edge of each of the tool panels, you can drag toolbars off
of the toolbar display and place them in different locations within the toolbar display or even place them on the main window.

Left click and hold at this point to drag individual tool bars.

You may notice that when you look at your particular screen, items in the toolbar display are arranged differently than on my screen. Don’t worry; this will not affect the way the program functions, and you can experiment by moving things around without hurting anything.

Also, if you right click in a vacant area on the right side of the toolbar display you will activate the tool bar menu and can see which of the available toolbars are being displayed, and which are not.

You can at any time change these settings by simply clicking on the box to the left of the toolbar name. You may from time to time during these sessions have to rearrange your tool bar display. Please feel free to arrange it in any way that makes your work more comfortable.

Next I would like to point out that within several of the different views available in Cakewalk the display might have a divider. Moving the divider left or right and up or down allows you to view a larger amount of one type of information or another. As you place the pointer over the dividing border, it changes shape from the regular pointer to this.

Once this happens, left click and hold to drag the border left and right. This is the display after the divider has been moved to the right side of the screen.

Our next step will be setting up a track for use in recording.

First, let’s review.
We have learned how to open a blank normal template; we also discussed the importance of viewing screens in a maximized setting. This keeps us from missing items at the edges of our display. Next I pointed out how the toolbar display may be changed by any user. You can move the individual parts, and add or remove them using the toolbar view menu. And finally, several of the Cakewalk views have movable dividers. By placing the mouse pointer on the dividing border you can slide the border to see more of one or another type of information.

Now let’s set up a track for recording.

In order for the computer to organize information that you want recorded, several settings must be made for each track. These settings tell the program where to look within the computer system for signals and on which channels to transmit. It also decides which kind of sound to use, how loud, and where to pan it. The quickest way to get to the track properties menu is to double click in the column labeled Patch and across from the track number that you would like to set up. This will display all of the related fields of information needed to completely set up a track.

To activate the “Track Properties” window for track number one double click here.

1. Source -- The source setting tells the computer where to look for incoming data. In the case of MIDI information, the setting is simply a transmission channel name. In our simple setup, you can leave this blank or choose MIDI Omni. Some keyboards can be set to transmit on one of the sixteen channels or all (MIDI Omni). Ours are set to transmit on channel 1. But it is still best to leave the Source setting at “none” or “omni” in case someone using the lab has changed the keyboard transmit setting.

2. Port – The port setting tells the computer in what physical part of the system to look to for new data. Some systems use a sound card and some use external synthesizers. In our lab, we use an external sound module or synthesizer for every station. On our systems this setting should automatically indicate the correct port when the rest of the settings are in place. On most of these computers, when you choose a channel the computer will automatically set the correct port.

3. Channel – The basic MIDI set up includes one port and 16 channels. It is a good idea when you first start using MIDI software to keep your track number and channel number the same. So choose channel one on your first track, and on each track following, use a new number. Also, General MIDI requires that you place percussion on channel 10; so if you’re doing a percussion track, don’t forget to place that track on channel 10.
4. **Bank Select Method** – This setting tells the software how to command the synthesizers to change banks. Several methods have been used as the MIDI language and synthesizers have developed. In our lab, choose “controller 00” for the old stations and “Normal” for the new. My synthesizer uses normal controller mode.

5. **Bank** – Synthesizers and sound modules all produce a set of sounds that conform to the General MIDI list of instruments. But manufacturers market their products by creating new and visionary sounds and sound effects. In order to provide both to the consumer, they create different sound sets within their synthesizer. These are called banks. Today let’s use the General MIDI bank. My Korg 03r/W, calls this bank “bank G”. If you are on an old station it is bank 20-Korg-N5R, and on the new stations it is 7424-gm-a or gm-b.

6. **Patch** – The Patch setting is the setting that tells the synthesizer which sound to play for this track. When you click on the pull down menu, you can hear each sound by playing the keyboard while the sound is highlighted. You can only hear the sound if you have first selected the information that is in the fields located above in the track properties display. Also, you can change this setting at anytime. Say for instance you wanted to hear what your piano part sounded like as a banjo; you can just click and change it.

7. **Volume** – In MIDI most settings exist between 0 and 127. A zero in the volume field means that no sound will come from that track and a 127 means that the track will sound as loud as possible depending on what is recorded within it. For now, it is a good idea to set your volume at around 84 on every track that you set up. We will discuss this in more detail when we begin editing our recorded information.

After selecting the new settings for a track be sure to exit the window by clicking “OK.”

