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Learning Music with Technology:
The Influence of Learning Style, Prior Experiences, and Two Learning Conditions on Success with a Music Technology Task

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ABSTRACT

Learning Music with Technology: 
The Influence of Learning Style, Prior Experiences, 
and Two Learning Conditions on Success with a Music Technology Task

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The purpose of this study was to investigate the influence of individual learning styles, music experience, technology experience, music technology experience, and varied learning conditions on participants’ achievement with a music technology task. In phase one of the study, high school students from four Midwest high schools (N = 94) were surveyed about their music experience, general technology experience, and music technology experience using a researcher-designed instrument. The participants also completed the Gregorc Style Delineator, a self-assessment instrument designed to measure dominant learning style characteristics. In phase two of the study, the participants learned to operate music notation software (Sibelius) using one of two learning conditions to which they were randomly assigned: unguided experimentation, or guided learning using a researcher-designed video tutorial. In phase three, the participants completed a timed task with the notation software, the results of which were scored to produce the dependent variable.

Data were analyzed using a five-way analysis of variance in which the effects of the five independent variables (music experience, general technology experience, music technology experience, learning style, and learning condition) on the achievement score were measured. Analysis revealed that none of the main effects or interactions between variable reached statistical significance. Further analysis of sub-scores for specific tasks within the larger set of
tasks did vary significantly between learning styles, with the Abstract Random learning style providing particularly disparate scores.

Conclusions from this study focus on the design of Sibelius as an example of music software that is appropriate for educational applications for students with varied learning styles and levels of experience. The results may be attributed to psychometric and practical limitations of the Gregorc Style Delineator, as well as limitations in time for completion of the activities, and diversity of the sample. Suggestions for further research are offered that include the investigation of gender as a variable in achievement with music technology, as well as physical design of the lab environment and diversification of the sample.
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CHAPTER 1 – INTRODUCTION AND THEORETICAL FOUNDATIONS

On any given Monday, a high school band director is teaching his students to perform *Chester*, by William Schuman, an important work for symphonic band in theme-and-variations form. Prior to the rehearsal, it is likely that he has applied some systematic method for score analysis and study, perhaps a harmonic analysis, melodic chart, thematic analysis, or some system he has developed based on his experiences as a teacher. Some of these techniques can be traced to his recent reading of *Blueprint for Band* (Garofalo, 2000). He has also read some background information about the piece and the teaching issues it implies, such as the conducting analysis by Michael Brown (1993) or the sectional analysis in *Teaching Music through Performance in Band, Volume 2* (Miles, 1998), which also places the piece in an historical context. Based on all of this work, he has made decisions about learning conditions that he thinks will encourage his students to be successful.

The opening section of the piece is a beautiful chorale setting of an American Civil War-era hymn. The ensemble does well with this section, even through the sudden key change and shift from the woodwinds to the brass colors. The students are equally successful with the fairly straightforward variations that follow. Near the end of the piece, the prominent lines are marked with a substantial number of accents. The director notices during the rehearsal that some of the students are not performing the accented notes with any remarkable difference than the notes that are not marked with accents. He decides to stick to his lesson plan and worry about the accent section at another time.
The thoughtful director takes the evening to ponder how to correct this issue. He thinks about his own performance experience and the advice that conductors and applied teachers have given him to make accented notes “stand out.” He consults *Instrumental Music Pedagogy: Teaching Techniques for School Band and Orchestra Directors* (Kohut, 1973) and *Contemporary Instrumental Techniques* (Read, 1976), two texts that he trusts, for advice on how to communicate the idea of accents to his students. He also considers a sequenced approach for implementing this concept into the next several rehearsals and determines that the most efficient way to proceed would be to include accents as a part of the ensemble’s warm-up which usually happens during the first ten minutes of the sixty minute rehearsal. To design these activities, he will apply some of the sequential structures popularized by Lisk (1991) for introducing instrumentalists to tonal and rhythmic patterns in an ensemble learning setting. He also thinks about experiences that he has had before in which individual students’ performance habits have necessitated modification of these types of plans.

In rehearsal the next day, the director begins to implement his plan for addressing the section of the piece that caused his students to stumble. After rehearsing the section, he notices that, while most of the ensemble has grasped the concept, several players are still not executing the section well. He isolates a trombone player who is having difficulty and coaches the student through a manipulation of her tonguing technique to correct the problem. To address the particular “fix” for this student, the teacher sings the rhythm demonstrating an exaggerated articulation. He tells a flute player who is also having difficulty with the accented passage that she needs to control her breath differently and move air faster across the mouthpiece. The teacher demonstrates this by having the student hold her hand in front of her mouth so that she is
more acutely aware of the speed of the air she is producing. He addresses the needs of individual students in order to correct the executive problems because he recognizes that the students all require different types of instruction.

After addressing several members of the band individually, the director leads the group through the accented passage and notices a remarkable difference. By recognizing that students learn differently, and therefore varying the conditions under which students learned, he has arrived at an effective way of teaching a particular skill. His knowledge of the ways in which students perform, coupled with his deep investment in the conditions that will encourage correct performance, have allowed him and his students to reach the performance goals for the day.

* * *

This anecdote is indicative of the processes that music teachers experience on a daily basis and the ways in which individual students’ learning preferences influence instruction. The teacher first planned a rehearsal based on analytical writings and on his own developed sense of the organization of a rehearsal. The teacher was able to call upon existing guides that not only address the concepts he was concerned with, but also the practical techniques recommended for teaching them. He diagnosed a particular skill at which students were deficient, and then identified the precise methods by which that deficiency could be addressed. He drew upon methods familiar to him, and that are considered idiomatic to the instrumental music realm, to attend to the issue. Though music teaching is not as formulaic as this anecdote may portray, through experience, the teacher was able to apply a specific set of curricular and methodological suggestions to the situation at hand. These circumstances, though fictional, are representative of the ways in which practicing music teachers often conduct their work.
The daily practices of music educators are informed by the traditional methods that they learn during their preparatory training and that they acquire through observation and experiences while in service. Teachers in elementary or secondary schools who teach general music, instrumental music, or choral music advantageously draw upon myriad materials and techniques to communicate the skills and particular knowledge of music education. Despite the teacher’s planning efforts, however, the need to modify his plans arose because he recognized that the ways in which some of his students learn required alterations to the learning conditions.

* * *

Later in the day, the teacher goes across the hall to his music technology class, a recent addition to his schedule. In his undergraduate work, over a decade ago, he had one class that addressed the use of technology in music teaching. The major emphases of that course were the use of office-type software for organizing and managing the instrumental or choral music program, and notation software, which at the time looked very different from the software the school purchased recently.

The students in this class are unlike his band students—they do not come to him with a background in classical music performance. Many of them do not read music, nor do they have a desire to do so. Many of them play “non-band” instruments in garage rock groups and want to learn about recording their own music. The teacher recognizes that the things these students do are still musical, despite the fact that they are doing them in a less structured, more informal environment (Green, 2002).

The music technology students have been working on composition projects with sequencing software. They have been experimenting with sounds and have recorded some
preliminary rhythmic tracks using percussion and bass patches. The teacher has decided that
today is the day to teach students to use the quantizing feature of the software which allows the
user to align rhythmically imperfect performances to a metronomic grid. He begins class by
explaining that this is possible using the software tools. He displays the program’s interface
through a project and shows the students where the quantize controls are. He also uses musical
notation on the marker board to show how rhythms may be shifted if they are not recorded with
accuracy. The teacher explains that he expects the students to use the quantizing feature to make
their rhythmic tracks sound “lined up” before they start adding other elements to their
compositions.

As class continues and students begin working independently, the teacher walks around
the room and listens in on student work. He listens to the work of a student who has some
training in the school’s choir and is impressed that the student has grasped the quantizing
technique—the rhythms in her composition approach perfection. Her ideas are simple but
elegant, and meet the teacher’s expectations for the project on which the students are working.
This student, he determines, has been able to use the musical experiences she has amassed over
time and apply them to this particular composition task.

Another student, one without substantial musical training, is having a more difficult time.
The composition demonstrates wonderful originality—the teacher has noticed in earlier lessons
and project work that the student has a gift for creating unique and sophisticated musical
material—but the rhythmic alignment is problematic. Regarding the quantizing tools, he says to
the teacher, “You showed us where it is, but I don’t understand how to use it. And showing all
those musical notes on the board really didn’t help me.”
This student clearly has different instructional needs than does the first student. The background and experiences of the second student have equipped him for different kinds of musical activities, and he requires different learning conditions to achieve similar results. The teacher realizes that the conditions under which the student learned to use quantizing—through explanation and use of traditional musical notation—were not sufficient for this student. Despite his particular abilities to compose with extraordinary sophistication, the methods by which the student learned to use quantizing were not appropriate because of the limitations of his prior musical experiences. The teacher decides that it would be best to sit with the student and demonstrate how the quantizing function could be used to shift rhythms into place. After a few minutes of explanation and demonstration, the second student is able to make effective use of the quantizing tools.

* * *

Increasingly, teachers are being called upon to integrate technology into music teaching, and to do so in ways that maintain musical integrity and emphasize the ideas of national, state, and local standards for music instruction. The difficulty of this pursuit for teachers is that they do not have the same sophistication of training in technology as they do in the traditional areas of general, instrumental, and choral music. The teacher in the above example is an exception to the profile of typical teachers who feel underprepared to incorporate or utilize technology in their teaching (Taylor & Deal, 2003). Teachers such as these not only feel at a loss about the nuances of the technological applications, but do not have access to curricular materials designed to help them teach. Students in technological music learning situations require the same types of adjustments to learning conditions as do those in traditional musical environments.
The teacher in this example has recognized that his technology students are not the same as his band students. The band students are used to learning to perform in a large group. They typically start a piece from the beginning and work toward its end. When they reach a rough spot, they have engrained techniques for addressing the difficulty—they slow down the passage then build up the tempo, for example. The traditional means of teaching an ensemble do not always account for the individualistic nature of learning. In the scenario that opened this chapter, while the strategies that the teacher decided to employ to teach his ensemble to play a particular passage may have ultimately been effective, they were truly centered around the methods that the teacher thought would work best, with little regard for the nature of diversity of the ways in which students prefer to learn. The teacher in this anecdote recognized that the students in the ensemble, as well as the students in the music technology class, required differentiated learning conditions to reach the same objectives.

Among the powerful benefits of learning music with technology is its ability to address individual students according to their distinct learning styles. This study will explore the notion that designing curriculum to account for the learning style preferences of individual students can enhance music learning.

In this study, the ways in which students prefer to learn, along with their musical and technological backgrounds will be investigated. It is proposed that these factors, along with varied learning conditions, may bear an influence on the efficacy of learning musical knowledge, skills, and concepts in a technologically enhanced environment.
Purpose of the Study

The purpose of this study was to investigate the influence of individual learning styles, music experience, technology experience, music technology experience, and varied learning conditions on participants’ achievement with a music technology task. The study was designed to provide information that can help tailor curricula in technologically-based music learning environments to better accommodate for the various learning styles and experiential characteristics that students bring to tasks.

Research Questions

The following research questions were addressed in this study:

1) Given a sample of high school juniors and seniors with experience in music performance, what are the dominant learning styles that students exhibit?

2) What are the effects of music experience, general technology experience, and music technology experience on the achievement of high schools music students in completing a music technology task?

3) How do varied learning styles affect the achievement of students in completing a music technology task?

4) How do varied learning conditions affect the achievement of students in a music technology task?

5) Do combinations of the above-mentioned variables produce significant effects on students’ achievement in completing a music technology task?
Research Hypotheses

The above research questions were operationalized through the following hypotheses:

Hypothesis 1:

In the selected sample of high school juniors and seniors with experience in music performance, there will be a fairly even distribution of learning styles as measured by a particular assessment of that phenomenon.

Previous research provides reasonable support that, given a large enough sample of participants that fall within the prescribed age range for which a learning style assessment is designed, a fairly even distribution of the associated styles will result. Several studies (Cross, 1980; Ester, 1992; Fortney, 1993; Ross, 1997; Thompson & O'Brien, 1991) provide support for the expectation of a fairly balanced distribution when the Gregorc Style Delineator is used to assess learning styles. This instrument will be discussed in chapter 2.

The second and third hypotheses will be stated in the null form. Gall, Gall and Borg (2003) explain this as a statement “that no relationship exists between the variables studied, or no difference will be found between the experimental treatments” (p. 46). Hypothesis 2 includes several independent variables which will be delineated for the sake of clarity.

Hypothesis 2a:

Individual learning style will have no effect on achievement in completing a music technology task.

Hypothesis 2b:

Prior music experience will have no effect on achievement in completing a music technology task.
Hypothesis 2c:

Prior general technology experience will have no effect on achievement in completing a music technology task.

Hypothesis 2d:

Prior music technology experience will have no effect on achievement in completing a music technology task.

Hypothesis 3:

Varied learning styles will have no effect on achievement in completing a music technology task.

These hypothetical statements reference each of the independent variables addressed by the researcher-designed survey form that the participants completed. Through statistical analysis, the effect of each variable on the task completion will be either rejected or not rejected.

Hypothesis 4:

Unguided or guided learning conditions will not cause a significant difference in achievement with a music technology task.

Hypothesis 5:

There will be no significant interaction effects between learning styles, music experience, general technology experience, music technology experience, and learning condition when these variables are considered in combination with each other.

The statistical procedures used will reveal the effects of interactions of the above variables. The five-way analysis of variance displays not only the main effects of the individual
independent variables, but it may reveal the presence of significant differences between groups based on combinations of two, three, four, and five variables.

Defining the Variables

Several variables mentioned in the research questions require clarification. Guidance for definition of these variables comes from the recent dissertation by Meltzer (2001). For the purposes of this study:

1. **Music experience** was measured by asking the students how many years they have been playing their instrument or singing, and by asking them to rate their own level of performance accomplishment on a Likert-type scale.

2. **Technology experience** included all exposure to non-music related computer technologies. Students were asked to rate their own level of comfort with these technologies and to provide a number of hours per week that they make use of these technologies.

3. **Music technology experience** included exposure to technologies associated with creation, manipulation, or distribution of music. This included both consumer-level and professional-level applications. Students were asked to rate their own level of comfort with these technologies and to provide a number of hours per week that they make use of these technologies.

4. **Learning style** will be assessed using the *Gregorc Style Delineator*, a commercial product designed to characterize the ways in which people prefer to learn based on a self-report measurement instrument. "Generically, style consists of outer behavior,
characteristics, and mannerisms which are symptomatic of the psyche and of particular mental qualities. Specifically, an individual’s outer visible style characteristics provide clues as to the inner visible nature and capacity of his psychological and mental makeup” (Gregorc, 2001, p. 1) Chapter 2 contains an examination of various conceptions of learning style and a discussion of some well-known instruments by which learning styles can be measured.

In order to address these variables, the following items appeared on a researcher-designed survey instrument (see Appendix A) given to the student respondents:

Questions related to music experience:

a. How many years have you been playing an instrument?

b. Rate your own ability at performing on your major instrument.

Questions related to general technology experience:

a. How many hours per week do you spend using a computer to do things like typing papers, email, instant messaging, and browsing the Internet, and other non-music related activities?

b. Rate your level of expertise at using a computer for these non-music activities.

Questions related to music technology experience:

a. How many hours per week do you spend using a computer or other technology to do music-related things like downloading music, recording/creating your own music, editing music, or making custom CDs?

b. Rate your level of expertise at using a computer for these music-related activities.
Each “a” question was posed in continuous quantitative scale form to allow the researcher to determine appropriate grouping of the responses. The “b” questions were framed using a six-point Likert-type scale where the low end was marked as “novice” and the high end was marked as “expert.”

**Need for the Study**

This study investigated the interactions of students with computer music applications, and offers suggestions based on the results of those interactions for molding learning conditions to meet student needs. Previous research on students’ interactions with computers in educational contexts is reviewed in chapter 2, most of which is situated in subjects other than music. There is little previous research about those interactions in music education.

There are two general needs that can be met by studying student uses of computer technology in music education. First, the nature of the student as an element in the technology-based environment can be studied with the goal of tailoring experiences to meet student needs. Studying student uses of computers allows for the examination of variations in usage that occur due to individual differences. In the present study, the independent variables address prior experiences in music, general technology, and music technology. Each of these types of experience may influence the ways in which students use music technology applications. It is necessary to investigate the influence that these experiences have on the ways in which students use technology applications so that the practices associated with technology-based music learning can be enhanced. An additional variable in the present study is that of learning style, a construct that may influence the ways in which students approach all learning tasks, not just
those in which students use computers or those that are based on musical content. Assessing learning style may allow us to determine the degree to which differentiation of learning conditions is necessary. Rather than implementing technology based on educational trends, it should be used to improve the ways that students learn in music and in all areas.

Second, the effectiveness of educational software products for students with varying experiences and learning styles can be evaluated. As the role of technology becomes increasingly prominent in the landscape of schooling, it is especially important to study the ways in which students interact with computers so that their learning experiences that are enhanced by technology are effective. It cannot be assumed, because computer applications operate within certain parameters, that all students will interact with them in the same ways. Many factors may influence the interactions that students have with computers in educational contexts. It has been suggested that the design and functionality of applications may influence usage patterns (Beckett, McGivern, Reeder, & Semenova, 1999; Chabay & Sherwood, 1992; Chang, Wilson, & Dooley, 2003-2004; de Oliveira & Baranauskas, 2000). However, designers can only make predictions as to the ways in which software will be used. It is therefore necessary to study software usage in environments that simulate the ecology of education situations.

The Confluence of Music Technology and Education

In the anecdote that began this chapter, the students in both the band class and the music technology class needed instruction that was tailored to the ways in which they learned best. A deep knowledge of subject matter on the part of the teacher allowed such individualized learning conditions to occur. While the present study addresses student use of a music technology
application, the depth to which teachers are familiar with technology, and to which they integrate it bears direct influence on the types of learning conditions they are to able design for their students.

This section will present a conceptualized view of the possible depths of integration. For explanatory purposes, these depths will be known as: (1) the technical plane; (2) the practical plane; and (3) the pedagogical plane. The following section will provide an explanation of these three depths of technological integration.

The Technical Plane

Educational technology has become a popular element in teacher preparation programs across disciplines. Since teacher education directly influences pedagogy, it is appropriate to examine this phase of education and consider its effects on classroom practice. The inclusion of technology into teacher preparation programs may take several forms including an integrated approach (see Bird & Rosean, 2005) which may help to “avoid a situation in which the demands of learning unfamiliar technology… compete with or detract from our other priorities” (p. 226).

The corollary structure is to provide an isolated course that addresses the technology of a discipline and its related sub-disciplines. While not necessarily the best method, many teacher education programs opt for this structure because of its convenience. Lack of training for many faculty members in the uses of technology also influences this decision. Since technology is a specialized area within music education, this second method is most often used.

The technical plane of technology in music education refers to the time when pre-service or in-service teachers learn to use available technologies, and when they acquire fluency with
these technologies. Coursework in technology for music educators is designed to expose them to the tools currently associated with music teaching and learning, and to provide practical advice for the use of technology in the music classroom. If such coursework focuses exclusively on the acquisition of technical facility, then it fails to serve the needs of future teachers to learn to apply technology in educational settings. At this least desirable level, future music educators study technology for its own sake, rather than studying technology as a tool for learning music. Mastery of technical skills is necessary to advance to more sophisticated levels of technology integration. The difficulty, given a limited amount of time, is that many courses in technology for music educators fail to address pedagogical uses of technology, instead focusing on procedural elements of music technology. While this is not necessarily the case in all pre-service coursework, it often applies to courses within the music education curriculum.

The Practical Plane

As music teachers begin to augment their practice with technology, a typical approach to doing so is to use technology as a tool for preparation of lessons. Popular examples of this include using software for creating worksheets and handouts, managing aspects of ensemble organization, and recording rehearsals or performances for review purposes. In the anecdotes that opened this chapter, the teacher made use of notation and drill charting software, which were both examples of practical uses of technology.

While these and others are all valid and acceptable uses of technology to enhance music teaching, they are largely teacher-centered pursuits. Unless these ideas are used with the intention of enriching the instruction of a musical concept, they often fall short of that goal. For
example, while the use of a database program for tracking attendance, instrument and uniform inventories, and students’ personal information may be extremely valuable to a busy teacher, the benefit of doing so does not often impact student learning in any direct sense. Uses of technology such as these are therefore relegated to the practical/pedestrian label because they do not necessarily address directly the delivery of instruction or enhancement of an educational objective.

The value of practical/pedestrian technology uses should not be underestimated—on the contrary, these technological tools are of tremendous worth. The concern is that teachers will claim that they are using technology to enhance their teaching and their students’ learning, when in fact they are simply taking advantage of administrative tools. Furthermore, it is possible that teachers fail to make the transition into the use of technology for teaching because they are not prepared to do so.

The Pedagogical Plane

In the most sophisticated plane of educational technology, teachers use technology to introduce, explain, reinforce, and provide practice with concepts. This practice truly requires a different kind of pedagogy than teaching without computer technology. Teachers who have traversed the pedagogical plane are able to apply educational theory and learning environment design, and employ technology tools while maintaining the integrity of the musical topic at hand.

