USING WEB-BASED INSTRUCTION TO TEACH MUSIC THEORY IN THE PIANO STUDIO: DEFINING, DESIGNING, AND IMPLEMENTING AN INTEGRATIVE APPROACH

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Dissertation Prepared for the Degree of

DOCTOR OF MUSICAL ARTS

UNIVERSITY OF NORTH TEXAS

May 2010

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This dissertation rationalizes the best use of Web-based instruction (WBI) for teaching music theory to private piano students in the later primary grades. It uses an integrative research methodology for defining, designing, and implementing a curriculum that includes WBI. Research from the fields of music education, educational technology, educational psychology, and interaction design and children receive primary consideration. A synthesis of these sources outlines several research-based principles that instructional designers can use to design a complete blended learning environment for use within the piano studio. In addition to the research-based principles, the precise methods of determining instructional tasks and implementing the program online are described in detail. A full implementation is then deployed, and piano teachers evaluate the extent to which the online program fulfills the research-based principles. This dissertation does not argue for the complete migration of theory instruction from traditional workbook approaches to an entirely Web-based medium but rather outlines the best use of face-to-face instruction, collaboration amongst students, teachers, and parents, and interaction with a Web-based program. This formative research provides a complete model of integrating WBI within the piano studio that can guide instructional designers and music educators.
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CHAPTER 1

INTRODUCTION

Purpose of the Dissertation

The purpose of this dissertation is to propose an integrative research methodology for defining, designing, and implementing a Web-based program to teach music theory fundamentals to private piano students in the later primary grades. Several research-based principles guided the design and implementation of the program. These principles were determined using an interdisciplinary approach that integrated theoretical writings and empirical studies from the fields of music education, educational psychology, and educational technology. After implementing the program on a remote server, piano teachers evaluated the extent to which the program fulfilled the research-based principles. This process helps define a new pedagogical paradigm for integrating Web-based instruction within the piano studio by providing a set of principles and methods based on research and practitioner assessments.

Justification for the Dissertation

Music theory instruction is an integral part of private piano lessons, but piano teachers often struggle to find effective and efficient ways to include it on a weekly basis. Theory instruction is often segmented and isolated from authentic musical activities since instructional tools, such as workbooks, rarely provide a sufficient way for students to listen to and experience concepts in meaningful contexts. Lesson time can include these experiences, but if some of these experiences could be handled outside the lesson, more time could be spent on skills requiring personal interaction (e.g., performance).

Some methods for delivering theory instruction outside of lesson time have been
investigated for decades, but others have yet to receive full attention. Numerous empirical studies have demonstrated the efficacy of computer-assisted instruction (CAI) for teaching music theory, and the emergence of the World Wide Web has provided an additional medium for delivering instruction. Web-based instruction (WBI) also possesses additional capabilities that may enhance learning within the piano studio, but very little research that describes how to implement WBI within the piano studio currently exists. Since personal interaction is one of the many benefits of private instruction, WBI should not migrate all theory instruction to the Web but rather determine the best application of both face-to-face instruction and WBI. This dissertation will rationalize a model implementation of an integrated learning environment that blends WBI with face-to-face interaction.

When considering how to deliver theory instruction through a computer-based medium, the empirical studies that specifically investigate using CAI to teach theory provide a good starting place. There are many similarities between WBI and CAI. By first examining these similarities and their shared benefits, one can begin to see how WBI can help piano instructors teach music theory.

Empirical studies consistently reveal that using CAI either as a supplement to traditional teaching methods or as the sole means of instruction is as effective or more effective compared to instruction that does not use the computer. Although research involving CAI and music theory instruction has been ongoing since the 1960s, the studies most relevant to this dissertation date back to the late 1980s. For example, Owens compared test scores of a control group using a traditional workbook approach and a treatment group that included CAI and found that the CAI

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group performed much better.\textsuperscript{2} More recently, Baker compared test scores between a treatment group using the Music Ace\textsuperscript{3} software and a control group not using CAI. She found no statistical difference between the two groups.\textsuperscript{4} While studies such as these may oversimplify instructional variables (i.e., CAI versus no-CAI), they do still show that CAI is an effective instructional tool.

Some of CAI's more specific benefits include increased student learning, allowances for different methods of teaching and learning, and more efficient use of class time when material that can be taught via CAI is handled through that medium. For example, Parrish found that CAI reduced the amount of in-class time needed for introducing and discussing music theory without a significant drop in student test scores. She claimed that this was beneficial largely because it freed up more class time for activities not suited for computer-based learning, such as music performance.\textsuperscript{5} Similarly if most theory instruction in the piano studio could be transferred to WBI, teachers would be able to spend more time on performance skills without neglecting theory.