Before we begin recording, we need to make another setting. We need to choose whether to use the Metronome or not. It is a big help to use a click track when making recordings on multiple tracks. So let’s set up the metronome. The metronome toolbar allows us to decide when to hear the click track and when not to.
It also allows us to control how many beats we hear before the computer begins recording. This is known as the “count in.” The first three areas on the metronome toolbar are inter-related. If you depress the second button, it causes the computer to click as many whole notes as are indicated in the first field before it begins recording. For example, if you put a 2 in the number field, and click on the whole note, when you press record you will hear eight beats before the computer begins recording.

![Metronome Toolbar with Count In Options]

If you leave the 2 and click on the third button (the quarter note), you will get just two beats before the computer begins recording. If you click in the fourth field you will get metronome on playback. Notice that the little playback triangle in the corner of the button looks just like the main transport. If you click on the fifth field you will also get metronome on recording. Notice the record figure.

![Metronome Toolbar with Additional Options]

Now, one last step is left. Let’s choose a tempo. The Tempo tool bar looks like this.

![Tempo Toolbar Example]

If you click in the field with the number in it, you can then scroll to a new number or type in a number. Scroll to a tempo of 80 beats per minute. This screen displays beats per minute, you may have seen tempo markings on your music as m.m. = 80 for metronome marking.

Now we may begin the recording process!

Next, the computer must be notified as to where we want our recorded data to be stored. By activating the record button in the track that we just set up, we are telling the computer to place the new information in track number 1.

![Track Listing Example]

Once the track record button is activated, you can click on the main record button in the transport toolbar.

![Transport Toolbar Example]

When the record button on the transport is pressed the metronome counts in the number of counts selected and recording begins. Press record and play anything on the keyboard. Then press the square to stop recording.
Playback of the recorded material can be heard by pressing the rewind button and then the right facing triangle or “play button” in the transport tool bar.

We can choose two types of record modes for simple MIDI uses. If you want to add to this track without changing what is already recorded, you can click Sound on Sound in the record toolbar.

If you change the setting to over write, the new data will completely wipe out the old.

We have covered a great deal of information. Let’s review the steps to set up track number two. Double click on Patch across from the number of the track you would like to set up. Then follow the fields from top to bottom in the track properties window. Following the process from top to bottom will save you from hassles later. We do not need to specify source because there is only one MIDI port on these systems. Check to make sure the port setting is on the option appropriate for your workstation. Then choose a channel. On most of these computers, when you choose a channel the computer will automatically set the correct port. Be sure that your new track is on a channel different from every other track. Now choose a bank select method. This will be “Normal” on the newer stations in our lab and “Controller 00” on the older stations. Now choose a bank. Now choose a patch.
Next, be sure to de-activate track one’s record button. This will keep both tracks for receiving the new information. The following graphic shows two tracks set up with the record activated on track 2.

![Cakewalk Home Studio](image)

This concludes Session #1 of Cakewalk Basics. The next segments will focus on editing skills and how to get the best from your tracks. Have fun with the activities that your instructor has designed for you, and remember to explore and experiment within the program. You can’t hurt anything.

Have fun and good-bye until Session #2.
Hello and welcome to Cakewalk Basics, Session #2. In this session we will explore some basic editing processes and the piano roll view.

First let’s open a demo project that was supplied with the software. It is entitled 80’s Rock by Igor Koroshev. It will give us a basic tune to demonstrate some simple edits. It can be found on the sample disk that you have been given.

Editing in Cakewalk is much like editing in a word processor. Before you can perform an edit you must select the information or area that you would like to change. Then you can perform a variety of functions like copy, cut and paste. Cakewalk performs these standard edits as well as some that are not found in a word processor. Let’s do a simple copy and paste edit.

Let’s edit this song so that the introduction plays twice at the beginning. This will involve selecting the data in a grid format within the track view. First you select the entire track and then you select the measures. You can click and drag down the left column of track numbers to select the entire length of every track. Notice the darkened areas in the track view as well as the measure bar.

Click on 1, drag to 4
Then, by dragging across the “measure number display” you can select one measure at a time until you have your desired length, which is eight bars.

Click and drag from here to here within the measure number display.

Now, the area that we would like to copy is shaded to indicate that it is a selected area. Then move to the top pull down menu and choose edit. Now choose copy.
If you then move the pointer back into the track display area and click once in the Measure Number display, a vertical line known as “the now time’ will appear.

Click here.

By doing this we are telling the computer where in the song we would like to start playback, recording or perform an edit function. This will save us from having to type in the starting point for the paste.

Choose paste from the pull down Edit menu and make sure it is starting at track one, measure 9, leave all of the settings as they appear. Except, be sure to choose the setting “slide old data over to make room.” Choose “OK” and now you we have the intro twice in a set of easy steps.