In the example at the beginning of this chapter, the fictitious ensemble director planned for the success of the student performers, and when they encountered difficulty, he was able to call upon music education theory and technique to design a procedure by which the complex
passage could be mastered. His own training also allowed him to recognize the individual needs of his students in both the ensemble setting and the technology class, and to address students with techniques that were appropriate. His case, however, has been shown to be an exceptional one. Most teachers feel discomfort toward implementing technological means of teaching music, (Taylor & Deal, 2003), and therefore students’ needs may be less adequately met than in traditional music learning settings. The research and practice communities are yet to fully explore the ways in which students interact with technology, and therefore are severely disadvantaged when we attempt to design practical, sequential, educationally sound curriculum for music in a technologically enhanced setting.

Figure 1.1 demonstrates the relationship between the three planes of technological integration.

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*Figure 1.1 The planes of technological integration*
The planes, as described herein, are related to one another and suggest progression from one plane to another. They are depicted in this fashion to demonstrate that they are not necessarily hierarchical, but it is logical to conclude that technical facility is necessary before one can make practical or pedagogical use of technology. Also, while the typical progression may be to move from the Technical to the Pedagogical through the Practical plane, it is possible that teachers will move directly from the acquisition of technical facility to pedagogical integration.

The most important suggestion that can be extracted from this description of the planes of technological integration is that the depth to which teachers integrate technology influences student uses of that technology. If technology integration into the music curriculum is shallow, reflecting only a technical or practical depth of integration, then students may not receive the same benefits from the technology as they would in a situation that involved deeper integration. As described above, pedagogical uses of technology are those that introduce, explain, reinforce, and provide practice with concepts. The larger goals of education are supported through pedagogical uses of technology. Pedagogical uses of technology, however, may vary in their effectiveness, so the interactions that students have with technology must be examined so that they can be refined to reflect appropriate design, sophistication, and features that appeal to individual differences of students.

Reese and Davis (1998) emphasized the amount of planning necessary to integrate technology into music teaching, claiming that selection of software and hardware, use of physical space, and curriculum are all interrelated issues. While this is certainly a logical notion, beyond addressing the standard elements of technology-based music teaching, the authors do not
suggest approaches for daily instruction in that environment. This is the consistent deficiency of literature and work in the area of music technology; the \textit{what} (content) is addressed, but the \textit{how} (procedures) is not.

Further support for the need for development of teaching methods in music technology is found in recent statements of policy from national and federal bodies. The United States Department of Education’s most recent plan for educational technology (2004) states that, although teacher sophistication with technology is improving, “the problem is not necessarily lack of funds, but lack of adequate training and lack of understanding of how computers can be used to enrich the learning experience” (p. 22). This document suggests seven steps for promoting technological integration in education: (1) strengthen leadership; (2) consider innovative budgeting; (3) improve teacher training; (4) support e-learning and virtual schools; (5) encourage broadband access; (6) move toward digital content; and, (7) integrate data systems. Despite the inclusion of improving teacher training in these suggestions, there are no concrete plans offered by the federal leadership to achieve that goal. For those purposes, we must look to documents aimed more specifically at promoting authentic technology use in the classroom.

The National Educational Technology Standards ("National educational technology standards," 2004), which are a set of guidelines developed by a consortium of educational, government, and corporate interests, approach this goal, but do not address any specific content area other than the teaching of computer science. While careful thought has clearly been focused on the infrastructure elements of advancing the cause of integrating technology into education, the human needs such as training, curriculum planning, and creative uses of the technology have been overlooked. Of importance in the analysis of the documents is their failure to address the
student perspective. The problem addressed through this study is the lack of time-tested, logical, sequential, effective methods for learning music in technology-enhanced environments.

The recommendations that come from the national level focus on how teachers’ uses of technology can be improved, but they exclude the pedagogical implications of technology and therefore disregard the needs of students. The foundation of teacher training in technology may be most appropriately based on the needs of students. It is therefore necessary to examine student interactions with technology in music, and in all areas of the curriculum, to improve educational experiences.

**Procedures**

A detailed explanation of the procedures for this study will be presented in chapter 3. In brief, the participants were asked to complete the researcher-designed survey described above, as well as the *Gregorc Style Delineator*, a commercially-published product for assessing the learning styles and personality characteristics of adults and young adults (Gregorc, 1982a, 1982b). Each participant was exposed to one of two learning conditions in which they learned to use the music notation program *Sibelius*. In the first of the two conditions, the Guided condition, participants viewed a researcher-designed multimedia tutorial which guided them through creation of a score in *Sibelius*. A detailed description of the creation of this tutorial will appear in chapter 3. In the second of the two conditions, the Unguided condition, students were given free exploration time to learn to use *Sibelius*. The major theoretical influences for the design of this tutorial came from the ideas of Papert (1980) and Mayer (2001). Both of these theoretical foundations will be explained in detail in the review of related literature in chapter 2.
In the final phase of the procedures, each participant completed a task using the music notation software they learned to use during the learning condition. The researcher collected the products of this final phase and scored them according to a pre-defined scale to measure the sole dependent variable.

Sample

The participants in this study were students from four high schools in Illinois, Indiana and Wisconsin. The participants’ names were collected so that their paper-based survey instrument could be matched with the digital product. For purposes of confidentiality and protection of the participants, the students’ names are not included in any portion of this document. The students who participated in this study were predominantly high school juniors and seniors. This group was selected intentionally so that their ages fit most appropriately with the prescriptions of the Gregorc Style Delineator (Gregorc, 1982a, 1982b).

In order to assemble the sample of participants, the researcher worked closely with a music teacher in each of the four participating schools. The students were selected by their teachers to participate. All of the participants were members of their school’s instrumental performing ensembles—in three of the schools the students were chosen from the bands, and in the fourth the students came from the string orchestra and choir. The participants therefore had substantial experience with reading Western music notation.
Protection of Research Subjects

A complete proposal and description of this study was submitted to the Northwestern University Office for the Protection of Research Subjects. That body found that, since the procedures associated with the study could be considered part of a normal educational protocol, and since the study was to be conducted in established educational institutions, it was exempt from review. The OPRS granted approval for the research to be conducted (see Appendix B).

Experimental Design

Given the factors associated with the design of this study, it can be considered quasi-experimental, a term used by Trochim (2001) to describe quantitative research designs that either do not use a control group or do not use random assignment. The participants in this study were indeed randomly assigned to one of the two learning conditions. However, no true control group was used because each participant group was exposed to a different experimental learning condition. Further explanation of the quasi-experimental characterization of this study will appear in chapter 3.

Limitations

The most important limitation of this study stems from the fact that it is based on the use of technology. The sites where research was conducted had to be equipped with the hardware and software necessary for students to participate in the research activities. Administrative privileges placed on computers in public school lab classrooms placed minimal yet important restrictions on the procedures. The participants for this study were from schools that can be
characterized as suburban or rural, as will be described in chapter 3. The non-random selection of these schools limits the generalizability of the results to samples in other types of environments.

Three important assumptions were established for this study. First, the ages of the participants fell within a reasonably small range. Since the sample was limited to high school juniors and seniors, all participants were between fifteen and eighteen years old. Second, the participants were pulled from ensemble classes of which they are members, so some degree of musical experience was assumed. Also, due to the nature of the task that participants completed, it was necessary for them to be able to read music with reasonable expertise. The school sites were selected, in part, based upon a general impression that the students involved in the school’s ensembles were receiving a music education of which reading traditional music notation is a part.

Chapter Organization

The second chapter will review relevant literature, and will include a discussion of the types of instruments used to assess learning styles. Chapter 3 will outline the methods used in the study including a description of the research sites, and will address the categorization of the study as quasi-experimental. Chapter 4 presents and analyzes the data. Chapter 5 will draw conclusions based on the analysis and will offer recommendations for curriculum and instructional design.
Connection to CSEME Research

Northwestern University’s Center for the Study of Education and the Musical Experience is a group of music education faculty members and doctoral students that works collaboratively to study the nature of musical experience. Investigations include the study of music perception and affect, and focus on many musical roles such as listening, creating, analyzing, and valuing music. Dissertations written by members of the CSEME focus on musical experiences and the ways in which education can influence or be influenced by those experiences.

The example of CSEME research that relates most closely to the present study is that of Daignault (1996) who investigated the use of technology as a mediating factor in composition. He studied the processes that students used during three researcher-defined phases of composition through the use of video footage. While the technology served as a point of interest, Daignault’s study focused more on the compositional process than on the interactions of the students with computer technology—the technology served merely as a convenient way to allow students to complete the task. His third research question, which examined the difference between composition practices of students with and without previous piano experience is similar to the question in this study that addresses previous musical experience and its effect on success with computer music applications.

While the connections between these this study and the present one are modest, they are linked in that they examine, at least on some level, the use of technology as a mediating factor in musical behaviors. With the ever-increasing emphasis on technology as an element of music teaching and learning, it is possible that future lines of research will maintain an interest in investigating technological mediation of other musical experiences such as performing, listening,
or analyzing. Several projects in process have begun to do so, and promise to further the mission of the Center for the Study of Education and the Musical Experience.

**Summary**

The daily practices of teachers are guided by the methods with which they are familiar. In turn, the pedagogical decisions that teachers make are reflected in the learning conditions that they establish for students. In the story that opened this chapter, a teacher was able to call upon techniques and principles that he had been exposed to during his teacher preparation and his formative years as a band director. Fewer techniques were available to him in the technology class, but he was able to adapt learning conditions for a student who required a different kind of instruction. As previously discussed, this teacher represents a minority of educators who would feel comfortable integrating technology into their teaching (Taylor & Deal, 2003). While this is a fictional account, music teaching and learning that occurs with technology is still, to large extent, a haphazard pursuit without established daily methods. To begin to develop those methods, this study examined the interactions that students have with technology in music education, and analyzed the successful achievement of those interactions based on factors of music experience, technology experience, music technology experience, and individual learning styles and preferences. The development of these methods will allow teachers to integrate technology into music teaching in an authentic manner that capitalizes on the special abilities of technology to motivate students and address the challenges of instructional design. The quasi-experimental structure of this study is based on the sample of high school juniors and seniors undergoing varied learning conditions, one of which involves the use of a computer-based video tutorial. The
researcher designed this tutorial with guidance from constructivist ideas, active learning principles, and the foundations of multimedia development for education, as will be explained in chapter 2.
The foundational literature for this study comes from several bodies of research: (1) literature related to learning with technology in general education and the benefits and detriments of this practice; (2) literature related to the design of technology-based music curriculum including current models and trends in the field; (3) literature related to the learning styles including their definition, measurement and implications both in music education and in other areas of teaching and learning; and (4) literature related to specific elements of the method for the present study. This chapter will explore literature in the first three of these areas; literature that supports the methodological choices implemented in this study will be explained in chapter 3. In addition, an important element of this study is the design and implementation of the video tutorial used in the guided learning condition. As such, this chapter will also include an extensive discussion of the theoretical foundations of the design of the tutorial.

Research on Learning with Technology

The basic practice of using computers to enhance instruction has been the subject of a great deal of research during the last few decades. The most common form of technology used in this research is hypermedia, a term that encompasses the electronic presentation of text, images, and sounds in a computer-based environment that offers navigational capabilities for the user, often in a non-linear fashion. Hypermedia can be housed locally within a computer’s storage devices, can be read from a removable device such as a CD-ROM, or can be delivered via the Internet. Regardless of their delivery, hypermedia environments range in their levels of
interactivity and student control, as well as their inherent organizational structures. These organizational formations may have an effect on the value of the learning students experience when using the hypermedia:

The research on organizing tools and system structure indicates that well-defined structures (such as hierarchies) are helpful if the learning goal is to achieve a simple, factual knowledge. . . Ill-structured systems are often beneficial for deep learning, especially for advanced learners. Providing less obvious organizational structures has the effect of challenging the learner to seek coherence within the system. (Shapiro & Niederhauser, 2004, p. 613)

There is little research that compares hypermedia environments to each other, perhaps due to the relative youth of computer-based instruction. Rather, these tools are typically studied in comparison with traditional methods of instruction. The prominence of computer-assisted instruction research literature is evidenced by the fact that several meta-analyses have been conducted to summarize this work. Bayraktar (2001-2002) synthesized the findings of 42 individual studies that each examined the effectiveness of CAI in science education, specifically in physics, chemistry, biology, general science, and physical science. Of those studies, all but one demonstrated significant differences between groups of students using CAI as opposed to traditional instruction methods; each of these differences showed better achievement for the technology group. Bayraktar states, based on the synthesis, that “an average student exposed to CAI exceeded the performance of 62% of the students who were taught using traditional methods” (2001-2002, pp. 178, 180). This study does note, however, that CAI designed to be used in a drill-and-practice mode was actually detrimental to science achievement, and that the
simulation and tutorial software were beneficial. Additional findings of this meta-analysis were that educational conditions in which computers were used as supplemental tools rather than as replacements for human instruction were more beneficial, and that achievement is also negatively correlated with the ratio of students to computers. The meta-analysis by Christmann and Badgett (1999) further supports the positive affects of CAI on achievement in several content areas within science education.

In another meta-analytic study (Bernard et al., 2004), the researchers examined 232 studies on the effectiveness of distance education mediated by electronic communication technology. The researchers included studies since 1985 because they claim that this was the year when technology reached a point of maturity at which it was truly possible to facilitate distance learning with computers. This synthesis examined the effects of computer-mediated distance learning on achievement, attitude, and retention rate of students. They found that distance learning positively effected achievement, but that attitude and retention rates were lower than with traditional instructional methods. All of their findings were statistically significant, but only barely so. It is possible, given the unusually large number of studies included in this meta-analysis, that the findings of the individual studies forced the effect sizes to centralize. Still, achievement, which is the sole dependent variable in the present study, was found to be significantly better in a technologically-mediated environment than in a localized, non-technological scenario.

Finally, Christmann and Badgett (2003) conducted a second meta-analysis of CAI literature that was aimed at synthesizing studies about elementary school students’ achievement in technologically-enhanced learning environments. Their research question was broad, as
research questions in meta-analyses tend to be: “What differences exist between the academic achievement levels of elementary students who were exposed to computer-assisted instruction, and those who were not exposed to this instruction during consecutive years?” (Christmann & Badgett, 2003, pp. 92-93). Based on statistical synthesis of the results of thirty-nine studies, it was determined that the effects of CAI were positive, but effect sizes decreased moderately over the course of the twenty-nine years of literature included in the sample; effect size decreased from 0.727 to 0.361. The authors attribute this decrease to the slight improvements in educational software as compared to the major increases in performance of computer hardware. The meta-analytical technique does not account for changes in other areas of education over time, or for the development of more complex technologies, calling into question of the validity of conclusions based on literature synthesized from such a long time span.

Meta-analyses are statistical combinations of individual studies. Therefore, there are isolated studies that deal with the effectiveness of CAI using a variety of research methods. Though the vast majority of these studies show a positive affect on achievement, some studies demonstrate affects of CAI that are either neutral or negative. For example, Watkins (1998) measured the attitudes and achievement of a sample of 118 college students who were divided between a lecture-based educational environment and a CD-ROM method. Though attitude did not differ significantly between the groups, achievement was higher for the lecture-based group than for the CD-ROM group. This effect could indeed be an attribute of the CD-ROM itself, given the under-developed nature of animation and interactivity in the mid-1990s. In addition, a lecturer could, either consciously or subconsciously, emphasize information that will appear on a measure of achievement. The presentation of information from a CD-ROM is, on the contrary,
consistent. Despite isolated studies such as this one that show neutral or negative effects of computer-based instruction, the vast majority of such studies provide support for the positive influences of technology on instruction, retention, interest, and attitude.

_Curriculum in Technology-based Music Teaching and Learning_

The broad purpose of this study is to explore the effects of several independent factors on students’ achievement with a music technology task. Suggestions for the development of curriculum for music instruction in technologically enhanced teaching and learning environments are by-products of the investigation.

This following section in this literature review is sequenced chronologically by design because the research and philosophical writing about technology is inherently influenced by the development of the technology itself. The early periods of technology education were times of disorganized approaches toward including technology in music teaching and learning. The literature prior to the early 1990s is reflective of this haphazard state (Dorfman, 2003b). Some early literature contributed to the global effort to develop curriculum in technology-based music instruction. At the of time of the publication of the first _Handbook of Research on Music Teaching and Learning_ (Colwell, 1992), the components of technology in music instruction that Higgins (1992) described were very different from what we would recognize as essential to technology today. Higgins reviewed programmed instruction and its connection to technology. Among the other important topics were audio recording, slides, filmstrips, motion pictures, and television. While all of these are still viable components of technology, they are approached differently in current teaching by placing ideas like recording, video, and slide presentations
within a computer-based context. In contrast, Webster’s (2002) chapter from the second Handbook (Colwell & Richardson, 2002) refers almost exclusively to research in computer-based environments. This shift of focus from earlier technologies toward computer-based instruction and production informed the next generation of scholarship and practice.

Willman (1992) suggested, during the formative years of this curricular transition, that music educators who desired to integrate technology into their teaching faced the problem that most software did not provide music instruction; rather, software provided information about or related to musical concepts. He suggested that the correct response to this problem was to choose software that addressed higher-level cognitive skills, that encouraged students to interact within music in a variety of ways, and that placed information in a musical context. Moore (1992) also addressed the trend of the computer becoming the prominent tool of technology-enhanced education in music. Moore suggested a list of music technology competencies that foreshadow those generally accepted today including synthesis, sequencing, notation, multimedia, and lab management. Deal and Taylor (1997) continued this line of suggesting basic competencies for music technology study, but framed their suggestions within the context of college degrees, and therefore within the requirements of the National Association of Schools of Music guidelines. These specific competencies were echoed by Reese and Davis (1998) who said that the processes of curriculum development, determining physical needs, selecting software, and choosing hardware are cyclical in nature; that is, each element of the system of planning for music technology instruction bears directly on each of the other elements.
**Curricular Design Efforts**

Though technology-based music instruction is a relatively young venture in comparison to the traditional methods of music teaching (Mark, 1996; Williams & Webster, 2006), teachers using technology are fortunate to be able to draw on some existing models. Dorfman (2003a) reviewed several efforts toward integrating technology into music teaching; these efforts demonstrated varying degrees of success. Simms (1998) investigated the use of the Miracle Piano, an interactive keyboard teaching system based on a game-like structure, and found that, in a self-guided learning situation, given the choice of progressing to greater levels of difficulty or maintaining a less challenging level, students will generally opt not to progress. Bush (2000) found more optimistic results when he used hypermedia to teach information about steel drum ensembles. He found that students who used the hypermedia system scored better on a test of that knowledge than students who learned the information in a traditional lecture scenario. A more recent study (Welch, Howard, Himonides, & Brereton, 2005) examined the use of real-time feedback in singing instruction with an application called *VOXed*, and found that participants improved in both execution of pitch accuracy activities and understanding of the vocal mechanism. These studies represent the idea of using technology as a substitute for human teachers. The present study explores the possibility of using hypermedia to learn computer music applications, but the researcher does not advocate the removal of human interaction from the teaching and learning situation. By studying the interactions of humans with computers, developers can better understand how to design these interactions. The Simms (1998), Bush (2000), and Welch et al. (2005) studies also represent curriculum design on a small scale; that is, curriculum design as it affects the practices of a single teacher in interactions with a single
student or a small group of students. The present study addresses the design of curriculum from a larger scope with the intention of designing daily procedures that teachers can draw upon in a variety of scenarios.

This section will provide details about the existing curricular materials for teaching music technology. It should be noted, however, that these resources, while extremely valuable for the instruction of musical-technological applications, are generally not associated with any established plans for daily music instruction. These materials are designed to help teachers (and some students) learn to use applications, but do not necessarily imply the types of daily objectives that teachers in the K-12 environment are often required to include in their lesson plans. In addition, while the foundational writing discussed in the previous section was presented chronologically to reflect the developmental nature of curriculum in music technology education, the following section examines resources that have are current, so they will not be viewed in historical context.

Perhaps the most widely known curricular materials for learning to use technology in music teaching are those published by the Technology Institute for Music Educators\(^1\) (henceforth referred to as TI:ME). This organization focuses mainly on the development of curriculum for practicing teachers, and offers certification in technology for music educators. The coursework associated with the TI:ME certification has become an important authority for those who wish to integrate technology into music teaching.

TI:ME certification courses are available in two levels. The Level I courses are general introductions to topics in music technology including notation software, music production

\(^1\) Further information about the Technology Institute for Music Educators can be found at the organization’s official website, http://www.ti-me.org.
software (MIDI/digital audio sequencing), electronic musical instruments, computer-assisted instruction (CAI), electronic communication, and digital media. The Level II courses each address an isolated element from this list in greater depth.

The curriculum is embodied both in the teacher and student workbooks\(^2\) associated with the coursework, and in Rudolph’s (2004) text. There is also a clear emphasis from within the TI:ME organization to align the curricular materials with the mandates of standards by which teachers are held accountable. This idea has spawned the publication of a text designed to explicate correlations between music technology curriculum and several sets of standards (Rudolph et al., 2005). Still, despite their thoroughness and adaptability, TI:ME curricula are generally intended to be used in training teachers rather than for implementation in the school classroom. Only a small portion of the coursework initiated by this organization addresses the development of content for elementary, middle, or high schools that use technology for teaching music.