Most of the studies that compared using CAI and traditional approaches used different research methods and different instructional formats. Nearly every time, the CAI program was shown to be an equally valid medium of instruction. These findings have led some scholars to conclude that additional studies comparing traditional approaches against CAI are no longer needed. Webster explains that additional research comparing traditional and computer-based approaches is not appropriate since "the data are clear that, at least for lower-level skills and

\begin{itemize}
\item \textsuperscript{3} Harmonic Vision, Inc., http://www.harmonicvision.com.
\item \textsuperscript{5} Regina Turner Parrish, "Development and Testing of a Computer-Assisted Instructional Program to Teach Music to Adult Nonmusicians," \textit{Journal of Research in Music Education} 45:1 (Spring, 1997), 98, 99.
\end{itemize}
knowledge, technological approaches do equally well or better than more conventional teaching."^6

Other studies also accept the efficacy of computer-based approaches and reveal a shift in the literature towards investigating how best to use CAI. For example, Hopkins developed a customized CAI program for teaching theoretical concepts. He tried to see whether an expository or a discovery method of instruction was more effective for CAI.^7

Yet few researchers have discussed using WBI to teach theory fundamentals to piano students, and this application of WBI seems to be the next most appropriate area for research. Webster observed that "little or no research exists" for evaluating the effectiveness of complete courses of instruction based online and that "serious work in distance learning in music education is just beginning" and "the results seem intriguing if not promising."^8 Similarly, Musgrove described a trend towards using WBI in pre-college settings. She had used WebCT®^9 to design an online class for teaching K-5 students how to play the recorder.^10 Using a Web-based course management system (CMS) as a platform for delivering online content has therefore received some attention from music educators.

Many studies seem to accept an instructional dichotomy of traditional instruction (i.e., written work alone) versus technologically-mediated instruction. While such a distinction may be worth considering, it may also be an oversimplification of instructional variables. If mediums for delivering instruction are to be compared, then the instruction should be otherwise identical

in order to determine if the medium itself was a factor in producing different learning outcomes. Yet such a distinction may also fail to fully consider the pedagogical implications afforded by the different mediums.

If pedagogy should drive instructional choices more than technology, then the precise methods of interaction within each medium require careful consideration. For example, with CAI, concepts could be heard as they are visually highlighted within the score (see chapter 4). This specific functionality produces a different learning experience compared to a workbook. Similarly, instructional methods, rather than the technology itself, should provide the main impetus for instructional design choices. Therefore this dissertation does not argue for a complete migration of theory instruction to a Web-based medium. Instead, it considers the pedagogical implications of various delivery methods and models of interaction. These considerations lead to an instructional model that integrates WBI with face-to-face teaching and written work.

Although music educators are just beginning to explore possible applications of Web-based learning for music students, other disciplines have more experience in this area. Therefore this dissertation also reviews empirical studies and theoretical writings from these non-musical sources. By using an integrative research methodology, this dissertation can "interpret, draw together, and bring new insight to bear on original research" across disciplines.\textsuperscript{11}

By synthesizing scholarship from the disciplines of music education, educational psychology, and educational technology, a theoretical foundation for integrating WBI within the piano studio is defined. Including this instructional medium to teach theory fundamentals to private piano students could result in many of the benefits documented by empirical studies

validating the use of CAI to teach music theory and the use of WBI to teach math and science. As the adoption of Web-based tools continues to grow, there is an increasing need for research that identifies the best use of these tools within the piano studio.

Overview of the Dissertation Design

Research from the fields of music education, educational psychology, and educational technology guided the formulation of several research-based principles. These principles were designed to define an ideal integration of WBI within the piano studio. After designing the program, it was developed and deployed on a remote server. Piano teachers were recruited to evaluate the extent to which the principles were fulfilled by the program. Data from these surveys were used to refine the design of the program and clarify the principles.

The program was built using Moodle®, Adobe® Captivate®, Adobe Flash®, and other programs. Many of Moodle's built-in modules, such as the forum, quiz, and other modules were used, but customized learning objects (LOs) delivered most of the content and assessments. The LOs, built with Captivate, Flash, and other programs, were inserted into Moodle using the SCORM-compliant export and import features supported by Captivate and Moodle respectively. Using the custom-built LOs allowed for more flexibility when designing content and provided a better overall user experience. For example, complex animations, interactions, and synchronized audio are possible with these LOs.

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The development of this program happened through a series of builds and tests. After conceiving of the course as a series of lesson modules or LOs, smaller LOs were constructed and tested first for feasibility and to discover integration issues with Moodle. The smaller versions of the full-scale LOs contained all of the features required in the full-scale versions, but all of the content necessary for effectively implementing the LO into an actual learning scenario was not included until all of the integration issues were resolved. Once all of the issues of integration were resolved, the remaining lesson content was added to the LO. Chuang described a similar design and implementation process for creating an online music fundamentals course. He advocated creating small modules first and then testing them at early stages of development.15

After the program had been developed and deployed on the server, it was evaluated by piano teachers. Teachers evaluated the extent to which the online program fulfilled the research-based principles using 10-point visual analogue scales and text boxes. They evaluated the implementation of these principles within the program as a whole, for each of the three main content areas (intervals, major scales, and major key signatures), and other aspects of the program. After reviewing data from the teacher evaluations, modifications to the original research-based principles and the method of implementing the research-based principles were considered.