When you first start performing editing functions, it is a good idea to check your edit before you move to the next operation. That way you can choose “undo” from the edit pull down menu and erase what you did if it didn’t turn out the way you intended. The undo function can remember a lot of steps but it must erase them in the order that they were created. This can cause a hassle if you decide that you want to undo something that was fifty steps ago. You will loose that much work when you revert to that particular place in your work.

Here are the steps that were used to make this edit:
  a. Select the area.
b. Choose copy from the pull down Edit menu.
c. Place the now time.
d. Choose paste, making sure that the slide data over selection is activated
e. Make sure that the Starting at track number corresponds to the top track in your paste destination.
f. Choose OK and your done.

Selecting data can also be done with a lasso, but in the last example it would not have served our purposes. By clicking and dragging diagonally across the area to select, a box is created and any event, or note, that begins within that box will be selected for editing.

Click here and drag to here.

In this case the program leaves out track three because it contains no data at this point in the song. If we copy and paste this group as selected, track three will not slide over with the rest of the tracks and it will be eight bars early through the rest of the song.

While we are at this point let’s look at two other easy features that can be used for selecting. By clicking on the track number of track 1 you can select the entire track. Now by holding down the “Ctrl” key and clicking once, you can add any track to the selection or click again and remove it. The Ctrl key can be very useful. It allows you to add or remove individual selections from a group of items already selected for edit. It acts in this fashion throughout Cakewalk and Windows as well.

Now let’s take a quick look at the editing functions that you may encounter as a new Cakewalk user. As you click on the Edit pull down menu you can see the functions that are used primarily for dealing with note data.

Near the bottom you will find slide, length, quantize, and transpose. Beside copy, cut and paste, these are the most often used functions in this lab. Take the time later to experiment with each one. They are self-explanatory and you can feel free to click on anything in this menu.

The piano roll view is the view in which most of your editing of
small details takes place. If you remember, in the track view we were dealing with measures and large sections of a work. In the piano roll view we can individually edit every aspect of any note we choose. We can add notes, change wrong notes, make notes softer or louder, shorter or longer, or change where they are located within the beat structure. Let’s take a look at the drum part of 80’s rock. Any of Cakewalks views can be reached by several methods, I prefer using the tool bar button, but it is faster just to double click within the track and on the measures you would like to see within that piano roll view.

(Views tool bar)

Piano Roll button

You could also get there by selecting view from the top pull down menu and clicking on piano roll view. The “now time” dictates which measure you are am taken to in the piano roll view no matter how you choose to get there, and the active or highlighted track tells you to which track you will be sent.
Let’s look at how to select notes within this view. As with most programs that allow editing, once an area is selected it changes color slightly. You can select with the same lasso as from the track view. Also, you can select by clicking or dragging vertically on the keyboard. This can be very useful when you are editing drum tracks. For example, we can change the drum track’s high hat sound to an open high hat sound instead of a closed sound. Let’s select just the high hat note and transpose it up two half steps to the open high hat note.

Here is the high hat note, and we are going to move it two half steps upward.

First select it by clicking on the correct note in the keyboard display, notice the selected notes turn dark indicating they are selected for editing. Now choose transpose from the edit pull down menu and click two half steps up. Choose “OK”

The selected notes move up two half steps and a new sound is played throughout the drum track.
Let’s make the high hat louder in the first two measures just to try it out. In order to edit certain aspects of note and controller information we use the bottom half of the piano roll view. For this you will need to select the pencil tool, which is located just above the keyboard display.

You can make a short horizontal slash above (click and drag) and across the velocity of each high hat note. The height at which the pencil crosses the old velocity is where the new velocity is placed. Notice you can increase or decrease the velocity of each note based on where you cross it with the pencil.

Cross the velocity here with the pencil tool to get result.

Notice the Velocity changed 64 to nearly 96 on the graph.

Here are the high hat notes before the change.
Here are the high hat notes after the change

Before we close, let’s look at how to deal with individual notes. First, by right clicking on any note we can view its settings.

If you know exactly what you would like to do to a note, this window can be a quick answer to a problem. The Note Properties window describes when a note starts, its pitch, its velocity, how long it sustains, and to which channel it is attributed.

An even faster way might be to use the pencil tool. It has three functions besides placing new notes in the track. If you place the pencil over the beginning of the note approaching from the front, you can drag it left and right. If you place it over the middle of a note, you can drag it up and down, and over the back of the note approaching from the back, you can change the notes length. The pencil tool is quick and powerful.
Let’s review. In both track and piano roll views notes can be selected using the lasso (click and drag diagonally), and in both views, large areas can be selected using the horizontal and vertical components of the display (drag down the track numbers, across the measure number bar, or down the keyboard). However, the piano roll allows you to use only one or the other at any given time. The pencil tool is powerful in that it can quickly change any part of the note you wish to edit. Don’t forget that you can quickly view everything about a given note simply by right clicking on the note. In windows programs, when in doubt, right click.