In addition to the TI:ME curricula, an influential set of ideas in the area of music technology curriculum can be found in the text by Williams and Webster (2006). The hallmark of this text is its focus on emerging technology, and, through the use of finely crafted tutorials, the authors emphasize learning to use computer music applications. It provides a thorough analysis of the many categories of music software and hardware, and in doing so implies the contents of curriculum. In addition, it is clear that the audience for this text is students, specifically those learning to use music software, whereas the Rudolph (2004) text is written for teachers who intend to use technology in instruction. The Williams and Webster (2006) text

\(^2\) The TI:ME workbooks are proprietary materials that are available only to teachers and students involved in the coursework. They are authored by the leaders of the TI:ME organization and are updated regularly.
approaches more closely the aim of the present study. While the Rudolph text has its place in professional development workshops and courses, *Experiencing Music Technology* is about the use of applications for creative and learning purposes. Students in classes designed around this text, or around the ideas behind it, are likely to be immersed in a setting where they not only learn the functionality of software, but learn to use it productively.

As different as the Rudolph (2004) and Williams and Webster (2006) texts and their embedded systems of thought may be, they share some commonalities. The authors, based on their extensive backgrounds in teaching people to use computer music applications, have arrived at a series of important and relevant skills with which people should be familiar after having completed technologically-based music courses. Common elements include: (1) the ability to operate a computer and perform tasks associated with managing files; (2) the use of music production software or sequencers; (3) the manipulation of digital audio; (4) the use of software for music notation; (5) performance with electronic/digital instruments, and; (6) the use of a computer for music learning (computer-assisted instruction). Others have suggested additional elements of music technology: the use of automatic accompaniment software, multimedia development, and design for the Internet (Deal & Taylor, 1997; Watson, 2005). These topics have been widely implemented as well. Hickey (2004) suggested that these areas of competency apply equally well to instruction of students at the K-12 level, for college level students, and for teachers interested in learning technology for music teaching.

The basic content of music technology study, then, is fairly well defined, and has certainly been modified since Higgins (1992) wrote about the important areas of music technology in education. Individual instructors who use technology as a tool in music teaching
are free to accept or reject the ideas of these resources, and to use them as they see fit for their teaching situation. It is extremely important to note, however, that these materials, which are the most prominent in the field, are intended for use in the college-level classroom. This study addresses the use of technology in music teaching at the high school level—an environment largely unaccounted for by these models. Although they may be adapted for the secondary environment, it is clear that both the Rudolph (2004) and Williams and Webster (2006) texts are intended for use at the undergraduate and graduate levels.

Another work in this field, the one edited and compiled by Reese, McCord, and Walls (2002) deserves substantial attention. This text, part of the Music Educators National Conference’s *Strategies for Teaching* series, represents an effort to provide teachers with the type of practical ideas that can be implemented immediately in a technologically-enhanced music classroom, given a modicum of equipment, appropriate facilities, and ample time. The editors have organized a collection of lesson plans and categorized them according to the content areas suggested by the National Standards for Music Education. For example, content standard 4, composing and arranging music within specified guidelines, is addressed using a lesson plan that employs the program *Making Music*. Students are instructed to create pitch rows and then modify them using the program’s arranging tools. Standard 3, improvising melodies, variations, and accompaniments, it is suggested, can be addressed using *Band-in-a-Box* software and relying on student replication of an *ostinato* bass line. Lesson plans are provided that would be appropriate for general music at two levels (grades 5-8 and 9-12), and for performing ensembles at the same two levels. The final section of the book contains lesson plans for secondary non-performing classes such as keyboard and music theory.
To be sure, the Reese et al. (2002) is a valuable resource for teachers interested in using technology in their music teaching. The practicality of the book is very appealing, and its lessons, which include references to prior necessary knowledge, objectives, procedures, and indicators of success, are educationally sound. The troubling part of the text, however, is that the lessons take isolated form. Indeed, teachers think of curriculum in many ways, but the type of curriculum in question for this study is that which is designed to be used over extended periods. Rather than approaching lessons that use technology as secluded from the rest of music teaching and learning, new curriculum designs need to account for music teaching that is based on technology, rather than those that use technology as a novelty that occasionally entices students back into showing interest. Just as the literature of an ensemble experience comprises the basis of its curriculum (Reynolds, 2000), technology-based music instruction can serve teachers and students to create a similar foundation.

Students Interacting with Music Technology

As noted in chapter 1, the need for the proposed study comes from the lack of traditional techniques for teaching music in a technologically-enhanced environment, and the affiliated assertion that by investigating students’ interactions with music technology, we can begin to formulate those curricular ideas. Other researchers have begun to investigate the ways in which students interact with music technology, and how those interactions can be shaped to promote deeper, richer experiences, or to enhance types of instruction usually viewed as “traditional.” Savage (2005) conducted a qualitative investigation with students in the British educational system to determine whether the implementation of technology into a curriculum for teaching
music composition affected the ways in which those students learn. He noted that, in a technologically-enhanced environment, students were able to relate directly to the sounds they used as part of their composition experiments, rather than focusing on academic elements:

Pupils enjoyed exploring the sounds within a pedagogical framework of exploration and discovery rather than in the context of right or wrong compositional choices. But more than this, the technologies themselves brought about a shift of emphasis in compositional enquiry, away from thinking about melody, rhythm or harmony towards an increasing focus on dealing with the sound itself, and its intrinsic value and place in a wider musical structure. (Savage, 2005, p. 171)

Due to the influence of technology, the students in Savage’s study were also able to organize sound and musical structures more efficiently than in an acoustic environment. This advantage of technology use was supported by Stauffer’s (2001) findings. Stauffer followed the development of composition practice of a young girl whose ideas became increasingly sophisticated and, Stauffer asserted, aided by the technology, Morton Subotnik’s *Making Music.* Stauffer said that, due to the technologically-situated nature of the composition sessions,

She could compose easily and fluently, and she could both see and hear her works as she composed them. She could save her works and listen to them whenever she wanted, and consequently, she could refer to previous ideas and build on them in new compositions. (Stauffer, 2001, p. 19)

Stauffer thus recognized the importance of the interaction between the three components of her participant’s experience. Ample time to compose, the technological tools, and the technique of using these tools all led to successful composition in this case study. The participant
received very little formal instruction in how to use the software, yet she achieved a remarkable level of sophistication in her composition. While an examination of the technological tools was not Stauffer’s major concern, she acknowledged the importance of technology in mediating a successful musical experience. She did not go so far as to speculate about whether the student’s achievement would have been different in a non-technology context, but the type of work that the student did would have been entirely different had technological means not been employed.

As previously mentioned, an independent variable in the present study is that of individual student learning style. The theory and assessment of learning style will be discussed in the next section. Because it involves the measurement of both the effectiveness and technology and of student learning style, perhaps the study that comes closest to the present one in terms of its methods and intended conclusions is the one by Fortney (1993). This study investigated the effects of the use of a CD-ROM for music instruction on students with various learning styles. Fortney’s CD-ROM was designed to teach students to recognize musical themes in various contexts and in various types of music. Fortney also investigated the students’ attitudes toward studying music in a hypermedia environment.

Fortney (1993) found that there was not a significant difference in achievement between students of various learning styles as measured both by Kolb’s Learning Style Inventory and the Gregorc Style Delineator. He also determined that students generally had a positive attitude toward using technology to learn musical concepts and content. Learning style was the only true independent variable in the study. Fortney (1995) reported, “While many factors may have influenced the results, a possible reason for this may be that the medium itself accommodates either random or sequential learning modes” (p. 91). This comment exposes a weakness in the
methodology of Fortney’s study; it suggests that in order to garner truly useful conclusions, Fortney should have used a control group in which students learned the same content in a different way. The present study uses two teaching modes to address whether the hypermedia environment accommodates all learning styles.

Hagen (2004) also investigated the instructional efficacy of technology in the setting of group piano class and included cognitive style as an independent variable. By the end of her study, the sample had undergone severe attrition rendering the analysis of several variables impossible. She concluded that there was significant improvement in piano performance across all variations in amount of practice and cognitive style. These results, as she admitted, are questionable when based on the small sample.

**Learning Styles**

The inclusion of learning styles as an independent variable in this study is based on the researcher’s belief that the ways in which students learn affect the interactions they have with technology, and in turn the educational efficacy of those interactions. Learning style, along with the other independent variables in this study, may mediate the effectiveness of computer-based instruction of musical concepts, skills, or information. This section will serve first to define learning styles, and to draw a distinction between learning styles and cognitive styles. Next, this section will provide examples of the types of research conducted in which this phenomenon is used as an independent variable in the music field, in the general education field, and in situations in which technology is an additional experimental factor.
Differentiating between Learning Style and Cognitive Style

A difficult aspect of the constructs that underlie learning style is the often-encountered confusion between learning style and cognitive style. “One of the problems is the way in which different terms are used interchangeably . . . There is no consensus on the use of terminology hence a coherent comparison of results is difficult” (Price, 2004, p. 683). Curry (1983) attempted to clarify the idea of learning styles by organizing the theories that make up the most important thoughts on the topic. Her model, known as the “Curry Onion,” presents learning style theories as a multi-layered figure in which the simplest theories are enclosed by the most complex, as the layers of an onion. As described by Giles, Pitre and Womack (2003), the innermost layer of the model is composed of theories that refer only to measures of personality; the next layer is information processing theories; the third layer deals with social learning theories; the outermost layer is made up of theories that deal with two or more of these concepts. Curry attempted to shed light on the complexities of learning style theory, however, confuses the issue in a later document: “Definitions of operation also vary widely, with loose distinctions between style, strategy, and tactic” (Curry, 1990, p. 51). Even in the most well-conceived and well-written literature, the concepts of learning style and cognitive style are often blended to refer to the same idea, and are often presented in operational definitions that ultimately cloud their precision.

For the purposes of the present study, the term cognitive style is reserved for situations in which the only issue is the processing of information. This construct should be called upon, for example, when examining students’ tendencies to process ideas as large, complex systems, or as component parts. Also, cognitive style may refer to the ways in which learners represent information internally—either as words, images, or other types of symbols.
Learning style, however, is a concept of larger scope that may, in fact, encompass cognitive style (Paolucci, 1998). In an interview, Keefe agreed with the view of learning styles as an overarching construct, and defined learning styles as “characteristic cognitive, affective, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact, and respond to the learning environment” (quoted in O'Neil, 1990, p. 5). While cognitive style refers to internal organization and structures, learning style tends to be related to the exploitation of one’s modalities or perceptions of learning. Pask (1988) calls learning style the “disposition to adopt one learning strategy” (p. 85). Learning style may refer to features of learning such as sequence; that is, students may exhibit learning styles by choosing between randomly presented information to which they will bring order, or more carefully sequenced content. Learning style preferences are typically related to external factors such as information ordering, learning environment, teaching method, amount of interaction, and experience.

This distinction between cognitive style and learning style may be approached from the perspective of a learning scenario within the domain of music. For example, a young clarinet player who is engaged with learning a piece of solo literature can impose both cognitive strategies and learning style tendencies on that task. Learning style tendencies would determine the global approach that the student takes toward the task: the student may choose to be in a quiet environment as opposed to listening to a recording of the piece; she may choose to focus on disparate sections of the piece before linking those sections together; she may change between seated and standing positions or rearrange the location of her equipment. Cognitive strategies will determine the techniques she uses to master the sections of the piece. For example, when she encounters a particularly challenging passage, she may slow to a more
manageable tempo, temporarily modify the articulation patterns or the pitches, or choose to practice fingering the pitch patterns without putting air through the instrument. These tendencies to adopt particular strategies are governed by cognitive style.

Learning Style Measurement Instruments

Learning style refers directly to the individual differences between learners. There is some debate as to whether these differences are biologically predetermined or are shaped by experience. There are many well-known theories of learning style that address this and other issues related to the construct. In order to clarify the arguments that surround learning style, it is necessary to address some of those theories, each of which is associated with an instrument for measuring learning style. While these theories all exhibit qualities that discriminate them from each other, they are similar in several ways: (1) they encourage focus on individuals rather than groups; (2) they examine characteristics, usually based on continua between two polar ends of discrete variables; and (3) they are historically and empirically tested (Dunn, 1990). An initial criticism of most learning style measurement instruments is that they are based on a self-report model rather than a structure in which a teacher or researcher elicits a response in other modes (Veenman, Prins, & Verheij, 2003). The instruments and theories discussed in this section, however, have been validated and tested for reliability so that they can be considered viable measurements of learning styles.

Kolb’s Cycle of Experiential Learning and Learning Styles Inventory

The theory of David Kolb has proven to be popular among those who measure learning styles, as has the instrument associated with his theory, the Learning Styles Inventory (1999).
Kolb’s learning theory is based on a cyclical model of experiential learning, in which students take part in concrete experiences, reflective observation, abstract conceptualization, and active experimentation in a continuous pattern. Davis (1988) further categorizes the cyclical phases into moments of grasping knowledge and moments of transforming knowledge. Those students who demonstrate strengths in particular elements of the cycle of experiential learning are classified as either accommodators, divergers, assimilators, or convergers (see Figure 2.1).

Figure 2.1. Kolb’s Cycle of Experiential Learning with Overlaid Learning Style Labels

Fundamental to Kolb’s beliefs is that learning styles are not fixed entities, but relatively stable behavior characteristics that change over time (Kolb, 1981). The instrument associated
with Kolb’s ideas has undergone thirty years of modification and improvement, which makes it a reliable and valid instrument for measuring the constructs that Kolb has devised, but there is still some debate about the validity of the construct of a learning cycle itself because some types of learning experiences are not accounted for by the model (Coffield, Moseley, Hall, & Eccleston, 2004). An additional criticism comes from Garner (2000) who notes that categorizing learners into only four types, as the LSI does, denies the individualistic nature of learning that Kolb professes. This criticism could truly be aimed toward many measures of learning style. The Learning Styles Inventory was originally created to predict job performance in adults and to match individuals to types of jobs based on their learning style. It may therefore be less appropriate for use in educational settings.

The Dunn and Dunn Model

Rita Dunn and Ken Dunn are prominent researchers in the field of learning styles inquiry; they have published papers, along with several co-authors, that describe their theory of learning styles (Dunn, 1984; Dunn & Dunn, 1979; Dunn, Dunn, & Perrin, 1994; Dunn, Dunn, & Price, 1979; Dunn & Griggs, 1988, 2000). Dunn and Dunn claim that the characteristics of the physical climate in which learning takes place affect student achievement, and that students prefer to learn in varying environmental conditions. Elements such as lighting, ambient noise, temperature, and physical arrangement of space are some components that Dunn and Dunn believe may have an affect on students; this is a unique element of their view of learning styles. Additionally, their model accounts for factors in four other categories: (1) Emotional factors including motivation, responsibility, task persistence and structure; (2) Sociological factors such
as independence or cooperation; (3) Physiological factors such as mobility and time of day; and (4) Psychological factors such as left- or right-brain processing.³

Lovelace (2005) performed a statistical meta-analysis of research based on the Dunn and Dunn learning styles model between 1980 and 2000. She determined, based on the combined results of seventy-six studies that met her criteria for inclusion in the meta-analysis, that students do benefit from instructional models designed with consideration for learning styles based on the Dunn and Dunn model. Carbo’s (1984) meta-synthesis of literature about the effect of learning styles on young students’ reading achievement includes summary statements that refer to the environmental factors included in the Dunn model. Some of her conclusions are: (1) “Research suggests that reading environments should have both quiet sections and sections where soft music is available” (p. 73); (2) “Research indicates that ample opportunities for movement and intake should be provided in the lower grades during reading” (p. 74); and, (3) “Poor readers demonstrate a decided preference for learning in an environment that differs markedly from that of many classrooms” (p. 75).

These statements demonstrate the types of considerations that are integral to the Dunn theory. A strength of this model is that teachers can make immediate changes to the physical environment based on students’ preferences; however, there is little independent support for the claim that modifications to these climate elements have an affect on the efficiency or depth of learning (Coffield et al., 2004).

³ A complete description of the Dunn and Dunn Learning Styles Model is available in graphic and text form at their web site, http://www.learningstyle.net.
The Myers-Briggs Type Indicator

Perhaps the most well-known assessment of learning styles is the Myers-Briggs Type Indicator (MBTI), which categorizes learners along four dimensions: (1) extraversion/introversion; (2) sensing/intuition; (3) thinking/feeling; and (4) judging/perceiving. The fact that this test has been administered so many millions of times supports its reliability (Hardy, 1995), but issues about the validity of these dimensional constructs do exist. There is question regarding whether the dichotomies that anchor these dimensions are true opposites, and therefore whether they are appropriate labels for the dimensions (Coffield et al., 2004). Herman (1994), in her text about planning and organizing the choral music classroom suggested that the personality type labels that the MBTI produces might be a strong foundation for the development of music lessons. This suggestion, however, seems to be based on Herman’s anecdotal experience rather than on any empirical investigation of the personality constructs. Like Kolb’s LSI, the MBTI is most appropriately used with adults to predict job performance.

The Gregorc Style Delineator

The Gregorc Style Delineator (Gregorc, 1982b), the measurement instrument used in this study, is similar to the MBTI in that it relies on elements of personality to reveal learning style preferences. The development of the theory behind the Style Delineator stems from Gregorc’s belief in a philosophy system that he refers to as “Organon” (Gregorc, 1982a, p. v). From this belief system, several principles guide the idea that learning styles should be a serious consideration in examining how people learn. Some of those principles are:
Every human being has universal qualities which are common to all other human beings.... Every human being is unique unto himself—physically, emotionally, and mentally.... Every human being is equipped to realize and actualize both his universal and unique qualities (Gregorc, 1982a, p. v)

These principles guide learning style theorists to explain how homogenous learning approaches fail to address individual differences. Gregorc’s early attempts to design a measurement instrument for learning styles were based on his phenomenological methodology in which he conducted extensive interviews and observations regarding the ways in which people prefer to learn (Gregorc, 1982a). These procedures led to the development of the Transaction Ability Inventory (TAI) in 1978. Its successor, the Style Delineator, is a version of the TAI that has been modified to increase construct validity and reliability. Unlike some other style inventories, the Gregorc Style Delineator (GSD) is designed to measure self-awareness of learning style and preference, rather than predict performance, for example, as it relates to a job (Gregorc, 2001).

The GSD itself is a relatively short test comprised of ten groups of four words. Gregorc claims, based on his study of the work of Carl Jung, that single words can “elicit whole complexes which have an attraction and repulsion upon an individual” (Gregorc, 2001 p. 52), which led him to design the instrument with groups of individual words rather than whole sentences. Examples of the word groups are: (1) objective/evaluate/sensitive/intuitive; (2) perfectionist/research/colorful/risk-taker; and, (3) solid/quality/nonjudgmental/insightful. Several of the terms are clearly outside of the vocabulary of a child, which provides further support for the claim that the test is best suited for adults.
Test-takers rank the words within each group according to how accurately they think each word describes themselves. The ranks are totaled, and then plotted on horizontal and vertical axes, each of which represents a continuum of a single learning style characteristic.

The horizontal axis represents the dimension of order, the extreme left reflecting a preference toward randomly ordered presentation of information and the extreme right representing preference toward sequential ordering. The vertical axis represents the domain of perceptual space with the upper extreme indicating a preference for concrete perception and the lower boundary reflecting a preference for abstract perception. Scores from the measure are plotted on the profile grid. Dominant learning styles are indicated by higher scores. It is, of course, possible for individuals to demonstrate strength in more than one quadrant of the plot, but it is most common to achieve results that exhibit dominance in a single area.

The quadrants that result from the intersection of the horizontal and vertical axes provide four distinct learning types: concrete-sequential (CS), abstract-sequential (AS), abstract-random (AR), and concrete-random (CR). Gregorc’s detailed accounts of the four learning styles describe each according to fifteen characteristics: (1) world of reality; (2) ordering ability; (3) view of time; (4) thinking processes; (5) validation processes; (6) focus of attention; (7) creativity; (8) approach to change; (9) approach to life; (10) environmental preferences; (11) use of language; (12) primary evaluative word; (13) major intolerances; (14) negative characteristics, and (15) observable traits.

There is significant overlap between styles that share scores along a single dimension. For example, concrete-sequential and abstract-sequential learners share similar traits in their
view of time. Gregorc (1982a; 1982b) provides users with descriptions of each of these styles, as follows:

1. Concrete-sequential (CS) learners are more objective than they are evaluative and they value persistence over experimentation. These learners place great care in thoroughness of detail rather than spontaneity. The greatest concerns of CS learners lie with the products of learning rather than with the impractical, risk-taking aspects.

2. Abstract-sequential (AS) learners are evaluative and analytical; they are detached from the situation or topic they are studying. AS learners are characterized by an enormous capacity to synthesize great amounts of data, which they will often seek to support understanding.

3. Abstract-random (AR) learners are less concerned with detail than the previous two types. AR is the most spontaneous of learning styles, often characterized as the “dreamer” style. Gregorc says of the AR learner that “…thoughts and feelings filter his subconscious to his conscious mind without apparent logical reason, motivation, control, or cognition” (1982a, p. 29). This learning style is also noted for its concern with quality of learning experiences over quantity.

4. Concrete-random (CR) learners are intuitive and creative, often viewed as the style of learner best suited for problem solving or trouble shooting. These learners are capable of seeing multiple solutions to problems.