Thank you for your time, I hope you enjoy the exercises your instructor has created for you, I’ll see you again in Session #3
Hello and welcome to Cakewalk Basics, Session #3. In this segment we will explore some basic editing processes within the piano roll view.

First let’s open the program and choose “open a project.” Demo 1 is the file that was created to help demonstrate some edits in an easy to hear environment. It is located on your samples disk in drive A:

Now play the file.
To open the piano roll view you can use the pull down “view” menu or the view tool bar.
Now let’s consider the velocity of each note. Remember each note has only one “on” velocity and it is independent of all other notes.

You can change the velocity by placing the pencil above or below the current value and striking a horizontal hash.

However, you can also draw changes quickly using the line tool.

Let’s make the phrase crescendo as it goes up in pitch. First, Select the line tool; choose a starting velocity by clicking and holding. Then move to the ending point.

All velocities will change to fall on the line between the two points.
Listen to the sequence now.

You can also free hand shapes for unusual effects. Even though the pencil tool draws a solid shape, the end result is only one value assigned to each note.

This is the result of the free hand.

Next let’s take a look at pitch. In Cakewalk, pitch control is labeled “Wheel” because on most keyboards the pitch bend mechanism resembles a wheel that the player can rock back and forth.
The wheel (or pitch) edit window is located in this pull down menu.

Notice that the numbers to the left of the grid have changed. It is no longer a scale from 0 to 127. The center of the graph or “0” is considered on pitch. All the way to the top would equal a change in pitch of a whole step up, and all the way to the bottom would equal a whole step down.

Let’s add a pitch bend fall to the end of a bell tone using the pencil tool.

The little black circles represent “on pitch”
Now listen to the file

One thing to remember about pitch, volume, pan, and the sustain pedal is that they are just like a home stereo. The setting you choose stays until you choose to move again. If you don’t reset the pitch to “0” after each change, it stays down a whole step for the rest of the sequence.

The next group of edit parameters fall under the controller pull down menu they are located here.

Once you choose controller from the first window, the second window to the right is activated. Now you can move to the second window and choose which controller to edit. Let’s look at volume first.

You can consider the volume controller to be just like your stereo volume at home. Think of it this way. No matter how loud the lead guitar plays on your favorite heavy metal album. You can still turn it up or down. MIDI files work the same way. No matter how high the velocity is for each note. We can still turn them up or down with volume. At first you may think that this is just the same as editing velocity, and in some ways it is, but with this edit we have added growth, or loss in volume during the sustain of the note not just at the beginning of each.

Let’s make some volume changes. When using the pencil tool changes in volume can be free handed. You can also use the line tool to produce very even changes.
Unlike velocity, volume can make changes during the sustained portion of a note, not just at the beginning. You can see the difference by realizing that the shape of the change is filled in with data. This display looks very different than the velocity window. Volume editing is a very important tool to have when you are reproducing believable performances from strings and winds because it allows us to simulate a more natural sounding expression.

Next, we can edit our sequences with the sustain pedal. This is a setting that works just like a piano sustain pedal. The sustain setting also stays where you put it. Let’s add a setting for the sustain pedal to the first rising line.

First we have to change controllers in the pull down menu.
A setting at the top, or above 64, lifts the damper and a setting of 0 dampens the notes.

Now the first phrase will sound like the pedal of the piano is depressed and the sounds will be connected. The second phrase will sound as it did before, separated.

Finally let’s make some pan settings. The pan control allows us to place sounds within the stereo field from left to right (left ear or right ear). If we choose a setting of zero, our sound will only come out of the left speaker. Also a setting of 127 will cause the sound to come from the right. In addition, we can make changes while the sound is playing; this causes the sound to sweep across the stereo landscape from one ear to the other. One thing to remember about pan is that it will not work on some drum set patches. They are already setup with a specific pan setting for each instrument. If you want to change those settings you have to edit the synthesizer’s global settings.

Let’s make settings to add some interest to our file. First we will need to change controller views to pan.
The change needs to be placed slightly ahead of the note. This will allow the computer time to transmit the settings and time for the synthesizer to make the changes. Most modern synthesizers will be very fast. However, older units like my KORG need some help. Also on my older synthesizer, once a note is played, it stays in place. On newer Models a note can be moved at any time.