In essence, although there are four resulting classifications, scores on the Gregorc Style Delineator fall along two dimensions. The perception variable falls somewhere between concrete and abstract; and the ordering variable fall somewhere between sequential and random.
The design of this particular study is intended to examine the ordering variable in greater depth than the perception variable for two reasons: first, it is much more difficult to measure the perception variable in a quantitative format because it has to do with the mental processes that individuals impose on information, and second, the ordering variable, in the opinion of the current researcher, may present more fertile information to help to develop curriculum for technology applications in music.

As it relates to a music technology task, such as the notation task used in this study, the ordering variable relates to the procedural order that students adopt in completing the task. A student who tends toward sequential order is likely to maintain a consistent path throughout the task. This could be associated with students who choose to complete note entry for an entire staff before moving on to a second staff. Random order may be associated with students who complete smaller sections before switching to a different part of the task.

An example of a study that uses the GSD for measuring learning styles, Miller (2005) studied the effects of learning style, as well as prior experiences with CAI and with the subject matter (mathematics), on the amount college students could learn through using CAI. In her repeated experimental design, she found that both Concrete Sequential and Concrete Random learners benefited from the CAI structure. In the vast majority of multivariate scenarios in Miller’s study that combined the variables of learning style, CAI experience, and mathematics experience, no significant results were found.

The GSD was tested by its author to support claims of reliability and validity. Gregorc (1982b) lists reliability measurements for the four domains ranging from 0.89 to 0.93, indicating
strong internal consistency. The author also conducted studies to support the predictive validity of the GSD, and found that the results of the test were highly correlated with self-report labels.

Additional concerns have been raised regarding the *Gregorc Style Delineator*. These include: (1) the possible implication that learning styles do not change over time; (2) a lack of clarity of some of the words used on the instrument; (3) the difficulty of empirically testing the validity of the perception variable; and (4) the questionable benefit of the type of self knowledge the test purports to provide (Coffield et al., 2004). Veenman et al. (2003) claim that self-report measures of learning styles, such as all of those discussed herein, are intrinsically flawed because they only reflect the students’ interpretations of their own habits. Schmeck (1988) stated, in relation to this criticism, that, “We can see components of personality only indirectly by observing behavior within varied stimulus situations. We cannot make direct observations of situational influences” (p. 10).

Further information on validity and reliability of the *Gregorc Style Delineator* will be presented in chapter 3 during the discussion of the procedures for this study. While other instruments were considered, the *Gregorc Style Delineator* seems most well-suited because of the characteristics described above, and the fact that it is designed for use with older students.

*Research on Learning Styles in Music*

Little research has been conducted that accounts for learning styles as an independent variable in music instruction. Frequently, when learning styles are discussed in music education literature, they are addressed anecdotally as a factor that teachers should consider in designing instruction and planning for daily activities. This is the case in the pedagogical article by Mixon
(2004) in which the author describes band rehearsals that are designed to accommodate auditory, visual, and tactile/kinesthetic learners. The author could just as easily have chosen a different set of learning style differentiations upon which to base his claims, but he apparently experienced some level of success in organizing his curriculum in this way. This article suggests a method of lesson design that accounts for as many learning styles as possible, and expects students to expand their natural, preferred methods of learning. This practice of matching or mismatching instruction to students’ learning styles will be discussed in the next section of this chapter.

Herman (1994) provided another source that seems to be an anecdotally- or experience-based text about planning choral rehearsals based on students’ personality traits. She uses four dichotomous pairs of personality traits by which to identify students: (1) introversion versus extroversion; (2) sensible versus intuitive; (3) thinking versus feeling; and (4) judgmental versus perceptive. These characteristics are reflective of and similar to those prescribed by the Dunn and Dunn model, though Herman does not make direct reference to those ideas as being influential.

Learning styles have been related to instruction in an ensemble setting. Authors who have addressed the technique of classroom management in the ensemble setting have stressed the importance of appealing to varied learning styles in order to promote desirable student behavior and to retain student involvement and interest (Gordon, 2001; Merrion, 1991; Woody, 2001). Bauer (2001) stated that, “Using a variety of activities and varying the mode of instruction (aural, visual, kinesthetic, or tactile) within any single class period will help to maintain interest and facilitate the different learning styles of students” (p. 30).
From the empirical literature, Moore (1986) investigated “the relationship between curriculum and learner by describing the demands which music composition (as an aspect of music curriculum) places upon specific learning styles conceived as characteristic of the learner” (p. 2). This study, which used the Gregorc Style Delineator as one of its learning style measurement instruments, examined the correlations between intuitive or rational musical ability and the four styles of the GSD. Intuitive musical ability, as defined in Moore’s study, referred to students’ abilities to create musical ideas spontaneously or through improvisation. Rational musical ability was a structured process that involved manipulation of existing musical ideas. Moore found that there were significant correlations between varying learning styles, the methods by which students composed, and their abilities to do so successfully.

Ester (1992) examined the efficacy of teaching vocal anatomy to college music majors of varying learning styles using an interactive CD-ROM or a lecture. Using the Gregorc Style Delineator as the learning style assessment instrument, he found that, for Concrete learners (with either Sequential or Random ordering preferences), there was not a significant difference between the lecture and the CD-ROM. Abstract learners, however, “learned more effectively via a lecture approach than they did when paired with CAI” (Ester, 1992, pp. 99-100). Based on these findings, Ester concludes that the use of CAI in teaching vocal anatomy is in no way harmful, and, that when used with learners of certain styles, can be beneficial. He therefore calls CAI a “viable instructional option” (p. 104) for teaching this content.

Stuber (1997) studied the ways in which teachers’ learning styles affect their classroom behaviors. Learning styles were measured using both the Gregorc Style Delineator and the Myers-Briggs Type Indicator. Specifically, the study investigated the relationships between
Learning styles and time usage, verbal and non-verbal communications, and musical concepts. Stuber collected and analyzed video data in which he captured both experienced and less experienced teachers in the classroom. His results were mixed; that is, teachers varied significantly across learning styles for some specific classroom behaviors within the previously mentioned categories, while for some the differences were not significant. For example, regardless of their learning styles, the teachers in Stuber’s sample were consistent in their uses of non-verbal communication behaviors. However, teachers categorized as Concrete Sequential according to the GSD “mentioned musical expression almost twice as frequently as did the other teachers” (Stuber, 1997, p. 86).

While this study is of interest because of its direct application of the concept of learning styles to music teaching and learning environments, it differs from the current study because it addresses teachers’ learning styles as opposed to those of students. In addition, the sample for the study was quite small (n = 20), which renders the use of both the GSD and the MBTI as questionable.

Matching Instruction to Learning Styles

The issue of using learning styles theory to promote effective learning leads curriculum designers to wonder about the forms of instruction employed in classrooms and whether matching instructional strategies and conditions to learning styles is a desirable approach. Hyman and Rosoff (1993) suggested that students’ learning styles should be examined, then the results of such an examination should be used as a foundation for curriculum and activity design. In addition, these authors suggest that learning styles should be assessed often, perhaps once a
year or more, because learning preference tendencies are in constant flux. This stands quite in
contrast to the learning styles models, for example, of Dunn, Dunn and Price (1979), who claim
that learning styles are biologically inherent characteristics.

Through a meta-analytic review, Baker and Dwyer (2005) provided evidence that
students of different learning styles do indeed exhibit different levels of achievement on certain
types of standardized tasks. They suggest that it is the job of designers to create materials and
curricula that compensate for varied learning styles and promote increased achievement in areas
that are typically weak for certain types of learners. While matching instruction to learning style
may not result in a positive feeling from the teacher because of the work involved with
implementing such an idea (Conwell, Helgeson, & Wachowiak, 1987), this strategy has been
shown to promote higher achievement among students. Teachers are charged with recognizing
the strengths exhibited by certain learners and allowing those learners to exploit the areas in
which they are comfortable, while urging them to develop skills in other types of tasks (Claxton
& Murrell, 1987). Ironically, while many teachers are aware of the individual nature of learning
preferences, they tend to describe their own students according to abilities the students do not
demonstrate, rather than by the strengths they do show (Haar, Hall, Schoepp, & Smith, 2002).

If the strategy of matching instruction to learning styles can promote higher achievement
or other positive benefits, then this approach should indeed be strongly considered as a
foundation upon which to design curriculum. Loo (2004) suggests that the use of multiple styles
is perhaps the smartest way to approach instructional design, and that we should “encourage
students to be receptive to different learning methods rather than try to link specific learning
methods to specific learning styles” (p. 107). While the matching approach has been examined in
certain domains, areas such as music and other arts are basically devoid of such research. Research that addresses certain under-investigated domains, such as music education, may help teachers to accomplish several goals: (1) to be better equipped to assess students’ learning styles; (2) to understand the diagnoses produced by learning style measurements, and the significance of those results; and (3) to understand their own teaching and learning styles and how their instructional tendencies may enhance or conflict with the learning styles of their students. It is the idea of matching instruction to students’ learning styles that inspires the methods used in this study.

**Tutorial Design**

**Theoretical Foundations**

The type of technology-based instruction that was used in the procedures for this study was a tutorial designed for instruction about the use of a particular software application. In this section, the theoretical foundation for the design of the electronic tutorial will be presented.

The modern movement of technology for teaching can be traced to the teaching machines based on Skinnerian programmed instruction. In the behaviorist approaches that underlie these methods, learners were led through a series of steps toward an instructional objective. Feedback would be provided for each incremental stride, but most often, the learner could not progress from one step to the next unless the associated information was memorized or mastered. This method is often called operant conditioning, and “is a form of learning in which the consequences of behavior produce changes in the probability of the behavior’s occurrence”
(Santrock, 1991, p. 173). In conditioning based purely on Skinner’s beliefs, correct actions are reinforced while incorrect actions are punished.

Though behaviorism is largely considered passé, and is criticized for “eliminating the distinction between training… and teaching” (von Glaserfeld, 1995, p. 4), many learning theorists and designers still subscribe to its power and effectiveness in changing learners’ actions. Software that is designed in the drill-and-practice style is a reflection of the lasting effects of behaviorist educational psychology.

Early computer programs were patterned on the principles of programmed instruction; subsequently, computers earned a reputation as rigorous (but elegant) drillmasters. The drillmaster software concept remains today; in many ways, it has forced computers into the role of modern-day teaching machines. (Taylor, 1988, pp. 52-53)

Newcomb (1988), in his criticism of the advances of the educational software market suggests that drill-and-practice software has maintained its popularity because the software itself does not need to be designed intelligently; that is, there is not much need for an “understanding” of the content, only the ability to react to correct and incorrect responses.

Despite the existence, and indeed the popularity of drill-and-practice software that is reflective of behaviorism, educational software has progressed beyond this antiquated use. Additional types of educational software have appeared based on newer theories of teaching and learning, including those that account for cognitive and constructivist learning models. Gibbs, Graves and Bernas state that “Computer-based instructional courseware is… generally thought to fall into one of the following categories: drill and practice, tutorial, simulation, instructional game, and problem solving” (2001, p. 2). Their article also contains a set of criteria and
guidelines for the evaluation of educational software, a topic that is beyond the scope of this paper but would be a worthy pursuit for music educators. It has been suggested that drill-and-practice software can still be beneficial for music learning, especially when it is combined with technologies that are designed with regard for newer theories of learning, and that capitalize on the latest technologies (Deubel, 2002).

The development of modern computer-assisted learning environments is perhaps most closely related to two theories of learning and engagement. The first is constructivism, which is based on the idea that all knowledge is built, or constructed, when learners undergo experiences and piece together information from previously existing knowledge (Bransford, Brown, & Cocking, 1999; von Glaserfeld, 1995). This theory has its roots in the work of Piaget, who claimed that young learners pass through developmental stages at which they are able to perform certain types of cognitive tasks, and that the tasks grow more complex as the stages progress (Hargreaves, 1986; Miller, P., 1989). Software that honors these ideas generally does not fall into drill-and-practice category; rather, it can be grouped with titles categorized as simulations, games, or problem-solving models (Gibbs et al., 2001). Software based on constructivist ideas allows the user to derive some meaning from the experience of using it, which is not typically a result of drill-and-practice software. Some designers take a hybrid approach by capitalizing on many of these techniques. This seems to be directed at the idea that, as mentioned above, students exhibit widely varying learning styles and preferences.

Second, and closely related to the theory of constructivism, is the idea of active learning with technology. Among the educational efforts that have been based on active learning with technology are those by Seymour Papert, who designed computer applications for learning
geometry and other mathematical domains, typically in an individualized setting. In brief, Papert believed in allowing students the opportunity to construct objects in individualized environments in which they achieve self-directed goals (Solomon, 1986). Papert wrote of his visits to two schools,

If the kinds of computer experiences we have seen… penetrate into everyday life, children will learn the kernel of these bodies of knowledge in the same natural way as they now learn the spoken language (in its colloquial dialects). Then school, defined as a place where the three R's are imposed by force (or by the kind of subterfuge called "motivation" which is just bad), will no longer be necessary. Society will be able to face the task of inventing environments in which the children can develop as social, loving, honest human beings without distorting this goal by the crudely technical one of stuffing the multiplication tables into their heads. (Papert, 1982, p. 41)

Papert explained his theory of active mathematical learning through programming in Mindstorms: Children, Computers, and Powerful Ideas (1980), in which he predicted that the development of computing power would make technological approaches to teaching and learning dominant forms of education.

Papert has said that he was making an instrument for teachers to teach with and that he would like it to be judged as an instrument for teaching in the same way as how teachers would decide what poetry to teach or what textbook to use. (Solomon, 1986, p. 130)

Later, Papert (1993) vented his frustrations about the slow adoption of computers into the educational landscape. He claims that despite both empirical and anecdotal evidence that completing tasks in a technological-educational environment has positive effects on students’
learning and achievement, the regime in control of School\textsuperscript{4} resists change and denies the appropriateness of computers in schools. Clearly, forces other than bureaucracy influence the uses of computers in schools, but this was Papert’s major concern in his 1993 book.

The development of modern, sophisticated educational software can, to an extent, be traced to the efforts of Papert and theorist-designers like him. Logo, as an example of simulation-based software, is clearly foundational in the thinking and programming of Edelson, Gordin and Pea (1999) who claim that technology lends itself quite naturally to the type of inquiry-based discovery learning associated with constructivism and active learning. Computers, in their assessment, address the five major challenges of inquiry-based learning: (1) motivation, (2) accessibility of investigative techniques, (3) provision of background knowledge, (4) management of extended activities, and (5) the practical constraints of the learning context (Edelson et al., 1999).

\textit{Mayer’s Multimedia Learning}

Mayer’s (2001) work represents the shift in educational philosophy that the profession has undergone since the prime of the behaviorism movement, and has truly served as a guiding set of principles for the aspects of this study that deal with multimedia learning. He presented a cognitive theory of multimedia learning that is based on three assumptions: (1) Humans possess discrete channels of visual learning and auditory learning, and designs should consider the distinction; (2) Humans have limited capacity for the amount of information they can process in each channel; and (3) Humans engage in active learning by organizing incoming information.

\textsuperscript{4} Papert’s use of the uppercase “S” in this term is intentional. It is meant to refer to the large entity of School, or the bureaucratic control over education that he observes.
Mayer’s work espouses several principles upon which multimedia designs may be based, all of which are rooted in human cognitive abilities.

Mayer proposes that there are two views of the design of multimedia products for education. The technology-centered view focuses on integrating the newest technologies into educational artifacts. “Instead of adapting technology to fit the needs of human learners, humans were forced to adapt to the demands of cutting-edge technologies” (Mayer, 2001, p. 10). The learner-centered view emphasizes the experience of the student. “The focus is on using multimedia technology as an aid to human cognition” (Mayer, 2001, p. 10). He clearly favors the second, student-centered approach. Mayer suggests that learning designs should be based solely on the ways in which the human mind functions, and that they should recognize the multiple modes in which the mind can receive information: as text, as graphics, and as aural data. He calls these the channels through which humans can learn. Mayer also claims that multimedia designs should apply several principles to make learning more effective:

1. The multimedia principle states that “Students work better from words and pictures than from words alone” (p. 63). Given this, the designer must determine the appropriate physical distance between pictures and associated text. Mayer claims that there is evidence supporting both proximity and distance between the two related elements.

2. The coherence principle states that “Students learn better when extraneous material is excluded rather than included” (p. 113). This principle addresses the temptations of many multimedia designers to include vast quantities of
information, rather than filtering the amount of information to only the relevant amount.

3. The modality principle states that “Students learn better from animation and narration than from animation and on-screen text; that is, students learn better when words in a multimedia message are presented as spoken text rather than as printed text” (p. 134). This principle suggests that designers take full advantage of the powerful elements of multimedia presentation.

4. Finally, the individual differences principle states that “Design effects are stronger for low-knowledge learners than for high-knowledge learners, and for high-spatial learners than for low-spatial learners” (p. 161). This principle relates directly to one of the purposes of this study, to investigate the power of multimedia for learners of varying types and preferences, and for learners with differing experiences.

Though Mayer does not refer directly to the concept of learning style as influential in his principles, clearly the ideas of individual preference and learner characteristics, as well as their implications on achievement have been strongly considered in Mayer’s work. Specifically, the individual differences principle is based on the idea that learners exhibit strengths and weaknesses in spatially-oriented tasks, and that learners can be categorized as low-knowledge and high-knowledge. Mayer describes specific techniques for targeting learners in all of these categories, but claims that well-designed multimedia messages should be effective for many types of learners.
Where possible, the ideas of constructivism and active learning have guided the development of the tutorial used in this study. In the physical construction of the tutorial, design decisions were based on these general considerations, as well as the more specific advice of Mayer’s four principles. Clifford (2005) suggested that design of multimedia environments that follow guidelines such as the ones described above can appeal to students of varying backgrounds and levels of experiences.

**Summary**

Several salient points can be extracted from this review of literature. Each of these points has had an impact on the design and purposes of this study.

1. A shift in curriculum development in technology-based education occurred in the early 1990s. That shift resulted in the majority of curricular efforts emphasizing several areas of competency that are fairly consistent across the range of technologically-infused designs, and emphasizing technologies that are computer oriented.

2. A large amount of the literature that addresses integration of technology into music teaching deals with individual instances of that integration, rather than addressing the goal of creating curricula that can be implemented for large numbers of students in varied learning environments, and addressing conceptual knowledge.
3. Prior attempts at researching the influence of learning styles on music learning with technology have failed to address the broader issue of the *application* of teaching methods to technologically-enhanced music learning environments.

4. The differentiation between learning style and cognitive style is difficult and important. Researchers who include either cognitive style or learning style as a variable in their studies often incorrectly identify which construct they are truly addressing, and are inconsistent in their uses of the appropriate terminology.

5. Though a variety of learning style theories and measurement instruments exist, each is based on a different set of ideas as to what constitutes learning style. Each instrument is therefore appropriate for certain situations, but may not be suitable for others. Given the methods and sample of this study, the *Gregorc Style Delineator* comes closest to measuring the learning style variable for the particular sample.

6. Theoretical bases for the design of multimedia learning environments can be traced to general educational psychology. Constructivism, active learning, and foundations of multimedia development lead to the conclusion that well-designed digital learning environments should address the capacities of human beings to learn in a variety of ways.

This chapter reviewed the literature that serves as a foundation for the development of the present study. The broad goal of the study is to suggest curricular methods for use in the K-12 environment for teaching music with technology. This section presented literature that defines the content of music technology study, largely for use in coursework with in-service or pre-
service teachers. While these sources are indeed valuable for advancing the music technology knowledge base of education professionals, they do not address the nature of teaching music in a technologically enhanced K-12 classroom scenario. Also addressed in this chapter were the areas of technology as an educational tool, and the foundational ideas and measurement of learning styles. Learning style serves as an independent variable for the present study. The complexity of learning styles and the controversial nature of their measurement and application to teaching necessitated an in-depth discussion, including a justification for the selection of the *Gregorc Style Delineator* for use in this study.
CHAPTER 3 – PROCEDURES

This chapter contains a detailed explanation of the procedures used in the design of the present study. It includes sections regarding the testing of the tutorial video, the selection of the sample, the experimental design, the activities in which the participants engaged, and the collection and recording of the data.

Purpose of the Study

The purpose of this study was to investigate the influence of individual learning styles, music experience, technology experience, music technology experience, and varied learning conditions on participants’ achievement with a music technology task. The study was designed to provide information that can help tailor curricula in technologically-based music learning environments to better accommodate the various learning styles and experiential characteristics that students bring to tasks.

Research Questions

The following research questions were addressed in this study:

1) Given a sample of high school juniors and seniors with experience in music performance, what are the dominant learning styles that students exhibit?

2) What are the effects of music experience, general technology experience, and music technology experience on the achievement of high schools music students in completing a music technology task?
3) How do varied learning styles affect the achievement of students in completing a music technology task?

4) How do varied learning conditions affect the achievement of students in a music technology task?

5) Do combinations of the above-mentioned variables produce significant effects on students’ achievement in completing a music technology task?

As will be described in the following pages, students were selected by the teachers and randomly assigned to one of two groups. Data were collected using a researcher-designed survey instrument, which addressed the independent variables of music experience, general technology experience, and music technology experience. The Gregorc Style Delineator was used to measure learning style. Each student, based on the group to which he or she was assigned, experienced either a guided learning condition using a video tutorial, or an unguided condition during which time they experimented with Sibelius notation software. The assignment of the groups to the conditions was done by random selection. All students then completed a music notation task, scores for which produced the dependent variable.