The first note will sound in the left ear only.

The second will sound in both ears.

The third note will sound in the right ear only.
Listen to your changes.

There is a file located on you’re a: drive that has an edited version of the demo file. It is called “demo 1 completed.” The edits described in this session were completed throughout this demonstration. Open this file and listen to it while you view each of the edit windows: velocity, pitch, and volume, sustain pedal, and pan.

This concludes Session C.
Velocity, Pitch (wheel), Volume, Sustain, and Pan can all be edited on the bottom half of the piano roll menu using the line tool or the pencil tool. Some things to remember are that most of the settings stay where you leave them. If you turn the volume down and fail to turn it up again, in the next section of your piece it will appear that you’ve lost something. Don’t worry, just go back and turn the volume up where you need it again. One of the great things about all of these controllers is that they work individually for each track of information. As long as each track is assigned to a separate channel, you could set up six tracks of different kinds of bells and have them placed in different pan settings and volume settings with their pitches going in different directions at different times. Sounds like chaos to me, but some would call it high art.

Thank you again for taking the time to read this presentation
APPENDIX C

TEST OF PRIOR KNOWLEDGE

AND

POSTTEST
MIDI

Test of

Prior Knowledge

Circle the letter of the answer that is most correct or best completes the sentence.

1. A MIDI file contains which of the following:
   a. A musical recording
   b. Data in WAV format
   c. Recorded sounds from a sound card or synthesizer
   d. An event list that catalogs a performance

2. How many channels are contained in a basic MIDI setup?
   a. 8
   b. 4
   c. 16
   d. 32

3. Which channel does a General MIDI drum set/percussion track reside on?
   a. 1
   b. 10
   c. 5
   d. 16

4. In General MIDI sequencing,
   a. Channel one must correspond to track one.
   b. Track one may be on any channel setting.
   c. Track ten must be on channel ten.
   d. Any track may be set on any channel.

5. In the software design world there are programs that specialize in notation and those that specialize in sequencing. What is the fundamental reason for this?
   a. People who compose/transcribe music are not necessarily interested in hearing a computer performance of their file.
   b. It is very difficult for computers to notate a human performance.
   c. Because of the digital nature of the MIDI file, it does not translate well to notation.
   d. Computer users tend to want either one or the other feature in their software.

6. MIDI data can be transmitted on what type of cable?
a. Any speaker wire.
b. Any signal level audio cable, like a guitar cord.
c. A five-pin Din cable.
d. Both b. and c.

7. A MIDI sequence can control virtually any aspect of a synthesizer's performance except.
   a. Pitch
   b. Left to right panning
   c. External effects
   d. None of the above

8. If I wanted to edit the volume of a single note, I would turn up or down its
   a. Velocity
   b. Volume
   c. It is not possible to edit single notes.
   d. Both a. and b.

9. A MIDI sequencer like Cakewalk cannot
   a. Cut and paste just like a word processor.
   b. Create a stereo mixed audio file ready for CD.
   c. Control your stage lighting.
   d. Synthesize sounds.

10. Which input/output device cannot enter MIDI data into your sequence?
    a. The microphone
    b. The mouse
    c. The keyboard
    d. The synthesized keyboard

11. The toolbar that controls start, stop, rewind, fast forward and record is known as
    a. The Transport
    b. The Player Controls
    c. The Synthesizer Interface
    d. The Now Time

12. This picture represents part of the track window in Cakewalk.
    If the “M” next to the third track is highlighted which of the following would be true?
    a. Only bass and piano are audible
    b. The drums are placed in multi-play mode
    c. Macro is activated
    d. Select Mode is designated
13. In this picture, if any “R” is bright red, it is an indication that:
   a. Record levels are too high
   b. The track must be rewound to hear it
   c. The track is reset and ready to be edited
   d. The track is activated to record

14. Controller data in a MIDI file is concerned with what?
   a. Who is running the show, the computer or the musical keyboard
   b. Nearly every aspect of the performance except note information
   c. Making sure that the Windows operating system knows exactly what is going on.
   d. When a sequence begins and ends

15. MIDI files are different than WAV files because
   a. MIDI files are much larger
   b. WAV files contain digitized audio signals
   c. They are the same thing, but labeled differently for software compatibility purposes
   d. Both b. and c.