Data from this study were analyzed using a five-way analysis of variance to investigate both main effects of and interaction effects between the five independent variables on the dependent achievement score. Both the procedures and the experimental design will be presented in detail throughout this chapter.
Instrumentation

Survey Instruments

Gall et al. (2003) suggested that when collecting data with a questionnaire, the instrument should be tested through the use of a pilot study. There were two paper-based instruments used in this study. The first was a researcher-designed instrument that merely collected demographic data to establish the independent variables of music experience, technology experience, and music technology experience (see Appendix A). The reliability of survey-based research is enhanced by following several general guidelines. Several sources on conducting survey research suggest that prior to developing the survey instrument, the researcher must develop a clear, sound experimental design, and a refined set of research questions that specifically address the issues under investigation (Fink, 2003; Nardi, 2003; Rea & Parker, 1992; Weisberg, Krosnick, & Bowen, 1996). The researcher followed this procedure prior to designing the instrument. Additionally, the length of a survey may affect its reliability (Porter, Whitcomb, & Weitzer, 2004). In order to promote the reliability of this instrument, it was intentionally written as briefly as possible. In lieu of a full pilot study, the survey was examined by several independent researchers who evaluated it for its clarity.

The Gregorc Style Delineator—Validity and Reliability

The second instrument was the Gregorc Style Delineator. There is contradictory evidence related to the reliability and validity of this test. Gregorc has published reliability and validity data for the instrument (Gregorc, 1982a, 1982b). He reported the internal consistency reliability ranging from 0.89 to 0.93 for the four learning style scales (1982b) as described in chapter 2. In
addition, Gregorc tested the “stability, repeatability, or the degree to which a second test predicts the first” (Gregorc, 1982b, p. 18). Correlation coefficients for this test-retest reliability ranged from 0.85 to 0.88. These results indicate significant and strong reliability for the GSD.

In addition, Gregorc studied the predictive validity of the instrument, or its ability to predict subjects’ self-ratings when presented with the constructs and characteristics that the test is intended to measure. Gregorc found that correlations between the results of the GSD and the self-ratings of 110 participants were moderately strong, ranging from $r = 0.55$ to $r = .76$. He therefore concluded that the predictive validity of his test was acceptable. Furthermore, Gregorc found that fifty-eight percent of the participants agreed with the classification ascribed to them by the GSD, while only one percent disagreed with their classifications.

Despite Gregorc’s attempts to validate his test and to provide reliability data, there are those who have been critical of the instrument. Joniak and Isaksen (1988) studied the internal consistency of the GSD and its relationship to another measure of learning styles, Kirton’s Adaptive-Innovative Distinction. While the second topic of their research is irrelevant in the context of the present study, in terms of the internal consistency of the GSD, they found lower coefficients (0.23 to 0.66) than did Gregorc. They recommended reanalysis and revision of the instrument.

O’Brien (1990) studied the internal consistency of the GSD. He was interested in “how well each of the four cognitive styles are defined by the items contained in the instrument” (O’Brien, 1990, p. 632). The results of his investigation yielded alpha coefficients ranging from 0.51 to 0.64 for the four learning styles. He concluded the following:

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5 O’Brien uses the terms cognitive style and learning style interchangeably.
The findings of this study suggested that while the four separate scales meet minimal requirements for factor definition and may have some practical utility, only three of the four could be considered defensible measurement models. Also, it was clear that the overall measurement model was incongruent with Gregorc’s theoretical model and that any speculations beyond the four separate scales are unsupported by these findings. (O’Brien, 1990, p. 636)

Sewall (1986) analyzed the GSD along with the Myers-Briggs Type Indicator, the Kolb Learning Style Indicator, and the Canfield Learning Styles Inventory. He points out several methodological weaknesses in the studies Gregorc conducted to support the reliability and validity of his instrument. He acknowledges the same strengths of the test that supported its selection for the present study, but concludes the following:

“Because of all the shortcomings… the **Gregorc Style Delineator** appears to have little practical value to the individual seeking a better understanding of their personal learning style… Until considerably more statistical support for the scale becomes available the instrument should probably be used strictly for research purposes” (Sewall, 1986, p. 54).

Finally, an unavoidable difficulty that the GSD presents is that it is possible for respondents to indicate two dominant learning styles. The presence of results that indicate more than one dominant learning style causes difficulty in analyzing data. The statistical adjustments for this factor used in this study will be explained in chapter 4.

For the purpose of the present study, the researcher concedes that there are criticisms of the **Gregorc Style Delineator** that point to important theoretical, psychometric, and methodological limitations. Despite these issues, the test continues to be a popular choice among
researchers interested in measuring dimensions of self-knowledge about learning style tendencies. As discussed in chapter 2, the brevity and ease of scoring made the GSD a feasible choice, as did its appropriateness for the age group of the sample. Also, its focus on self-assessment as opposed to a predictive or prescriptive emphasis made the GSD a good match for measurement of learning styles in the present context.

**Video Tutorial Design and Testing**

*Applications of the Guiding Theories*

The previously discussed theories of learning and multimedia design were applied as closely as possible to the development of the tutorial used in this study. Since the multimedia artifact was indeed a tutorial (rather than a simulation, game, or drill-and-practice), some of the ideas were not entirely germane to the process, but general notions of design and learning theory dictated the design nonetheless.

Constructivist concepts governed the entire selection of the research topic and the selection of the sample. The students involved had substantial experience with music performing, and presumably with reading and writing standard musical notation, and the tutorial and the technology task capitalized on their abilities with these modes of musical behavior. The participants were able to use their traditional skills in reading and writing music, coupled with their technological skills, to produce notated music through technological means.

Active learning theory dictated some of the elements of the tutorial. Rather than being a completely passive product, the tutorial capitalized on one of the inherent qualities of multimedia, the ability to solicit user response. Embedded within the tutorial were moments
when the user was responsible for answering questions about the content of the tutorial, or simply asked to click a button to continue to the next step. These simple elements help to maintain the focus of the tutorial viewer, and to ensure that the user is retaining the information that the tutorial presents.

Mayer’s (2001) multimedia principles guided the entire development process. His first principle, that the use of text and sound is better than the use of text alone, led to the use of voiceover narration throughout the whole tutorial. The coherence principle guided decisions about exclusion and inclusion of elements of the tutorial; that is, no extraneous information was added. The modality principle led to the use of animation in conjunction with text, still images and voiceover narration. The individual differences principle influenced the experimental design of this study.

**Pilot Testing**

The tutorial video used in this study was an original artifact that the researcher created, as described in chapter 1. In order to insure that the video was understandable and valid, it was pilot tested. Three undergraduate music education students from VanderCook College of Music in Chicago, Illinois were selected to view the video, all of whom had been taught to use *Sibelius* by the researcher during their regular coursework, and were high-achieving students as determined by their grades in Music Technology class. The students were asked to watch the video on their own time and to try to view it from the perspective of someone who had little to no experience using computer music applications. It was also explained to the pilot participants that the actual
research participants would be expected to use Sibelius to construct a score immediately after watching the video. The three pilot participants responded to the following prompts:

1. How clear were the procedures in the video? Were there any confusing spots?
2. Were there specific ideas that were not in the video that you think would be important in building this score?
3. How well do you think you would be able to build a Sibelius score after watching this video, assuming that the score contained almost the same elements as the one in the video?
4. Were there any technical glitches or problems with the video?
5. About how long did it take you to get through the video?
6. Are there any other comments that you think might be helpful?

The students selected to participate in the pilot phase provided responses to these open-ended questions via email. Their responses allowed the researcher to identify several small content errors in the video. Questions two and three above refer specifically to the content validity of the video; that is, they address whether or not the video explains the specific procedures that participants would be asked to carry out during the phases of the research. The respondents suggested some minor changes to the spoken soundtrack for the video including adjustments to compensate for fluctuations in volume. The pilot participants commented that they appreciated the multi-channeled elements in the video such as the reinforcement of ideas through color highlights, and that the pacing of the video was appropriate and easy to follow. They stated their opinions that a novice Sibelius user would likely feel comfortable using the program after viewing the video. Their experiences watching the video ranged from 17 to 20
minutes. The students also viewed the video on both Macintosh and Windows platforms, confirming compatibility of the Flash-based movie across operating systems.

Sample

The researcher was provided with a list of possible research sites from Sibelius USA, the manufacturer of the software used in the study. The manufacturer’s list contained ten schools that had purchased laboratory installations of the most recent version of the software, or of the version prior to that.

The sample of participants was chosen to be representative of high school students with substantial training in musical performance, either in choral, band, or orchestral ensembles. The accessible population from which the sample was gathered was comprised of high schools in the states of Illinois, Indiana, and Wisconsin.

The sample frame from which the participants were selected for this study was determined through analysis of several factors:

1) Students were included if they attended a school that had a laboratory installation of the appropriate software titles.
2) Students were included if their music teacher was willing to allow them to participate in the study.
3) Students were included if they were in their junior or senior year of high school.
4) Students were included if they had substantial (at least two years) experience performing on an instrument or voice.
Of the ten schools that Sibelius USA listed, four met all of the criteria described above and were willing to participate in the study. Though not ideal for the generalizability of the results of the present study, selection of these schools was purposeful and non-random. These schools are depicted in greater detail in the next section.

*Participating Schools*

Portage High School (Indiana) and Watertown High School (Wisconsin) are located in areas that display characteristics of both suburban and rural environments. All four schools have populations that are predominantly white and wealthy. Adlai Stevenson High School (Illinois) and Lake Zurich High School (Illinois) are located in clearly suburban areas. The original intention was to collect data from thirty participants at each school, for an $N$ of 120. Due to scheduling conflicts and student availability, the $N$ for the study was 94.

All four schools have reputations in their respective state school music associations for their excellence in ensemble performance. Demographic figures for each of the four participating schools are listed in Table 3.1.
Table 3.1

Demographic Data for Participating Schools

<table>
<thead>
<tr>
<th>School Name</th>
<th>Total Enrollment</th>
<th>Percentage of white students</th>
<th>Percentage of students from low-income families or eligible for free/reduced lunch programs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Portage H.S. (Portage, Indiana)</td>
<td>2385</td>
<td>82</td>
<td>2</td>
</tr>
<tr>
<td>Lake Zurich H.S. (Lake Zurich, Illinois)</td>
<td>2124</td>
<td>92</td>
<td>3</td>
</tr>
<tr>
<td>Adlai Stevenson H.S. (Lincolnshire, Illinois)</td>
<td>4568</td>
<td>80</td>
<td>2</td>
</tr>
<tr>
<td>Watertown H.S. (Watertown, Wisconsin)</td>
<td>1427</td>
<td>91</td>
<td>13</td>
</tr>
<tr>
<td>Mean</td>
<td>2626</td>
<td>86.25</td>
<td>5</td>
</tr>
</tbody>
</table>

Based on these data, the four schools clearly fit the description of large, wealthy, predominantly white schools. While the homogeneity of the demographics may represent a confounding factor in this study, it was necessary to select participant schools that had computer labs and successful ensembles. This limitation will be discussed further in chapter 5.

Teacher Contacts

Each of the teachers who agreed to have their students participate in the study are responsible for directing an ensemble and are also involved in teaching classes in their school’s computer lab. This involvement in technology led the teachers to have a vested interest in

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6 These demographic data were found using the web site http://www.greatschools.net/.
exploring the ways in which their students learn to use music technology, and therefore in the results of the study. The initial contacts with each of the teachers were designed to explain the nature of the study and predictions of what might be found through conducting a study of this sort. The description piqued the interest of the teachers because it was presented in a practical sense as a study that might directly affect the ways in which they approach their technological music teaching.

Each of the teachers has also been involved in graduate study in music education or educational leadership, and therefore understands the intricacies of collecting data in a school setting. All four teachers were extremely supportive and helpful in arranging data collection visits.

During the initial contacts, each of the four teachers suggested dates and times during which the researcher would be able to come to the school for the data collection sessions. In each case, students were released from their regular ensemble class to complete the sessions. The teachers were told that participants needed to be juniors or seniors in high school who were members of the ensembles. The cooperating teachers also assured the researcher that very few of the students who would participate in the study had any substantial prior training with Sibelius.

The teachers selected the students to participate based on their knowledge of the students’ backgrounds. Two of the teachers selected students based on instrumentation so that their ensembles could continue to rehearse with intact sections while the research was being conducted. Though this was not an ideal method to gather the sample, the priorities of the cooperating teachers needed to be respected, so the researcher worked with the teachers to arrange for acceptable numbers of students to participate in the study. Students were given the
opportunity to decline participation but no students opted out of the study. The activities that could be completed during each visit varied due to each school’s distinct scheduling scheme.

In addition, permission to conduct the research was granted by each school’s administration. This permission was sought by the individual teachers as representative of the researcher. As mentioned in chapter 1, the study was submitted to the Northwestern University Institutional Review Board, a component of the Office for the Protection of Research Subjects, and was found to be exempt from review.

Data Collection

Data were collected during April and May of 2006. The researcher visited each of the four schools on two separate occasions. During these sessions, the participants completed three phases of the study: (1) Completion of the paper-based instruments; (2) The assigned teaching/learning condition; and (3) The music technology task. Due to time constraints and varying school day schedule configurations, the sequence of phases was often divided into two days. In those cases for which the sequence was divided over two days, the participants completed phase one during the first day, and phases two and three during the second day. Figure 3.1 is a graphic depiction of the activities in which the students participated.
Phase One

In phase one of the study, the students completed both paper-based instruments. The demographic instrument (see Appendix A) includes a space for the students’ names, so the students were assured that their names would be kept confidential and that their names would only be used to match the various components of the study to one another. The researcher directed the students to complete the single-page instrument and stop when they reached the end of that page. Participants were also given directions as to how to complete the Likert-type scale items in order to prevent them from indicating more than one response. Also, for the continuous scale questions that asked for a number of hours per week the participant spends on a particular
activity, instructions were given for students to provide a single number in order to prevent responses with a range of numbers (e.g., “6-8”).

When all students finished the demographic data instrument, the researcher gave instructions for the completion of the *Gregorc Style Delineator*. As is suggested in the manual for this instrument (Gregorc, 1982b), the researcher read aloud the instructions that appear on the inner flap of the instrument. The participants were allotted three minutes to complete the GSD. At the conclusion of this time, the researcher explained the procedure for scoring the test, then several minutes were allowed for the participants to examine the results and the traits associated with their dominant learning styles. Both paper instruments were collected and checked for completeness prior to moving to the second phase of the study.

*Phase Two*

In the second phase of the study, participants underwent one of two learning conditions, each of which will be described below.

Guided Condition

The guided learning condition was mediated through the use of the researcher-designed video tutorial. Appendix C is the text for the narration of the tutorial. The researcher gave instructions as to how the students were to access the video. In all cases, the video file was copied to each computer from a data compact disc. A shortcut to the video file was placed in a conspicuous location on the computers’ desktops.
The tutorial was created using Adobe Captivate, a program designed for creation of video training projects for computer-based tasks. The tutorial delineates three phases of constructing a score using the notation program Sibelius: (1) the score set-up “wizard”; (2) editing the score layout; and (3) entering notes, rests, and other symbols (see Figures 3.2 - 3.4 for screen capture images of the tutorial video). Students viewed the video, which contains several interactive elements, at their own pace. Narrations were recorded in the researcher’s speaking voice through an M-Audio Aries condenser microphone. The sound was captured using an M-Audio Ozone MIDI controller/audio interface, and was recorded onto hard disk using Audacity audio editing software and a Toshiba M35-S456 laptop computer running Microsoft Windows XP. The audio was recorded in stereo at 44.1KHz/16-bit fidelity to insure acceptable audio quality. All audio was processed through normalizing functions to approximate even volume levels throughout and to eliminate plosive sounds.

Adobe Captivate allowed for export of the video as a .swf file, but also created an associated HTML file so that the video could be played through a standard web browser. Rather than relying on the less common stand-alone Flash player, the creation of the HTML file made the movie accessible through virtually any computer.
Figure 3.2. Video tutorial phase one.

The initial phase of the video tutorial focuses on setting up the *Sibelius* score with the setup “wizard.” Shown here is the selection of the tempo marking. Audio narration accompanied each step of the tutorial.
The second phase of the video focuses on additional setup elements within the score. Shown here is the process of deleting extraneous measures.
The final phase of the video involves the entry of notes, rests, and other symbols. Here, an orange highlight box is used to draw attention to a particular on-screen element.

The contents of the video tutorial detail the procedures for building a score in Sibelius for Johann Sebastian Bach’s Invention No. 1 in C Major with some symbols such as ornaments removed (see Appendix D). The participants were given a printed copy of this score to be used as a reference while viewing the video. Each student viewed the tutorial at his or her own pace. The physical arrangement of each school’s lab allowed the students to listen to the sound associated with the tutorial through headphones and control the volume of their own station. While the lab arrangement was beneficial for this phase of the study, the next phase may have suffered some damaging effects due to physical constraints. This will be addressed in the section of chapter 5 that deals with the limitations of the study.
Unguided Condition

During the unguided learning condition—the second of the two conditions—the students were also given a printed copy of the Invention No. 1 score. Rather than watch the video tutorial, the students were told that they would have 20 minutes (the approximate time that the guided condition students spent watching the video tutorial) to explore the software. They were instructed to attempt to replicate as many elements of the score as they could in the time allowed. It was also made clear to the students that these twenty minutes were “practice” or “experimenting” time and that the results of this initial use of the software would never be scored or seen by anyone. The students in the unguided condition were given warnings when ten minutes, five minutes, and two minutes remained in their exploratory time. At the conclusion of the time, the students were instructed to close any and all files they had been working on without saving them.

Phase Three

For the final step of the data collection process, all participants were involved in the same activity. The printed score that each student had used as a reference in phase two was collected from them and they were given a new printed score, this one for Bach’s Invention No. 10 (see Appendix E). Students were told that they would have a set amount of time to use Sibelius to replicate the new printed score as accurately as possible. The researcher instructed the participants that they should aim to remember as many procedures as possible from their respective learning condition (which they experienced in phase two), and to attempt to input as many elements of the score as possible in the given time. The allotted time was again twenty
minutes, but this information was withheld from the participants. The students were reminded that they could use any method of note entry with which they felt comfortable. They could also work on the elements of the score in any order they felt was appropriate.

At the conclusion of 20 minutes, the researcher called for the participants to stop entering symbols into the score. The participants were instructed to place their name directly on the score, to save the files to the computers’ desktops, and, if possible, to print the file. The researcher verified that each file was correctly identified and saved, then copied each file to removable flash memory before each student was instructed to leave their station.

Scoring Student Work

Scoring of the students’ productivity was based on the number of musical notation symbols that they were able to enter into the score correctly. Each item was assigned a point value according to the complexity associated with entering the symbol and its correct placement. For example, each note that was correctly entered into the score (both as the correct pitch and rhythmic value) earned the student one point. To increase efficiency of recording students’ scores, points for notes and rests were combined into measure values. Each of the text and “setup” elements such as time signature and key signature were worth two points. Selection and deletion of extraneous measures was worth three points because to accomplish that task it is necessary to use the control+click command in the first extraneous measure followed by the shift+click command in the last extraneous measure before deleting the group of measures.

The scale used for determining the total score is included in Appendix F. The total number of points the participants earned produced the dependent measure. There were a total of
536 possible points that participants could earn. All of the student products were scored by the researcher. In order to promote validity of the scoring process, ten percent of the files were randomly selected and scored a second time, a process which yielded a high accuracy rate.

Recording the Data

Shortly after the conclusion of each data collection session, the data were entered by the researcher into a Microsoft Excel spreadsheet. Although the names of the participants were collected for the purpose of matching the paper-based instruments to the task output, each participant was assigned a code number during the recording process. The spreadsheet included the participants’ responses to all of the demographic questions, their total scores for each of the four dominant learning styles on the Gregorc Style Delineator, and the series of points assigned to each music notation symbol or group of symbols in the task. Since the paper instruments and the printed task output contained student names, they were kept in a secure location in the researcher’s home to protect confidentiality agreements.

Once entered, all data were copied to SPSS Version 13.0 Student Edition for analysis. All statistical procedures were performed using SPSS.

Characteristics of the Design

As stated in chapter 1, this experiment is consistent with the description of a quasi-experimental design. Fraenkel and Wallen (2006) describe experimental research as that which meets several characteristics: 1) The design features a comparison of at least two groups; 2) The independent variables are manipulated as part of the procedures; 3) Randomization of
assignment is present, and; 4) The design attempts to control for extraneous variables. In order to clarify the present study’s design classification as quasi-experimental, each of these characteristics will be addressed individually.

**Characteristic One: Comparison of Groups**

The sample for this study was divided into two groups that each received a different treatment in the form of the learning condition (guided versus unguided). Applying the *experimental* and *control* group labels to the groups that experienced the guided and unguided learning conditions in the present study would stretch those labels beyond their normal bounds. In this study, since both groups received a treatment that is outside of the methods by which notation software is typically learned, they are both experimental groups. No true control group exists in the design of this study.

**Characteristic Two: Manipulation of Independent Variables**

The manipulation of independent variables is perhaps less clear than in traditional experimental research due to the fact that there are several independent variables associated with this study. The constructs of learning style, music experience, technology experience, and music technology experience were all treated as independent variables, none of which could be purposefully manipulated because they are attributes of the participants rather than controllable variables. The learning condition variable (guided versus unguided) is the only one that the researcher was able to manipulate. Part of the purpose of the study, however, was to determine whether the interactions between any of these independent variables would significantly affect
performance on the music technology task. While this experiment displays some characteristics of experimental research design, the employment of several independent variables that could not be manipulated make it impossible to characterize it as such.

**Characteristic Three: Randomization**

Random selection, or the possibility that all members of a sample have an equal chance of being selected to participate in the study, was not present in this study. The selection of the sample was left to the cooperating teachers who made their selections based on personal knowledge of their students, and on factors of convenience. For example, at Stevenson High School, the two groups were primarily selected based on instrumentation so that the band director could hold rehearsal with certain members of his ensemble while others participated in the study. While this strategy disallowed random selection, concessions such as this are frequently encountered when attempting to conduct research in a school setting where the priority must obviously be the consistent education of the students.

Random assignment was initially present in this study, but a technological shortcoming compromised the integrity of that process. Two groups of students participated in the experiment from three of the four schools. In those three cases, a coin toss determined which group would participate in each of the two learning conditions. The fourth school had an installation of an earlier version of the *Sibelius* software which made the use of the guided learning condition impossible. Rather than eliminate the school entirely from the sample, data were only collected from a group that experienced the unguided condition.
Characteristic Four: Control of Extraneous Variables

While few experimental environments are able to control for every extraneous variable, all attempts were made to do so. Students who participated in the study were within an age range described as “young adult” (McCauley & Salter, 1995) and fit the criteria listed above. Materials were prepared that would compensate for cross-platform operating systems. The researcher personally set up all computer workstations to ensure that as few technical issues as possible would arise during the experimental time. The computer labs were kept quiet, doors were closed, and windows were covered to avoid distractions. The researcher moderated all data collection sessions so that presentation of procedural directions was consistent. A digital stopwatch was used to monitor the time available for each phase of the research.

Based on the descriptions of these four characteristics of the design, it is not possible to conclude that the study qualifies as a truly experimental design. No true control group existed. An independent variable was manipulated, but was used in conjunction with several other independent variables. Efforts were made toward randomization, but the selection process and technological shortcomings prevented true random assignment. Therefore, the study qualifies as quasi-experimental.
CHAPTER 4 – RESULTS AND ANALYSIS

The purpose of this study was to investigate the influence of individual learning styles, music experience, technology experience, and music technology experience on participants’ achievement on a music technology task. The research questions posed to address these issues were:

1) Given a sample of high school juniors and seniors with experience in music performance, what are the dominant learning styles that students exhibit?

2) What are the effects of music experience, general technology experience, and music technology experience on the achievement of high schools music students in completing a music technology task?

3) How do varied learning styles affect the achievement of students in completing a music technology task?

4) How do varied learning conditions affect the achievement of students in a music technology task?

5) Do combinations of the above-mentioned variables produce significant effects on students’ achievement in completing a music technology task?

This chapter will present the data collected to address the research questions and will display the results of statistical analyses conducted to determine answers to each of the research questions. In addition, this chapter will include analysis of subsets of the data that may provide support for the claim that certain elements of notation software are better learned through guided
instruction than through unguided experimentation. These additional analyses will appear after
the presentation of the main and interaction effects on the achievement score.

Demographics and Descriptions of the Sample

A total of ninety-four students participated in the study ($N = 94$). The ages of these
students ranged from fifteen to eighteen years, and mean age of the participants was 17.03 years.
Table 4.1 represents the age distribution of the participants.

<table>
<thead>
<tr>
<th>Table 4.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age Distribution of the Participants</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>15</td>
</tr>
<tr>
<td>16</td>
</tr>
<tr>
<td>17</td>
</tr>
<tr>
<td>18</td>
</tr>
</tbody>
</table>

Although no definite range of ages is recommended for appropriate use of the Gregorc
Style Delineator, it is designed to be used with young or mature adults. Various age ranges may
be associated with the label of “young adult,” but a typical range is anywhere from ten to twenty-
four years (McCauley & Salter, 1995). All members of the sample fit this criterion.
The participants were all performing members of their schools’ ensembles. They were asked to identify their primary instrument. Table 4.2 lists the frequencies associated with these responses.
Table 4.2

*Frequency Distribution of Participants’ Primary Instruments*

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baritone Horn</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>Bass Clarinet</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Bassoon</td>
<td>3</td>
<td>3.2</td>
</tr>
<tr>
<td>Clarinet</td>
<td>15</td>
<td>16.0</td>
</tr>
<tr>
<td>Flute</td>
<td>11</td>
<td>11.7</td>
</tr>
<tr>
<td>French Horn</td>
<td>3</td>
<td>3.2</td>
</tr>
<tr>
<td>Guitar</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>Oboe</td>
<td>6</td>
<td>6.4</td>
</tr>
<tr>
<td>Percussion</td>
<td>14</td>
<td>14.9</td>
</tr>
<tr>
<td>Piano</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Saxophone</td>
<td>8</td>
<td>8.5</td>
</tr>
<tr>
<td>String Bass</td>
<td>3</td>
<td>3.2</td>
</tr>
<tr>
<td>Trombone</td>
<td>3</td>
<td>3.2</td>
</tr>
<tr>
<td>Trumpet</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>Tuba</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Viola</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>Violin</td>
<td>11</td>
<td>11.7</td>
</tr>
<tr>
<td>Voice</td>
<td>7</td>
<td>7.4</td>
</tr>
</tbody>
</table>
Since several of the represented instruments in the above table only appeared once, the responses have been compressed into instrument families, as appear in Table 4.3.

### Table 4.3

**Compressed Instrument Responses**

<table>
<thead>
<tr>
<th>Family</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woodwind (Bass Clarinet, Bassoon, Clarinet, Flute, Oboe, Saxophone)</td>
<td>44</td>
<td>46.9</td>
</tr>
<tr>
<td>Brass (Baritone, French Horn, Trumpet, Trombone, Tuba)</td>
<td>11</td>
<td>11.7</td>
</tr>
<tr>
<td>Strings (String Bass, Violin, Viola)</td>
<td>15</td>
<td>16.0</td>
</tr>
<tr>
<td>Percussion (Percussion, Piano)</td>
<td>15</td>
<td>16.0</td>
</tr>
<tr>
<td>Voice</td>
<td>7</td>
<td>7.4</td>
</tr>
</tbody>
</table>

**Music Experience Variable**

The musical experience variable was measured by asking participants to indicate the number of years that they had been either playing their main instrument or singing. The mean number of years for the entire sample was 6.98 ($SD = 1.94$) with a minimum response of two years and a maximum of thirteen years. This is indicative of the fact that the students in this sample had substantial musical experience. On the six-point Likert-type scale upon which the participants rated their own ability on their instrument or voice, the mean response was 4.149 ($SD = 0.621$) which further indicates an experienced, confident group of student musicians. This conclusion is supported by findings in the general music cognition literature that deal with levels
of experience and development of musical expertise (Hargreaves, 1996; Sloboda, Davidson, Howe, & Moore, 1996).

**General Technology Experience Variable**

The technology experience variable was measured by asking participants to indicate the number of hours per week they spend using a computer to do things such as typing papers, emailing, instant messaging, browsing the Internet, and other non-music related activities. The mean number of hours participants reported that they spend on this type of activity was 13.32 hours per week. The six-point Likert-type scale that measured expertise in these types of technological activities resulted in a mean response of 4.45 ($SD = 1.07$). The analysis indicates that there is a moderate positive correlation between the number of hours spent engaged in non-music technology applications and self-reported expertise with those types of tasks ($rho = .385$). This result can be interpreted by concluding that students who spend greater amounts of time on non-music technology tasks tend to claim greater expertise in that area.

**Music Technology Experience Variable**

The music technology experience variable was measured by asking participants to indicate the number of hours per week they spend using a computer to do music-related things like downloading music, recording or creating their own music, editing music, or making custom CDs. The mean number of hours that they spend on this type of activity was 4.42 hours per week. The six-point Likert-type scale that measured expertise in these types of music technology activities resulted in a mean response of 3.34 ($SD = 1.36$). The analysis indicates that there is a
moderately strong positive correlation between the number of hours spent engaged in music technology applications and self-reported expertise with those types of tasks ($\rho = .688$). This result can be interpreted by concluding that students who spend greater amounts of time on music technology tasks tend to claim greater expertise in that area.

**Learning Styles Variable**

An inherent characteristic of the *Gregorc Style Delineator* is that it does not force a result of a single dominant learning style. Rather, even test-takers who answer with complete honesty and disregard for the results can produce “tie scores” that indicate that they are equally prone to learning in two or more ways. While this is appealing to learners who are interested in capitalizing on their strengths, and to teachers who seek to exploit those strengths or bolster areas of weakness, it provides difficulty in analyzing learning style as a categorical independent variable because participants can fall into more than one category, as was the case with seven participants in the present study.

In order to compensate for this feature of the GSD, statistics which used learning style as an independent variable were calculated exclusive of the participants whose responses resulted in more than one dominant learning style. Data collected from participants who produced results of more than one dominant learning style were removed from those calculations.

Table 4.4 displays the results of the assessment of learning styles using the *Gregorc Style Delineator*. 
Table 4.4

Learning Style Frequencies

<table>
<thead>
<tr>
<th>Style</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete Sequential (CS)</td>
<td>32</td>
<td>34</td>
</tr>
<tr>
<td>Abstract Sequential (AS)</td>
<td>7</td>
<td>7.4</td>
</tr>
<tr>
<td>Abstract Random (AR)</td>
<td>18</td>
<td>19.1</td>
</tr>
<tr>
<td>Concrete Random (CR)</td>
<td>30</td>
<td>31.9</td>
</tr>
</tbody>
</table>

Tie Scores

<table>
<thead>
<tr>
<th>Tie</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>CS &amp; AS</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>CS &amp; AR</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>CS &amp; CR</td>
<td>2</td>
<td>2.1</td>
</tr>
<tr>
<td>AS &amp; AR</td>
<td>1</td>
<td>1.1</td>
</tr>
<tr>
<td>AR &amp; CR</td>
<td>1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

The above distribution addresses research question one regarding the learning styles that are present given a sample of upper division high school students who have experience in music performance. The uneven distribution of learning styles raises questions about the generalizability of the results of this study. A larger sample, a more diverse student population, or the selection of a group of schools that varied more along demographic measures may have produced a more even distribution, and therefore promoted generalizability. This topic will be addressed further in chapter 5.
Learning style, as measured by the GSD, is a categorical variable. The data do not constitute a scale; that is, the dominance of a learning style for a single participant may not indicate the same level of dominance from another participant. As discussed in chapter 2, the results of each participant’s responses on the GSD are plotted along intersecting axes. To demonstrate an instance in which two participants had the same dominant learning style, but that style dominated to different extents, data from two participants will be examined more carefully. Participants W1 and W13 both exhibited dominant Concrete Sequential learning style. Their responses to the GSD are summarized in Table 4.5.

Table 4.5
Scores on the GSD for Participants W1 and W13

<table>
<thead>
<tr>
<th>Participant</th>
<th>CS Score</th>
<th>AS Score</th>
<th>AR Score</th>
<th>CR Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>W1</td>
<td>36*</td>
<td>26</td>
<td>18</td>
<td>20</td>
</tr>
<tr>
<td>W13</td>
<td>29*</td>
<td>20</td>
<td>23</td>
<td>22</td>
</tr>
</tbody>
</table>

*indicates dominant learning style

While these participants both exhibit dominant Concrete Sequential learning styles, the extent to which that style dominates their learning profiles differs. Figures 4.1 and 4.2 are images of the results of the GSD that each of these participants plotted along the intersecting axes. Note that these images are scanned versions of the actual instruments that have not been edited in any way.
Figure 4.1. Style profile plot of participant W1.
As illustrated from the above figures (4.1 and 4.2), it is possible for participants to produce scores on the GSD that exhibit the same dominant learning style, but have profiles that are different when viewed in conjunction with the entire set of results for each participant.

To determine the statistical significance of the differences between the dominant learning style categories, a chi-square statistic is appropriate. The chi-square goodness of fit test is used to measure statistical significance of the differences between groups given a single categorical variable (Cronk, 2006; Pyrczak, 2006). This statistic tested the hypothesis that the distribution of
dominant learning styles would be spread relatively evenly among the participants. Significant deviation from this expectation was found ($\chi^2 = 18.61, p < .05$).

In response to research question one, then, in this sample of high school juniors and seniors with music performance experience, all learning styles indicated by the Gregorc Style Delineator are present, but are not equally distributed. Possible causes of this unbalanced distribution will be discussed in chapter 5. Collection of data from a larger sample may have produced a more unified distribution of learning styles.

Effects of the Variables on Achievement Scores

Based on the researcher-determined scoring scale (Appendix F), there were a total of 536 possible points to be earned for the phase three achievement task. The range of scores returned from student work was between zero and 536 with a mean of 211.14 ($SD = 132.012$). Figure 4.3 displays the distribution of the achievement task scores against the normal curve.
Though skewed toward the lower end of the scale, the group of achievement scores approximates a normal distribution. Skewness (.833) and kurtosis (.202) support this judgment based on the above histogram.

*Preparation of the Data*

In order to apply the multi-way analysis of variance statistical technique that would determine the main effects and interaction effects of the independent variables on the task score, the data needed to be transformed. The multi-way ANOVA requires two or more categorical independent variables and a single continuous dependent variable (Pallant, 2001). In the researcher-designed survey instrument, the data that measured music experience, general
technology experience, and music technology experience were all collected using numerical response scales. Therefore, the results of those survey items were continuous and disparate, and needed to be divided into groups in order to be treated as categorical independent variables in order to calculate the above-referenced five-way ANOVA statistic. This was accomplished using the Transform function in the SPSS statistical package.

Students’ responses to the music experience item ranged from two to thirteen years. The participants were divided into three groups: (1) Participants with 2 to 6 years experience were categorized as “least experienced” ($n = 38$); (2) Participants with greater than 6 to 8 years experience were categorized as “experienced” ($n = 42$); (3) Participants with greater than 8 years experience were categorized as “most experienced” ($n = 14$). Table 4.6 displays the descriptive statistics for achievement scores according to the music experience variable. Also included are skewness and kurtosis values which are descriptive of the distribution of the sample.

Table 4.6

<table>
<thead>
<tr>
<th>Music Experience Level</th>
<th>Mean Group Score</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Least Experienced</td>
<td>160.08</td>
<td>112.512</td>
<td>1.288</td>
<td>2.165</td>
<td>38</td>
</tr>
<tr>
<td>Experienced</td>
<td>233.67</td>
<td>136.689</td>
<td>.76</td>
<td>.073</td>
<td>42</td>
</tr>
<tr>
<td>Most Experienced</td>
<td>282.14</td>
<td>122.579</td>
<td>.593</td>
<td>-.671</td>
<td>14</td>
</tr>
</tbody>
</table>

Figure 4.4 displays the distribution of the entire sample superimposed against the normal curve.
Similarly, general technology responses ranged from 0 to 84 hours per week. Participants were again divided into three groups that are descriptive of their general technology experience:

1. Participants who indicated fewer than 5.5 hours were categorized as “low” \((n = 35)\);
2. Participants who indicated from 6 to 14.5 hours were categorized as “medium” \((n = 31)\);
3. Participants who indicated greater than 14.5 hours were categorized as “high” \((n = 28)\). Table 4.7 displays the descriptive statistics for this measure, and Figure 4.5 shows the distribution superimposed against the normal curve.
Table 4.7

*Descriptive Statistics for General Technology Experience Variable*

<table>
<thead>
<tr>
<th>General Technology Experience Level</th>
<th>Mean Group Score</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>207.37</td>
<td>125.372</td>
<td>.987</td>
<td>.606</td>
<td>35</td>
</tr>
<tr>
<td>Medium</td>
<td>158.52</td>
<td>101.279</td>
<td>.898</td>
<td>1.239</td>
<td>31</td>
</tr>
<tr>
<td>High</td>
<td>274.11</td>
<td>146.72</td>
<td>.356</td>
<td>-.576</td>
<td>28</td>
</tr>
</tbody>
</table>

*Figure 4.5. Normality of distribution – general technology experience variable.*
Finally, music technology usage responses ranged from zero to forty-five hours per week. Participants were divided into three groups based on their reports of their music technology experience: (1) Participants who indicated zero to 1.5 hours per week were categorized as “low” \( (n = 40) \); (2) Participants who indicated 2 to 3.5 hours were categorized as “medium” \( (n = 24) \); (3) Participants who indicated four or more hours were categorized as “high” \( (n = 30) \). Table 4.8 displays the descriptive statistics for this measure, and Figure 4.6 shows the distribution superimposed against the normal curve.

Table 4.8

**Descriptive Statistics for Music Technology Experience Variable**

<table>
<thead>
<tr>
<th>Music Technology Experience Level</th>
<th>Mean Group Score</th>
<th>SD</th>
<th>Skewness</th>
<th>Kurtosis</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>170.8</td>
<td>101.235</td>
<td>1.316</td>
<td>2.942</td>
<td>40</td>
</tr>
<tr>
<td>Medium</td>
<td>249.67</td>
<td>148.608</td>
<td>.418</td>
<td>-.372</td>
<td>24</td>
</tr>
<tr>
<td>High</td>
<td>234.1</td>
<td>143.426</td>
<td>.555</td>
<td>-.491</td>
<td>30</td>
</tr>
</tbody>
</table>

Skewness measurements are positive values in most instances, indicating that scores for most of these distributions cluster around the low end values of the scales. Kurtosis measurements indicate the most of the distributions are rather peaked, which is congruent with assessments of the visual representations in Figures 4.4 - 4.6 in that they generally resemble the normal curve.

**Main and Interaction Effects**

As stated previously, the appeal of the multi-way analysis of variance is that the procedure allows for analysis of the main effects of each individual independent variable on the dependent variable, and also provides information about the interaction about those variables.
when analyzed in the presence of each other. The independent, categorical variables examined in this study were: (1) learning style; (2) music experience; (3) general technology experience; (4) music technology experience; and (5) learning condition. The continuous, dependent variable was the achievement score. Table 4.9 provides the analysis of the main and interaction effects of these variables. Due to the conditions of the number of participants in the sample \((N = 94)\) and the number of independent variables, the number of degrees of freedom calculated by SPSS for interaction effects involving more than two variables yielded a value of zero. For this reason, only main effects and two-way interaction effects will be reported (Table 4.9).

<table>
<thead>
<tr>
<th>Independent Variable(s)</th>
<th>df</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Learning Condition (LC)</td>
<td>1</td>
<td>2.356</td>
<td>.137</td>
</tr>
<tr>
<td>Dominant Learning Style (DLS)</td>
<td>3</td>
<td>.154</td>
<td>.926</td>
</tr>
<tr>
<td>Music Experience (ME)</td>
<td>2</td>
<td>1.557</td>
<td>.230</td>
</tr>
<tr>
<td>General Technology Experience</td>
<td>2</td>
<td>.758</td>
<td>.479</td>
</tr>
<tr>
<td>Music Technology Experience (MTE)</td>
<td>2</td>
<td>1.431</td>
<td>.257</td>
</tr>
<tr>
<td><strong>Interaction Effects</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LC * DLS</td>
<td>1</td>
<td>.447</td>
<td>.510</td>
</tr>
<tr>
<td>LC * ME</td>
<td>1</td>
<td>.235</td>
<td>.632</td>
</tr>
<tr>
<td>DLS * ME</td>
<td>3</td>
<td>1.116</td>
<td>.361</td>
</tr>
<tr>
<td>LC * GTE</td>
<td>1</td>
<td>.368</td>
<td>.549</td>
</tr>
<tr>
<td>DLS * GTE</td>
<td>2</td>
<td>.481</td>
<td>.624</td>
</tr>
<tr>
<td>ME * GTE</td>
<td>1</td>
<td>.038</td>
<td>.848</td>
</tr>
<tr>
<td>LC * MTE</td>
<td>2</td>
<td>.140</td>
<td>.870</td>
</tr>
<tr>
<td>DLS * MTE</td>
<td>3</td>
<td>1.083</td>
<td>.374</td>
</tr>
<tr>
<td>ME * MTE</td>
<td>1</td>
<td>.002</td>
<td>.963</td>
</tr>
<tr>
<td>GTE * MTE</td>
<td>2</td>
<td>.375</td>
<td>.691</td>
</tr>
</tbody>
</table>
Interpretation of Results

There were five independent variables used in this multi-way analysis of variance. None of the main effects for these independent variables reached statistical significance. In addition, all possible combinations of the independent variables were analyzed to determine significance of interaction effects. Each of the two-, three-, four-, and five-way interactions also failed to reach statistical significance. Thus, it can be concluded that the five independent variables, both in isolation and in combination, did not have a statistically significant effect on the students’ level of achievement with the music technology achievement task.

The procedures for a multi-way ANOVA statistic state that post-hoc tests should be executed if statistical significance is found in one or more of the interaction effects to further investigate the differences between groups. Since no statistical significance was found, these tests were not necessary.

Additional Analyses

All analyses described above have focused on the single dependent variable of the participants’ scores on the music technology task. Achievement scores were recorded in such a way that further sub-scores could be calculated. The contents of the video tutorial—used by the students who experienced the guided learning condition—focused heavily on the tasks involved in the initial “setup” stages of score creation in Sibelius. These included the tasks in the setup wizard (choosing the score piano grand staff layout, entering the time signature and key signature, entering the title and composer’s name, and entering the tempo text), as well as initial manipulations made to the score such as removing unneeded measures and correcting pagination.
The video explained these steps methodically and pointed out many possible modifications that could be made to a *Sibelius* score using the setup tools.