16. In a MIDI sequence, tempo can be set and changed
   a. At the beginning of the piece only
   b. Only at breaks between notes
   c. At any time during the piece
   d. Tempo is never set, the music is simply recorded at a different speed

17. The difference between Analog and Digital format is that Digital gives us the ability to freely edit
   a. Key
   b. Duration
   c. Meter
   d. All of the above

18. Program changes allow the MIDI sequencer to
   a. Quickly access other software applications
   b. Turn MIDI files into WAV files
   c. Turn on and off certain tracks
   d. Change the patch or sound that a synthesizer is playing

19. The General MIDI (GM) standard specifies all of the following except
   a. Types of sounds contained in GM instrument mode
b. How controller messages are interpreted  
c. The response of the MIDI instrument  
d. The sounds contained in the user banks

20. Local Control enables the user to  
a. Give control of a synthesizer’s sounds to the computer  
b. Lock out any parameter changes except those made by the computer  
c. Dictate exactly what instruments are heard in a song file  
d. Gives the user the ability to keep other people from changing a new file.

21. Cakewalk and similar sequencers have how many basic record modes?  
a. 1  
b. 4  
c. 3  
d. 2

22. Some sequencers allow you to  
a. Record digital audio alongside MIDI tracks  
b. Record a CD and extract individual instruments  
c. Print notation in score format  
d. a. and c.

23. When comparing tracks to channels which of the following is true?  
a. You can have virtually unlimited channels  
b. You can have virtually unlimited tracks  
c. You can set only one track per channel  
d. Channels are places where data is stored

24. MIDI stands for  
a. Multi Interconnect for Digital Instruments  
b. Multiple Instrument Dual Interface  
c. Musical Interface for Digital Instruments  
d. Musical Instrument Digital Interface

25. MIDI is what kind of language?  
a. System Exclusive  
b. Protocol  
c. Audio  
d. Proprietary
Midi Seminar Post Test

All of the tasks required on the following test will be carried out using the computer workstations. You will not have to write down any answers. Please do not write on this test form. Thank you for your time and participation during these sessions.

1. Open the file labeled Test01 on drive A:
   a. Set up track number 1 for a violin part.
   b. Set up track number 2 for a bass violin part (acoustic bass) and activate it for recording.
   c. Close the file and choose “save changes” when prompted.

2. Open the file labeled Test02 on drive A:
   a. Change the track settings so that a piano sound is used for the first track.
   b. On track number 2, add accents using a velocity of 120 or higher on count one of every measure.
   c. Close the file and choose “save changes” when prompted.

3. Open the file labeled Test03 on drive A:
   a. Copy all of the tracks in the file and paste them twice so that the entire sequence plays a total of three times.
   b. Over the last two measures of track 3 fade the volume setting to zero.
   c. Close the file and choose “save changes” when prompted.

4. Open the file labeled Test04 on drive A:
   a. Change the tempo of this sequence to 80 beats per minute.
   b. Change the meter of this sequence to \( \frac{3}{4} \).
   c. Set up the metronome toolbar to count in for three beats and play only on recording.
   d. Close the file and choose “save changes” when prompted.
5. Open the file labeled Test05 on drive A:
   a. Track 1 is a drum track. Use the correct record setting to add a cymbal part to the track without changing what is already in the track (the cymbal part does not have to be amazing).
   b. Set the “now time” to measure 3 in the track view.
   c. Close the file and choose “save changes” when prompted.

6. Open the file labeled Test06 on Drive A:
   a. In measure 25 insert a tempo change from 105 to 80 on beat one.
   b. Add two pitch bends to the Bass. Don’t forget to return the pitch to zero after each bend.
   c. Close the file and choose “save changes” when prompted.

7. Open the file labeled Test07 on Drive A:
   a. The author of this track is having a problem with her pan settings. She cannot seem to get the piano track to pan right and the bass track to pan left. Try to fix this problem.
   b. Choose “File” from the top pull down menu, and then click on “info”. In the large area provided for text describe the change you made to solve the problem. If you were unable to solve the problem make some suggestions as to the possible reason that this problem may have occurred. Close the window with the X.
   c. Close the file and choose “save changes” when prompted.

8. Open the file labeled Test08 on Drive A:
   a. There is problem with this file. The playback of track one cannot be heard. Try to discover why and fix it.
   b. Choose “File” from the top pull down menu, and then click on “info”. In the large area provided for text describe the change you made to solve the problem. If you were unable to solve the problem make some suggestions as to the possible reason that this problem may have occurred. Close the window with the X.
   c. Close the file and choose “save changes” when prompted.
Now, Close Cakewalk and open the software program titled “Anvil Studio”. This is a multi-track freeware sequencer. It is similar to Cakewalk on which you received your training. Please follow the instructions to the best of your ability.

9. Open the file labeled Test09 on drive A:
   a. Set up track number 1 for an electric guitar.
   b. Set track number one at a volume of 100 and a pan setting of far left.
   c. Set up track number 2 for an electric piano.
   d. Set track 2’s volume to 85, and pan it to the far right.
   e. Close the file and choose “save changes” when prompted.