Participants were awarded a predetermined amount of points for successful completion of each of these tasks. Given the nature of the scoring method, however, it was possible to examine in greater detail the individual items or groups of items with which the participants had particular success. Of the 536 available points associated with the scoring of the achievement task, thirty-two points were allotted for items involved in the “setup” section of score construction.

In addition to calculating the total achievement score, the researcher calculated scores that resulted from the above-mentioned items. A one-way between-groups analysis of variance was conducted to examine the impact of the learning condition on the participants’ achievement with these “setup” tasks. The group that was assigned to the guided learning condition produced a mean score of 16.95 ($SD = 4.75$), while the unguided group produced a score of 13.89 ($SD = 5.33$). The differences between these groups are significant at the *a priori* level of $a \leq .05$ [$F (1, 92) = 8.298$].

A similar one-way analysis of variance was conducted to examine the impact of learning style on the setup score. Mean scores for the four learning styles were more homogenous (AS = 16.31, AR = 16.86, CS =14.33, CR = 14.13). The setup score measurement did not vary significantly across the four learning styles at the .05 level [$F (3, 83) = 1.319$]. Therefore, it can be concluded that, while students’ learning styles do not affect their achievement on setup-related tasks, exposure to a video tutorial does. This conclusion has implications for the instruction of these particular tasks, which will be discussed in chapter 5.
Analytical Trends

Despite the lack of statistical significance found from analysis of the main and interaction effects, it is still possible to recognize trends in the data that may reveal certain tendencies that the participants displayed in completing the task. Figure 4.7 is a line graph that displays the tendencies of the participants according to their musical experience.

Figure 4.7. Achievement analyzed across learning styles according to musical experience.
Though statistical significance does not emerge when considering these variables, it is evident from Figure 4.7 that the “most experienced” musicians scored higher on the achievement task than did “experienced” or “least experienced” musicians. Interestingly, the highest scoring learning style among the “most experienced” group (Abstract-random) was among the lower scoring learning style in the “experienced” and “least experienced” groups. The fact that the Abstract Random learning style group demonstrates this tremendous discrepancy may be of particular consequence given the analysis shown in Figure 4.8 below.

Figure 4.8 displays an analysis of the dependent task score as it varies across learning styles in the presence of the guided and unguided learning conditions.
Figure 4.8. Achievement analyzed across learning styles according to learning condition.

Again, though the analysis does not reach statistical significance, there is a practically significant difference between the means, specifically in the Abstract Random learning style. This is the same learning style that demonstrated the most substantial difference in Figure 4.7 when analyzed according to music experience. The description of the characteristics of dominant Abstract Random learners may shed explanatory light on these discrepancies. Practical significance refers, in this case, to a finding that, while not statistically significant, may hold important implications for practice (Kirk, 1996). This result will be addressed in the conclusions section in chapter 5.
CHAPTER FIVE – CONCLUSIONS

Purpose of the Study

The purpose of this study was to investigate the influence of individual learning styles, music experience, technology experience, music technology experience, and varied learning conditions on participants’ achievement with a music technology task. The study was designed to provide information that can help tailor curricula in technologically-based music learning environments to better accommodate for the various learning styles and experiential characteristics that students bring to tasks.

Research Questions

The following research questions were addressed in this study:

1) Given a sample of high school juniors and seniors with experience in music performance, what are the dominant learning styles that students exhibit?

2) What are the effects of music experience, general technology experience, and music technology experience on the achievement of high schools music students in completing a music technology task?

3) How do varied learning styles affect the achievement of students in completing a music technology task?

4) How do varied learning conditions affect the achievement of students in a music technology task?
Do combinations of the above-mentioned variables produce significant effects on students’ achievement in completing a music technology task?

Responses to the Hypotheses

This section will address each of the hypotheses stated in chapter 1 by applying the results of the statistical analyses to each. Explanations regarding each of the hypothetical responses will be given in the next section.

Hypothesis 1:

In the selected sample of high school juniors and seniors with experience in music performance, there will be a fairly even distribution of learning styles as measured by a particular assessment of that phenomenon.

Using the chi square goodness of fit test, it was determined that, while the sample contained members of each of Gregorc’s learning styles, the distribution of those learning styles was unbalanced. Therefore, hypothesis 1 is rejected.

Hypothesis 2a:

Individual learning style will have no effect on achievement in completing a music technology task.

Learning style, as measured by the Gregorc Style Delineator, did not have a statistically significant effect on student achievement with the music technology task at the predetermined .05 level of significance. Therefore, hypothesis 2a is not rejected.
Hypothesis 2b:

Prior music experience will have no effect on achievement in completing a music technology task.

Music experience, as measured by the researcher-designed questionnaire, did not have a statistically significant effect on student achievement with the music technology task at the predetermined .05 level of significance. Therefore, hypothesis 2b is not rejected.

Hypothesis 2c:

Prior general technology experience will have no effect on achievement in completing a music technology task.

General technology experience, as measured by the researcher-designed questionnaire, did not have a statistically significant effect on student achievement with the music technology task at the predetermined .05 level of significance. Therefore, hypothesis 2c is not rejected.

Hypothesis 2d:

Prior music technology experience will have no effect on achievement in completing a music technology task.

Music technology experience, as measured by the researcher-designed questionnaire, did not have a statistically significant effect on student achievement with the music technology task at the predetermined .05 level of significance. Therefore, hypothesis 2d is not rejected.
Hypothesis 3:
Varied learning styles will have no effect on achievement in completing a music technology task.
Varied learning styles, as assessed by the Gregorc Style Delineator, did not have a statistically significant effect on student achievement with the music technology task at the predetermined .05 level of significance. Therefore, hypothesis 3 is not rejected.

Hypothesis 4:
Guided or unguided learning conditions will not cause a significant difference in achievement with a music technology task.
Variation of instructional strategies between guided and unguided learning conditions did not have a statistically significant effect on student achievement with the music technology task at the predetermined .05 level of significance. Therefore, hypothesis 3 is not rejected.

Hypothesis 5:
There will be no significant interaction effects between learning styles, music experience, general technology experience, music technology experience, and learning condition when these variables are considered in combination with each other.
The five-way analysis of variance statistic did not show any interaction effects between the independent variables of learning styles, music experience, general technology experience, music technology experience, and varied learning conditions on student achievement with the music technology task. Therefore, hypothesis 4 is not rejected.
Discussion

Generalizability

Generalizability is “the applicability of findings to settings and contexts different from the one in which they were obtained” (Gay, Mills, & Airasian, 2006, p. 407). An intention of this study was to generate results and conclusions that would be generalizable to the larger population of high school music students. The characteristics of the schools that participated in the study make such generalization difficult because, as discussed in chapter 4, the schools were of similar socio-economic status and racial profile. The method by which students were selected to participate in the study makes generalizability challenging. Generalizability would have been promoted had students been chosen at random, either by the researcher or by their teacher. The results could be generalized to samples with similar economic and racial characteristics, but to generalize these results to samples from urban or rural areas would be misguided.

Learning Style Distribution

As stated in chapter 1, previous research suggested that results of the Gregorc Style Delineator would be fairly evenly distributed across the four learning styles. This was not found to be the case in the present study. The chi square goodness of fit test determined that there was a statistically significant difference among the frequencies of learning styles for the given sample. While it is impossible to be sure of the reason for this unbalanced sample, the source of the inequity may be the characteristics of the sample itself. The two largest groups from the distribution were comprised of students that fit into the Concrete Sequential style ($n = 32$) and the Concrete Random style ($n = 30$). Of note, then, is that the vast majority of students in this
sample of high school musicians fall toward the \textit{concrete} side of the \textit{perception} variable in Gregorc’s two-variable scheme. Gregorc’s description of the concrete learning styles is as follows:

This quality enables you to grasp and mentally register data through the direct use and application of the physical senses. This quality permits you to apprehend that which is visible in the concrete, physical world through your physical senses of sight, smell, touch, taste and hearing. (Gregorc, 1982a, p. 5)

On the contrary, \textit{abstractness} is associated with such characteristics as reason, emotion, intuition, subjectivity, feelings, and spiritual motivation. That the majority of the students in the sample prefer to learn through \textit{concrete} rather than \textit{abstract} means is a finding that is potentially troubling for music education because the characteristics associated with \textit{abstractness} are those at which aesthetically-based music education should be aimed. The imbalance of the learning style distribution in this study could be attributed to the sampling methodology employed. That is, had the sample been gathered from schools with more diverse populations, or schools that emphasized learning with varied techniques, the sample may have demonstrated a more evenly distributed set of learning style tendencies.

Tie Scores

None of the literature about the GSD discussed the empirically perplexing characteristic of the instrument that it can produce “tie scores,” as was the case for several of the participants in this study. A “tie score” can be interpreted in several ways: (1) The student demonstrates equal strength in more than one learning style and would therefore learn with equal effectiveness when
engaged in activities that exploit either of their strengths; (2) The students’ learning style preferences are underdeveloped and they lack the ability to delineate clearly between the learning styles they prefer; or (3) The design of the test is flawed, leading to results that cannot be clearly interpreted. The most critical opponents of the use of the GSD, such as Coffield et al. (2004) point to its psychometric flaws and to Gregorc’s largely unsubstantiated claims that learners who work in domains other than those in which they are strong may bring themselves harm; they do not, however, address this quantitative limitation.

These criticisms, coupled with the fact that almost ten percent of the sample produced “tie scores” is indeed a concern that may result in the decision to use other measures of learning style for future projects along this line of inquiry. Setting aside issues of reliability and validity of the GSD, the nature of the data it produces creates difficulty in calculating statistics and causes the forceful elimination of otherwise useful data. This analytical difficulty may also present opportunities for researchers to approach learning style from a different perspective. It is possible that students who exhibit strength in more than one mode of learning provide us with interesting cases that should be examined through the collection of qualitative data. None of the prior pedagogical or critical literature about the Gregorc Style Delineator addresses this potentially confounding factor.

Future researchers might anticipate the possibility of this type of result and account for it in their research designs. In the case of this study, 7 out of the 94 participants (7.4%) produced tie score results from their administration of the GSD. An additional line of investigation would be to employ the results of the GSD as a dependent variable and examine factors that may produce students who exhibit strengths in multiple learning styles. Researchers might also
examine the possibility of tendencies toward certain tie scores over others. Rather than being treated only as a confounding factor, tie scores may actually present an additional area of deeper, more detailed research in that they may cause us to question factors that cause the existence of the “bi-modal” learners, as well as the validity of the GSD.

Experience Variables

While none of the experience variables (music, general technology, or music technology) ultimately had a statistically significant effect on the achievement score measure, the form in which these variables were examined still provided important information. Each variable was addressed on the survey with two questions, the first of which served to quantify experience, the second of which measured students’ perceptions of their expertise in each area based on their experience. The intention of this measurement was to examine the interaction between experience and achievement with the music technology task. However, the correlation statistics determined that there was indeed a positive relationship between the quantity of experience and the perception of expertise for each variable.

Experienced teachers would probably assume that the longer students have been involved in musical activity, the more confident they would tend to feel about labeling themselves with a strong degree of expertise. The approach that many music teachers take toward performance instruction is one of developing progressive skill over time, which leads to advancing expertise in the canon of performance skills. The technological variables support the conclusion that the same is true for students involved in those types of activities. The difference between these variables is that, while the music performance instruction that these students have received has
come from the school environment (they were all participants in their schools’ ensembles), the types of tasks suggested by the technology questions lean toward independent, self-taught types of activities. This difference implies, and the analysis supports that students are capable of learning to execute technological tasks under a variety of conditions including guided and unguided, in school and out of school.

Interaction Effects

The five-way analysis of variance was conducted in order to assess the effects of the five independent variables when considered in all possible combinations. None of these interaction effects were found to be statistically significant. However, closer observation of the analysis reveals important trends regarding the participants’ performance along several of the independent variables. As expressed by Heller and Radocy (1983), the value of significance must be examined within the context of the ideas under investigation. Despite a failure to produce statistical significance, the data are rich in information about the ways in which students of particular learning styles and levels of experience performed the music technology task.

The “most experienced” musicians largely scored better on the task than did the “experienced” or “least experienced” groups of musicians. While these differences were not found to be statistically significant, it may provide music educators with a degree of contentment to know that, in general, students who are more musically experienced tend to perform better on music technology tasks and, in this case, do so regardless of learning condition and levels of general technology and music technology experience. It is also possible that the “most
experienced” students are more skilled with notation than the “experienced” or “least experienced students.

Of particular note within the analysis of this trend is that, within the “most experienced” group, those who prefer the Abstract Random learning style scored the highest, while Abstract Random learners in the other two groups scored quite low (see Figure 4.7). Revisiting Gregorc’s descriptors of his four learning styles reveals that Abstract Random learners are generally less concerned with detail than the other learning styles. AR is the most spontaneous of learning styles, often characterized as the “dreamer” style. Gregorc says of the AR learner that “thoughts and feelings filter his subconscious to his conscious mind without apparent logical reason, motivation, control, or cognition” (1982a, p. 29). This learning style is also noted for its concern with quality of learning experiences over quantity. Given these descriptors, it is apparent that the “most experienced” group performed contrary to Gregorc’s ideas; their scores imply that they stressed quantity over quality.

Abstract Random learners’ achievement also differed substantially between the two learning conditions: those who experience the guided condition with the tutorial video generally scored lower than those in the unguided condition (see Figure 4.8). In contrast to the above discussion, this measure seems to reflect Gregorc’s notion of the Abstract Random learner who prefers to approach learning in an unordered fashion.

It is important to remember that none of these measures demonstrated statistical significance, so it must be said that any of these effects could have occurred by chance. The contradictory conclusions in this section remind us of that, and also call to further question the
construct validity of the *Gregorc Style Delineator*, or the reliability and validity of the achievement measure.

**Setup Score Findings**

In addition to measuring the participants’ total achievement score for the music technology task, a sub-score was calculated that included achievement in tasks associated with score setup. While 536 points could be earned for the total achievement score, thirty-two of those points were associated with the setup tasks that included selecting the staff layout, entry of text elements, selecting key and time signatures, and determining pagination. These tasks comprised approximately the initial half of the tutorial video. A statistically significant difference was found between the two learning condition groups; the guided condition group scored significantly higher than the unguided group.

Admittedly, the tasks that comprised the sub-score are not truly musical tasks. However, they do require engagement in the music technology application in question. This result leads to the conclusion that, for these particular tasks, students will be more successful when they are taught how to complete the tasks in some traditional sense (such as a human teacher or a tutorial) than if they are left to experiment and figure out how to complete them.

**Limitations**

Several limiting factors existed in the design and execution of this study. A primary limitation was the amount of time to which students were exposed to the two learning conditions. Because the students were being pulled from their regular class time, the researcher determined
that it would be difficult to have the students miss more than two days of those classes—this notion was supported by the responses of the cooperating teachers. Had more time with the students been available, the tasks and procedures would have been more refined. For example, it may have been possible to integrate additional elements of interactivity into the guided learning condition. Given the amount of time available for students to participate in the study, the results produce as many additional questions about this subject as they do conclusions that can be drawn from the data.

User-friendliness is a major concern in the design of music software. The sophistication of leading notation software titles lends an expectation in the minds of students and teachers that they should be able to use the program with some level of proficiency without much instruction. While 20 minutes of experimentation may not seem to be sufficient, the results of this study support the notion that, with either guided or unguided learning conditions, students of varying experience levels can use the software with minimal instruction time.

A second important limitation is the method by which the sample of students chosen to participate in the study. This was a non-randomized process in which students were selected by their teachers. In order to obtain a large enough sample to promote valid and generalizable results, the researcher relied upon the cooperating teachers to gather students to participate. The process was influenced by the scheduling circumstances in each of the four schools. Though students were randomly assigned to the two learning conditions, random selection had to be sacrificed in order to obtain a substantial sample size. This was a significant but unavoidable limitation to the methodology of this study.
Third, as explained in chapter 3, the schools at which the research was conducted all demonstrated a similar set of demographic characteristics; they could be described as predominantly white, wealthy, suburban schools. Though these characteristics may not be representative of the majority of schools throughout the country, participants had to be drawn from an accessible population, and from schools with the available technological resources. It is possible that similar research conducted in schools with differing demographic characteristics may have produced different results, and that those results would have approached statistical significance.

Fourth, the ages of the participants had to be reasonably uniform due to the design of the Gregorc Style Delineator. The manual for the GSD suggests that test-takers should be young adults or older, partially because the vocabulary of the test may be too sophisticated for young children. Older high school students were therefore selected for participation in the study. On two occasions during data collection, participants questioned the researcher as to the definition of a word on the instrument. The manual for the test dictates that the proctor is not to define words should this situation arise, so the students were forced to find their own resolution to this issue.

Fifth, all of the participants in this study were musically experienced high school students. The type of musical experience that they brought to the study, though it varied in quantity, was fairly homogenous—they had all been members of their schools’ performing ensembles and had therefore studied instrumental or vocal performance in a traditional sense. In this type of musical training, it can be assumed that Western music notation is a component of the curriculum, which made the students eligible to complete the procedures of the study.
Students with other types of training, such as non-Western performance, or informal music training, may have achieved substantially different scores on a task that involved music notation.

Sixth, a potentially confounding factor is that no efforts were made to control for additional independent variables. As mentioned in chapter 1, it was assumed that, since the participants were members of their schools’ ensembles, they were familiar with Western music notation, but their level of familiarity with notation was not measured. Also, performance experience on a variety of instruments may have been advantageous. That is, students who perform on instruments for which music is traditionally written in different clefs may have been more comfortable with the grand staff notation used in phases two and three of this study. Piano experience may also be advantageous in that the use of the MIDI keyboard for note entry may have allowed students to enter notes into the Sibelius score faster than those who used other note entry methods.

Finally, limitations exist in research that is based on the use of technological tools. In at least one of the schools where data were collected for this study, the computer equipment was old and may have caused participants to work more slowly than at the other locations. The physical arrangement of computer lab equipment may be an inhibiting factor that influences students’ abilities to work efficiently. In several instances while collecting data, computer malfunctions caused disruptions in the timed sections of the research. One computer quit unexpectedly at Stevenson High School. A similar event occurred at Portage High School, in addition to a disruption to the application’s license server at that school. The next section of this paper, which offers suggestions for further research, will explore these issues more deeply.
Implications and Curricular Suggestions for Music Education

Software Evaluation

Evaluation of the software used in this study was not a primary concern, but music educators would certainly benefit from a substantive method by which to assess educational software.

Although it is not easy to define precisely a universal set of criteria for evaluating educational software, the effort to make explicit the basis for our judgments and to provide for them a foundation that can be subjected to discussion, criticism, and possibly even empirical test is an important part of the overall task of improving educational software. (Walker & Hess, 1984, p. 204)

The procedures for this study may be viewed not only as a means for evaluating student performance in a music technology task, but also as an evaluation of the software tools used as part of the study. The evaluation of educational software focuses on some important tenets:

- Adherence to one or more of several categories of software such as tutorial, drill and practice, simulation, and game-based;
- Attention to clear, usable electronic interfaces that make obvious the program’s affordances, and that are aesthetically pleasing (Mishra, Zhao, & Tan, 1999);
- Sensitivity to the culture in which the application will be used (Beckett et al., 1999);
- Balance of interactivity and control (Chabay & Sherwood, 1992);
- Appeal to the needs of teachers and students (Char, 1983) and to the ways in which students learn (McKenzie, 2003; Rodrigues, 2000).
A complete discussion of the methods by which educational software can be evaluated is beyond the scope of this dissertation. However, it is clear that software that is well-designed, as judged according to the above criteria and others, will allow for students to have successful experiences with the software.

In the present study, statistical analysis supported the conclusion that students of varied learning styles and levels of experience performed approximately the same on a task despite varied conditions under which they learned to use the software for that task. A possible interpretation of this result is that Sibelius, as an example of music notation software, is so well designed that it is usable by students with diverse characteristics. That is, the software appeals to students of all learning styles, with widely varying levels of experience, and can be learned through several teaching methods. This robust piece of software is widely applauded for its “user-friendliness,” which may have contributed to the lack of significant differences in achievement between the groups of participants. Software with weaker design, that offers fewer visual and aural cues, and that displays fewer of what Norman (1988) refers to as affordances may have resulted in less productive achievement scores.

The implication of this interpretation is that in selecting software for student use, across the many categories of music software, educators should seek the most robust, well-designed software available in order to insure that it will allow for successful experiences for their students. Software that is not designed to account for idiosyncrasies in usage patterns may yield less successful results for students who vary along learning style and experience variables, or who are taught to use the software in varying ways.
Legitimacy of Technology-based Music Learning

The National Standards for Music Education (Music Educators National Conference, 1994) represent the set of skills and knowledge that American students should acquire throughout their K-12 schooling in music. The procedures followed for this study address at least one of the content areas of the National Standards for Music Education: Standard #5, reading and notating music.