10. Open the file labeled Test10 on drive A:
    a. Copy and paste the drum track so that it plays twice with no break.
    b. Copy and paste the bass track so that it plays twice with no break.
    c. Close the file and choose “save changes” when prompted.

11. Open the file labeled Test11 on drive A:
    a. Find the piano roll view and add an accent to count one of each measure of the bass part. Set the accent to at least 100.
    b. Change the tempo of the piece to m.m.= 104.
    c. Close the file and choose “save changes” when prompted.

12. Open the file labeled Test12 on drive A:
    a. There is problem with this file. The playback cannot be heard. Try to discover why.
    b. Select the view pull down menu and click on “comments.” Type in a possible cause of the problem, or if you found the problem describe it.
    c. Close the file and choose “save changes” when prompted.
Now, Close Anvil Studio and open the software program titled “Audacity”. This is a
digital audio editor. In some ways it is similar to Cakewalk on which you received your training.
Please follow the instructions to the best of your ability.

13. Open the file labeled Test13 on Drive A:
   a. Use copy and paste to make the sound entire sound occur twice.
   b. Close the file and choose “save changes” when prompted.

14. Open the file labeled Test14 on Drive A:
   a. Add a blank new audio track to this file.
   b. Set the sample rate of the file equal to the first two tracks.
   c. Close the file and choose “save changes” when prompted.

15. Open the file labeled Test15 on Drive A:
   a. Import the audio file labeled IMPORT from Drive A:
   b. Mix the existing tracks together.
   c. Close the file and choose “save changes” when prompted.

16. Open the file labeled Test16 on Drive A:
   a. Add a noticeable echo to the entire file.
   b. Reverse the entire file.
   c. Close the file and choose “save changes” when prompted.
APPENDIX D

DEMOGRAPHIC SURVEY

AND

ATTITUDINAL EXIT SURVEY
MIDI Seminar Survey

Name_____________________  Age_________
Gender__________    Current GPA_________
Year in School _________________    Are you a music major?  YES    NO

1. Estimate the number of hours you spend using the computer per week. _________

2. Do you use a computer daily? (circle one)     YES         NO

3. Have you had any courses in computer technology (circle one)     YES          NO

4. If yes, list the courses you have taken in computer technology.

______________________________________________________________  ________________________________
______________________________________________________________  ________________________________
______________________________________________________________  ________________________________

5. Please list any computer programs you can use effectively, i.e., Word for Windows, Photoshop, etc.

______________________________________________________________  ________________________________
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6. Have you used MIDI related software before this course?     YES         NO

7. If YES, please list the MIDI related software you have used.

______________________________________________________________
8. Have you used digital audio software before this course?  YES   NO
9. Do you consider yourself a PC user or a MAC user? (circle one)  PC   MAC
9. What are the four computer programs that you use the most?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
10. Do you use a computer at work? (circle one)  YES   NO
11. If you answered yes, how often do you use a computer at work? (circle one)

   1  Less than once a month
   2  Once a month
   3  A couple times a month
   4  A couple times a week
   5  About once a day
   6  Several times a day

12. Do you own a computer? (circle one)  YES   NO
13. For which of the following purposes do you use a personal computer? (check all that apply)

   [ ] Word processing
   [ ] Research search engines
   [ ] E-mail
   [ ] Computer assisted instruction
   [ ] Data base management
   [ ] Entertainment / Games / DVD
   [ ] Graphics
   [ ] Programming
   [ ] Spreadsheet
   [ ] Statistical analysis
   [ ] Other  _________________________________________________________

14. How long have you been using computers?  Years ________  Months ________
15. Which do you primarily consider yourself to be?  Vocalist   Instrumentalist
# MIDI Seminar Survey

Please circle the number that you feel best answers the question. Please do not circle between the numbers.

1) How well did the support materials provide information about the software?
   - Poorly
   - 1, 2, 3
   - Very Well
   - 4, 5

2) How prepared do you feel to use MIDI in the future?
   - Poorly
   - 1, 2, 3
   - Very Well
   - 4, 5

3) How well did the support materials prepare you for the tests on the new software?
   - Poorly
   - 1, 2, 3
   - Very Well
   - 4, 5

4) How successful do you feel after completing the training?
   - Not Successful
   - 1, 2, 3
   - Very Successful
   - 4, 5

5) How clearly was information presented in the seminar?
   - Not Clear
   - 1, 2, 3
   - Very Clear
   - 4, 5

6) How well did the presentation of software training material prepare you for the practice sessions?
   - Poorly
   - 1, 2, 3
   - Very Well
   - 4, 5

7) How well did the instructor relay information?
   - Poorly
   - 1, 2, 3
   - Very Well
   - 4, 5

8) Other than the instructor, how well was information presented?
   - Poorly
   - 1, 2, 3
   - Very Well
   - 4, 5

9) How comfortable would you feel using what you learned about Cakewalk on other programs?
   - Not Comfortable
   - 1, 2, 3
   - Very Comfortable
   - 4, 5

10) How have your feelings towards using computers changed as a result of this seminar?
    - More Negative
    - 1, 2, 3
    - Same
    - 4
    - More Positive
    - 5

11) How enjoyable was learning MIDI?
    - Not Enjoyable
    - 1, 2, 3
    - Very Enjoyable
    - 4, 5

12) How often did you return to the support media for help during the practice sessions?
    - Never
    - 1, 2, 3
    - Very Often
    - 4, 5

13) How well did the support materials prepare you for the posttest on Cakewalk?
    - Poorly
    - 1, 2, 3
    - Very Well
    - 4, 5

14) How did the length of practice sessions affect your learning?
    - No Affect
    - 1, 2, 3
    - Great Affect
    - 4, 5

15) If you could change the length of the practice sessions what would you prefer?
    - Shorter
    - 1, 2
    - Same
    - 3
    - Longer
    - 4, 5
APPENDIX E

POSTTEST DATA
## Participant Data Sorted by Group (Ascending)

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<th>PostTest Composite (Raw)</th>
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**Note.** Group: 1 = Computer-Based High School; 2 = Computer-Based High School Pairs; 3 = Paper-based High School; 4 = Paper-based High School Pairs; 5 = Paper-based College; 6 = Computer-based College, TPK = Test of Prior Knowledge

Raw scores represent total number of correct responses. Posttest Composite is the sum of Posttest MIDI, Posttest MIDI Transfer, and Digital Audio Transfer.

Total possible correct answers: TPK = 25; Posttest Composite = 36; Posttest MIDI = 18; Posttest MIDI Transfer = 11; Posttest Digital Audio Transfer = 7
APPENDIX F

ATTITUDINAL EXIT SURVEY DATA

AND

DEMOGRAPHIC SURVEY DATA
# Attitudinal Exit Survey

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**Note.** Group: 1 = Computer-Based High School; 2 = Computer-Based High School Pairs; 3 = Paper-based High School; 4 = Paper-based High School Pairs; 5 = Paper-based College; 6 = Computer-based College

Question numbers 1, 3, 6, 8, 12, and 13 were used to calculate the average located in the right most column. These questions were also used in the Pearson Correlation test for Null Hypothesis 7.
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APPENDIX G

LETTER OF PERMISSION FROM CAKEWALK
September 15, 2007

Carl Jacobson, Marketing Director
Cakewalk
268 Summer Street
Boston, MA 02210

Dear Mr. Jacobson:

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If these arrangements meet with your approval, please sign this letter where indicated below and return it to me in the enclosed return envelope. Thank you very much.

Sincerely,

Scott A. Meier
Assistant Professor of Music
D’Angelo Department of Music
Mercyhurst College

PERMISSION GRANTED FOR THE USE REQUESTED ABOVE:

[Typed name of addressee below signature line]

Date: 9/26/07

Carl Jacobson, Marketing Director
Cakewalk
268 Summer Street
Boston, MA 02210
REFERENCES


BIOGRAPHICAL SKETCH

Scott Meier began his studies at the University of Wyoming, receiving a Bachelor of Science degree in music education. After seven years of teaching instrumental and choral music in the Arizona public schools, he earned his Master of Music in woodwind doubling at the University of Redlands in Redlands, California where he studied saxophone and conducting with Eddie R. Smith. Later, during his doctoral work at The Florida State University he studied conducting with James Croft, Rodney Eichenberger, and Andre Thomas.

Meier is currently an assistant professor of music education in the D’Angelo Department of Music at Mercyhurst College and now resides in Erie, Pennsylvania with his wife, Mary Elizabeth Meier. He teaches applied saxophone, conducts the wind and jazz ensembles, teaches music education and technology courses, and is conducting research in multimedia education and cooperative learning. In addition to his teaching responsibilities, he serves as the coordinator for the annual Tri-State Music Festival and sits on the Board of Directors for JazzErie. Meier also plays professionally with several local ensembles including the Presque Isle Saxophone Quartet (as a founding member), the Dave Stevens Big Band, the Doug Dressler Big Band, the Crossroads Jazz Orchestra (as a featured soloist), as well as the Sivelli Concert Band.