It has been suggested that each of the types of activities embedded within the recommendations of the National Standards in fact requires subset of the skills usually associated with the larger constructs of musicianship or musicality, and that each of these roles should be addressed distinctly and with appropriate pedagogical expertise (Reimer, 2003). The statistical analysis provides support for the claim that students of varying experiences, levels of expertise, and individual learning preferences can achieve equally well at computer-based music activities that address the above-referenced Standards. The implication of these findings, therefore, is that computer-based instruction may be a legitimate means by which to teach notation and listening concepts and to engage students in activities that reinforce these concepts. This proposition may substantiate teachers’ investments of time, and schools’ financial investments, in technologies as a way to provide these types of activities to widely varying populations of students. Rather than viewing technology as a dangerous replacement for the human interactions between teachers and students, technology can be presented as a powerful means of enhancing those interactions. This is an indirect conclusion, but echoes the type of claims made in reports of previous research that has examined learning styles and technology use (Ester, 1992).
Revisiting Learning Styles

As previously addressed in this chapter, several of the statistical analyses of learning style varied substantially for the Abstract Random style. While questions were raised about the reliability and psychometric validity of the Gregorc Style Delineator, a possible implication of this study is the suggestion of the importance of examining learning style. Regardless of the principles upon which assessment of learning style is based, or the instruments used to assess it, if we can accept the premise that students do indeed learn best with activities that address their individual preferences, then the measurement of those preferences remains an important pursuit. The differences between learners in the Abstract Random category support this assertion. The implication for music teaching and learning is that, if students do indeed learn differently based on individual preferences, then curriculum should account for those differences.

For example, Figure 4.8 portrayed the finding that, among Abstract Random learners who participated in this study, those who were part of the unguided learning condition performed better than those who followed the guided tutorial. Teachers should capitalize on this finding by using the method of instruction appropriate for individual students. The only way we can know students’ learning preferences is to measure them according to some established scale, be it the Gregorc Style Delineator or some other reputable measurement instrument.

In addition, the statistically significant findings about the “setup” score indicate that, for those particular tasks, students achieve higher when they are subjected to a guided learning condition. A direct implication of this finding is that, when teaching these initial steps of score creation in Sibelius (or perhaps in any notation program), teachers should use some type of guided method rather than allowing students to find their way through those steps.
Observations and Suggestions for Further Research

The nature of the procedures for this study allowed the researcher the opportunity to record some observational data during the second and third phases of the study. These observations lend themselves to suggestions for continuing the line of research that examines the ways in which students interact with technology in music education environments, and the factors which affect those interactions. The following suggestions are, in part, based on observations recorded during the data collection.

Instructional Techniques

The nature of the design of Sibelius, and perhaps of other notation software packages may suggest to students that the foremost task should be the entry of notes and rests. The significant disparity in the “setup” scores supports that students who were instructed in the use of the score setup tools recognized the importance of the visual layout of a notation file. If these tasks are not emphasized by the instructor, it is possible that students will address them incompletely or skip them entirely.

Designing multimedia learning artifacts, such as the video tutorial used in this study, must be done thoughtfully, and should involve interactivity. The students who participated in the study were all very focused on the tasks at hand, but none were more focused than the group who used the guided learning condition. They became deeply involved in the interactive elements of the video. This suggests the possibility that teaching other music technology lessons through the use of interactive multimedia may be equally as effective as unguided instruction or “live” teacher instruction. Future research should examine the use of multimedia for teaching other
types of music technology concepts and skills. This line of research could expand into the other suggested elements of music technology competency discussed in chapter 2.

Gender

In his synthesis of music technology education research, Webster (2002) called for further research in music technology as it is mediated by gender. Though not a variable in this study, it is possible that gender would affect student achievement in music technology tasks. It has been suggested that learning styles and cognitive styles may be mediated by gender (Sadler-Smith, 2001). Dorman (1998) reported that high school girls spend about two hours per week less using computers at home than do boys, and that there are differences in the tasks for which boys and girls use their computers; these gaps between gender were supported by Gilley’s (2002) findings. Fung (2003) found that, in a sample of pre-service music education majors, males \((n = 50)\) demonstrated greater familiarity with fourteen types of computer applications than did their female counterparts \((n = 85)\).

McGrath (2004) suggested:

A good deal more research is needed on the factors that encourage both girls and boys to accomplish greater fluency with the technologies available to them and to be able to use them to benefit their understanding of the subjects they are studying. (p. 31)

In relation to the present study, the group at Stevenson High School that experienced the guided learning condition was entirely female. Since the students were selected by the cooperating teachers, there was no way for the researcher to control for this variable. Future
research might examine the relationship between gender and learning styles, and the effects of both on achievement in music technology-based tasks.

Ergonomics and Lab Structure

As mentioned above, the physical arrangements of the labs at which data were collected may have had an effect on the efficiency with which students worked. Mills and Murray (2000) alluded to the limitations that young students experienced given equipment that was not designed to be ergonomically pleasing. The researcher observed the differences in ergonomic functionality between the four labs. In one of the labs used for data collection, the tables at which students worked did not have enough room for a MIDI keyboard and a computer keyboard to be placed side by side. For students who chose to use MIDI for note entry, this may have caused discomfort. Further research could examine the effects of ergonomic workstation design on the efficiency of students’ work with music technology.

Similarly, the students who experienced the guided condition were instructed during the tutorial that it was possible to use the MIDI keyboard to enter notes. The unguided condition participants may not have deduced that MIDI keyboard entry was possible; that is, the appearance of Sibelius is somewhat favored toward the use of the mouse for “point-and-click” note entry. The researcher observed only a small number of students in each group using the MIDI keyboard for data entry. Rather than quantifying music experience in the way that it was measured for this study, future research might examine the effects of specific types of music experience, such as piano study, on the use of music technology. It stands to reason that, among
students who enter data with a MIDI keyboard, better pianists would enter data more efficiently. This is another possible avenue of investigation.

Computing Experience

The analysis of the general technology experience variable presented in chapter 4 revealed that the participants in this study were a technologically-savvy group. Familiarity with the general functionality of computers and operating systems was evident in the observations. Students could be seen using techniques that had not been explained in the tutorial to access features of Sibelius. For example, many students discovered that clicking the right mouse button accesses several features and contextual menus. Students also made use of the “undo” commands without being made explicitly aware of the existence of that feature. These behaviors could logically be linked to a general knowledge of the functionality of computers. Though they might be difficult to find, an interesting line of research would be to examine the computer interactions of students with extremely limited computer experience.

Instrumentation

As discussed previously in this chapter, questions have been raised about the reliability, validity, and psychometric accuracy of the Gregorc Style Delineator. Given these criticisms, it may be appropriate to employ other measures of learning style in future related research. Specifically, issues such as ergonomics of workstation design may make appropriate the use of the Dunn and Dunn model of learning style measurement because it is largely concerned with environmental factors. In the present study, the results Gregorc Style Delineator were employed
as an independent variable; future work may examine the validity of learning style measurement in music and technology research by employing multiple learning style inventories and testing their predictive validity.

While questions are raised about the efficacy of the Gregorc Style Delineator, it is also possible that the lack of statistical significance for the main and interaction effects can be attributed to the other measures of independent and dependent variables for this study. It is possible that other means of measuring the independent variables (music experience, general technology experience, and music technology experience) were insufficient and that, as mentioned above, constructs such as notation experience and piano performance experience should have been measured.

As discussed in the limitations section above, more time with the students may have allowed for more intricately designed experiences for the two learning conditions. In addition, the guided and unguided experiences represent two extreme ends of the spectrum of procedures that might be employed to teach students to use the software. These two conditions were elements of the study that were almost completely controllable; that is, the interactions that students would have with the two conditions were uniform and could generally be predicted. Further research should consider the more ecologically realistic scenario of including a teacher in the learning equation. Introducing a teacher into this picture, of course, adds infinite subtleties and complexities to the investigation, but may indeed raise valuable implications about the technique of teaching music in a technologically-enhanced environment.
Other Dependent Measures

Analysis of the data from this study revealed the unexpected finding that a “sub-score” related to students’ achievement with tasks associated with setting up the notation file differed significantly between the two learning conditions. This difference was found because the analytical techniques were allowed to evolve throughout the course of the study. It is possible that other sub-scores or factors for which data were not collected would reveal similar differences. For example, additional research could examine the procedures that students use for note entry as a function of their prior musical experiences. There are infinite subtleties related to the ways in which people make use of software tools that, once reliably measured, may influence the efficiency of the practices of teaching people to use the software.

Other Software Tools

Finally, the underlying activity for this study, as discussed earlier in this chapter, was a series of procedures in which students were engaged in music notation tasks. Students were also able to use listening skills to detect errors. Further research efforts may focus on the effects of mediating variables on other musical skills. Presumably, research on this path would employ other software tools. A particularly interesting line would be to examine the ways in which students use sequencing software, which is an inherently more open-ended type of software. This type of research would follow more closely the course of recent studies (Daignault, 1996; McCoy, 1999; Smith, 2004; Strand, 2003; Younker, 1997) that examine students’ compositional practices.
Summary

The purpose of this study was to investigate the influence of individual learning styles, music experience, technology experience, music technology experience, and varied learning conditions on participants’ achievement with a music technology task. Students participated in a researcher-designed task to produce a dependent score which was analyzed in the presence of each of the independent variables. The five-way analysis of variance also examined the effects of the interactions of these variables on the dependent measure. None of the main effects, nor the interaction effects were found to be statistically significant. A measure of students’ achievement in certain elements of the task comprised a “sub-score” that was shown to vary significantly in the presence of guided or unguided learning conditions.

Despite the lack of statistical significance yielded from the main and interaction effects of this study, trends in performance were recognized that implied a degree of practical significance. In particular, students whose self-report measures categorized them as Abstract Random learners showed interesting deviations. Teaching music with technology is lent legitimacy from the results of this study because students who brought varying learning styles and experiences, and who were exposed to diverse learning conditions, were able to achieve consistently. The recognition of statistically significant differences between groups in the sub-score measure, along with the interesting learning style-based anomalies, warrants further investigation into the ways in which students interact with technology. Further study of students’ interactions with technology in music learning environments might employ other measures of individual learner characteristics and preferences, other independent variables, and different types of music technology.
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APPENDIX A

Demographic Survey Administered during Research Phase One

Music Technology & Learning Survey

Please write your name here: _________________________  _________________________

(Last)                                                               (First)

Directions: Your answers to these questions will provide valuable information about the ways
you learn music and use technology in your life. Please respond to each question carefully.

How old are you? ____________

What is your main instrument or voice type? ____________________

If you play other instruments, you may write them below:

How many years have you been playing your main instrument or singing? ____________

Rate your own ability at performing on your major instrument/voice type by circling one number
in this scale.

Novice     Expert

1  2  3  4  5  6

How many hours per week do you spend using a computer to do things like typing papers,
emailing, instant messaging, browsing the Internet, and other non-music related activities?

____________

Rate your level of expertise at using a computer for these non-music activities.

Novice     Expert

1  2  3  4  5  6

How many hours per week do you spend using a computer or other technology to do music-
related things like downloading music, recording/creating your own music, editing music, or
making custom CDs? ____________
Rate your level of expertise at using a computer for these music-related activities.

| Novice | 1 | 2 | 3 | 4 | 5 | Expert | 6 |

Thank you for completing this survey!!
APPENDIX B

Approval to Conduct Research from Northwestern University IRB

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March 20, 2006

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IRB Project Number: 1150-022
Study Sites: Other: Adlai Stevenson High School, Lincolnshire, IL; Watertown High School, Watertown, WI; Portage High School, Portage, IN; Lake Zurich High School, Lake Zurich, IL.

Project Title: Interactions of Styles of Learning Styles as Categorized by the Gregorc Style Delineator, Matched and Unmatched Teaching Conditions, and Student Achievement in a Music Technology Task

Submission Accession Number: 200602-1130
Submission(s) Considered: New Project
Recruitment Material: Other: email and telephone communications with teachers

Status: APPROVED

Your application for exemption from human subjects review for your project referenced above has been considered and approved. IRB approval includes approval of HIPAA Compliance. The study has been declared exempt from IRB review under 45 CFR 46.101(b) in accordance with the following criteria:

(i) Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

IRB approval is granted with the understanding that the investigator will:

• Change neither the procedures nor the consent form without prior IRB review and approval of those changes. Proposed changes must be submitted via the IRB Revisions Submission Form found on the OPRS website.
• Send a copy of the final approved consent form and a copy of this approval letter to the Office of Sponsored Research (OSR) if this is a sponsored project. Additionally, OSR must be contacted if any amendments are made to this project that may affect the award.

Sincerely,

Natalia Haidley, MS
IRB Manager

CC: Jay Dorfman
School of Music
711 Elgin Road
Room 123
EV

For more information regarding OPRS submissions and guidelines, please consult http://www.northwestern.edu/research/OPRS/ib.
This institution has an approved Federalwide Assurance with the Department of Health and Human Services. Assurance ID# FWA60001549.
APPENDIX C

Narration Text for the Video Tutorial

1. This tutorial will show you the steps you should take to build a score in the program *Sibelius*. This program can help you build just about any type of score, but for this activity, you will be focusing on writing music for a piano. You will learn how to re-create a piece of music by the composer Johann Sebastian Bach. The tutorial will show videos about how to do each step.

Before you begin, take a quick look at the piece of sheet music you have been given called Invention No. 1. Notice items such as the clefs, time signature, and any unusual elements that occur throughout the score. Click the Continue button when you are ready to go on.

2. Once *Sibelius* is open, you will see the QuickStart window. We are going to start a score from scratch, so click the selection for Start a new score, then click ok.

3. *Sibelius* has many different pre-made templates that you can use for writing music for different types of ensembles. For this activity, the music we will write is for piano. Scroll down in the list until you see the entry for piano, and select it. Click next to move to the next step.

4. Choosing a house style in *Sibelius* changes the whole look of the score. The fonts used for music notation and text change as part of the house style. For this activity, you do not need to change the house style. Leave the selection as Unchanged and click next.

5. a. In this part of the setup wizard, you can choose some of the initial elements of the score. As you may have noticed when you looked at the Invention No. 1 score, the time signature is common time. Should the time signature for your score not be listed, you can choose other and then select the top and bottom numbers manually.

b. This score does not have a pick-up measure, so we can skip that part of this window.

c. The tempo of the finished score is Allegretto. Click the dropdown arrow next to the tempo text box and choose that term. You can also have *Sibelius* create a numerical indication of
tempo. The program automatically determines the correct tempo when you select the text. We will click next to go to the next part of the wizard.

6. Here you can select from any of the major or minor key signatures. The finished Invention No. 1 score is in C major, which means there are no sharps or flats in the key signature. Be sure that C major is selected, then click next.

7. a. This is the final step of the score setup wizard, where you will enter elements of text to appear on your score. First, click in the title area and type the title of your piece, which in this case is Invention No. 1.

b. Next, click in the Composer/Songwriter area and type the composer’s name, which in this case is J. S. Bach.

c. Since this is an instrumental piece, there is no lyricist, so click in the copyright area. We don’t want any copyright information to appear, so simply highlight the text that is there and click delete.

8. We still have some preliminary steps to take to get this score ready to enter items such as notes and rests. By default, Sibelius builds a score with many measures that we don’t need, since our finished score will only be 22 measures long.

9. You can move around the score using the navigator window.

10. Or you can click in any blank area of the score. When the cursor turns to a hand, you can drag the score around just like a piece of paper on a desk.

11. We will find measure 23 since that is the first measure that we don’t need. In order to delete the measure, press control on your keyboard then click in the measure. Notice that a double purple box appears around the measure.

12. To select the entire group of measures we don’t need, we will navigate to the last measure.

13. Pressing shift and clicking in the final measure of the score will extend the double purple box around the entire group of measures.

14. Then press delete on the keyboard and they are removed from the score.
15. Use the navigator, or click and drag in a blank area to return to the top of the score where there are 22 empty measures.

16. With all of these elements entered, we are ready to start entering notes and rests into this score. There are several ways to enter notes and rests in *Sibelius*. The first one we will see is using the mouse to point and click them into the score.

17. Use the mouse to select the 16\textsuperscript{th} note from the keypad. Since the first symbol in this score is a 16\textsuperscript{th} rest, also choose the rest button.

18. Move your cursor into the score. You will notice the cursor carries a shadow that looks like a 16\textsuperscript{th} rest. Move that shadow to the spot in measure 1 where it should be placed, then click to insert the rest. *Sibelius* automatically converts the remainder of the beat to rests.

19. Notice that one element of the measure is highlighted in blue. Whenever something is lit in a color that means it is selected. To deselect elements, press the Escape key a couple times until nothing is selected. This can be a source of frustration with *Sibelius*, so make sure your press escape before selecting anything new.

20. Now move back to the keypad and select the 16\textsuperscript{th} note, but this time do not select the rest.

21. Return to measure 1 and enter the 16\textsuperscript{th} notes for the remainder of measure 1 in the treble clef staff.

22. Beat 3 in this staff switches to 8\textsuperscript{th} notes. From the keypad, select the 8\textsuperscript{th} note and enter the last two beats of this measure.

23. It is really up to you whether you continue working with the treble staff or switch to the bass staff. For the purposes of this demonstration, we will skip ahead a bit. Here we see the score with the first 4 measures of notes and rests entered. In measure 4 of the bass staff, the quarter not C is tied to the next note. To tie a note, click on it, then select the tie from the keypad. Notice that the keypad is the same configuration as the number pad on a computer keyboard. If you have a number pad on your keyboard, you can press the enter button to tie notes.

24. Now let’s look at another way to enter notes. This way may be a bit quicker than using the mouse to point and click. Select measure 5 of the treble staff. This measure starts with an 8\textsuperscript{th}
note on the pitch A. Choose the 8th note from the keypad, or press 3 on your computer keyboard’s number pad. Then type the letter A on your keyboard. Sibelius understands the letters A through G and notates them on the staff. The letters you choose will record pitches in the octave closest to the previous note. If you want to change octaves, use the arrows on your keyboard to move the note up or down.

25. Continue entering the rest of this measure using the number pad and the letters A through G on your keyboard.

26. When you encounter the F# at the end of beat 3, pressing 8 on your number pad will add the accidental.

27. Measure 5 is now complete. Another way to enter notes into Sibelius is to use a piano keyboard. If you have one attached to your computer, you can choose a rhythmic value, then press the note on the piano. It is not necessary to play in tempo if you enter notes this way.

28. The last way to enter notes into a score is using the piano keyboard in real time. If you are not a good piano player, this way might be difficult, but it is definitely the fastest way to get notes into the score. To do this, highlight a measure in the staff you want to record. Make sure the metronome button is pressed in the playback window, then click record. You will hear one measure of metronome clicks before recording begins. If you make mistakes, you may need to go back and edit them using the methods we have already seen.

29. This score now has 8 completed measures. Notice that in measure 9, the bottom staff switches from bass clef to treble clef. We need to enter that change manually. First, enter the first G 16th note.

30. Almost anything you would want to enter into a score can be found using the create menu. First, press the Escape key a couple times to make sure nothing is selected. Then choose the create menu, and select clef.

31. In the box that appears, choose the treble clef and click OK.

32. Something you won’t see in this video is that the Sibelius cursor turns colors. When the cursor turns a color, that means it is loaded up with an item. When you click on the score
with an arrow that has a color, you will place that item in the score. After the 16th note G, click in the staff to enter the treble clef. Now we can continue to enter the notes in the bottom staff.

33. We will skip ahead to the end of measure 12 where the bottom staff switches back to bass clef. We will follow the same procedure: press escape a couple times to deselect everything, choose create and clef, this time select the bass clef, click ok, and enter it in the score.

34. We are going to skip ahead again so that all 22 measures of notes are entered. This can be done using any of the methods we have seen such as pointing and clicking, using the computer keyboard, or using a piano keyboard. You may notice while building a score that Sibelius does quite a bit of re-spacing and moving measures from one line to the next so that the score looks clean and well-organized. You can always change these adjustments, and we will see how to do that later on in the tutorial.

35. The final measure of the piece has fermatas on both the top and bottom staves. Let’s see how to add those now. First press escape a couple time to deselect everything.

36. Then click on one of the notes where you want to place the fermata.

37. The keypad window does more than just add notes and rests. Click on the tab at the top of the keypad that looks like a fermata to see the functions in that area.

38. Now click the fermata button to add that symbol to the selected note.

39. Follow the same procedure for the bottom staff.

40. The last thing that this score needs is some adjustment to put the correct number of measures on each system. The first system contains 3 measures, and that is correct according to the completed version you have.

41. The second system starts with measure 4, but only contains 3 measures right now, so this needs some formatting changes. In this situation, we first need to select all of the measures to be included in the second system. Click in the first measure, here measure 4.

42. Then click in the last measure to be included in this system, which is measure 7, while holding the shift key. Now the whole group is selected.
43. From the layout menu, choose format, then make into system.

44. These four measures are now kept together in the second system.

45. Follow the same procedure to make a system that contains measures 8 through. Select measure 8…

46. Then hold shift and click in measure 11.

47. Choose the layout menu, then format and make into system.
Small errors were found in the scores for both Invention No. 1 (measures 10 and 13) and Invention No. 10 (measure 16) following the conclusion of data collection. The data were reviewed and it was determined that these errors had no bearing on the statistical procedures or the results of this study.
Appendix F
Point Values for Items Entered into the Score in the Achievement Task

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**Bass staff**

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</table>
VITA

Jay D. Dorfman

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Fields of Study
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Studies in Research: Professors Janet R. Barrett and Scott D. Lipscomb

Studies in Instructional Design and Education: Professors Daniel C. Edelson, Bruce Sherin and Allen Collins