The end result from this dissertation is a series of general principles for integrating WBI within the piano studio and a model for implementing these principles. Web-based programs built around these principles should foster deeper musical understanding, save lesson time,

increase student motivation, encourage collaboration and creativity, and provide a more comprehensive method of theory instruction within the piano studio.
CHAPTER 2

REVIEW OF RELATED LITERATURE

Computer Assisted Instruction for Teaching Music Theory

The studies discussed below used some degree of computer-assisted instruction (CAI) for teaching music theory. Careful review of these studies will show typical research approaches, methods of curricular integration, types of interaction with the computer and other students, and unique instructional tools using CAI. Although many of these studies simply consider whether or not computer use can improve learning outcomes, some do start to reveal a trend towards considering alternative instructional strategies with CAI. Most curricular models described below use CAI as a supplement to other types of instruction. Frequently the potential of the computer as a social agent or as a tool for facilitating interaction amongst classmates is considered. By reviewing these aspects of the studies below, the significance of the current study can be more fully understood.

Owens compared the test scores of two groups of 11 students each using instruction without CAI and instruction supplemented with CAI. Both groups of students ages 6-12 met for 30 minutes each week for 18 weeks. Group A received "traditional" instruction with puzzles, exercises, and board games. Group B primarily used CAI but also workbooks to practice written notation. The CAI program used drill and practice, tutorials, and games with two to three students at each computer in a classroom with teacher assistance. On posttests students in group B had a mean score of 97.15 compared to the control group's mean score of 85.46 with a confidence level of .05.¹ Although the difference between these two groups does seem to strongly favor the CAI approach, this study has some weaknesses that slightly diminish the

significance of its findings. Eleven students in each group is too small a sample size for a comparative study of this type, and Owens' only controls for creating equally heterogeneous groups was pretesting each student using the theory test developed by the Texas Music Teachers Association. Many of the studies below used more rigorous controls and have much larger control and treatment groups.

Hesser conducted a study with 100 3rd grade students divided into three groups: a control group that did not use CAI and two groups that used CAI. All the teacher-led instruction took place during music classes that met for 30 minutes, twice a week, for six weeks. For each week, the first class period was the same for all three groups as the teacher presented new material. The second class period varied between the three groups. In the non-CAI group, the second class period was a teacher-led review session. In the first of the two CAI groups, the teacher presented a lesson in music appreciation in the second weekly session while the students were allowed to use the CAI program on their own during regular class time. In the second CAI group, the students reviewed concepts at computers for the full 30 minute class period. Both CAI groups used the computer only for reinforcement since all of the material was introduced by the teacher. When comparing the differences between posttest and pretest scores of the three groups, both CAI groups performed much better than the group that did not use CAI. The classes taught staff, pitch, and duration identification. Hesser credited the change in learning outcomes to the "electronic learning environment" itself. She argued that it created a change in the students' processing of the information by making the symbols easier to manipulate onscren. Additionally, she thought that CAI offered better reinforcement compared to the classroom review.² Therefore Hesser seemed to attribute the enhanced learning of the treatment groups to

² Lois Annette Hesser, "Effectiveness of Computer Assisted Instruction in Developing Music Reading Skills
the instructional model (i.e., drill) that provided immediate feedback and the interactive features of the interface.

Bresler's study is one of the few within last two decades of the twentieth century to assert that the computer should not be treated as an independent variable. She argued that the success of CAI is largely determined by the context in which it is used. She used open-ended interviews with 20 college students taking an introductory music theory course in which 6 students did not use CAI and 14 supplemented their in-class learning with CAI. She found that the operational curriculum (i.e., that which actually occurs within the classroom) often conflicted with the intended method of integration between the program and classroom instruction. She observed that the instructor's use of the CAI program within the course was the primary determinant of its success. Specifically, she believed that the instructor was reluctant to relinquish his position of authority by encouraging students to use this additional tool, and that he ignored other potential curricular designs afforded by the computer program.3

Bresler's later work with Walker also investigated the processes that determine the success or failure of CAI programs using an introductory college music theory class with an optional CAI component to supplement in-class instruction and the textbook. They similarly found that people and institutions ultimately determine the success or failure of CAI and not simply the program's ability to meet a need. They argued that new curricular approaches are required in order to incorporate CAI with instruction. Teachers must be willing to adjust their traditional role as the exclusive facilitator of instruction. Additionally, if the use of the CAI component is not compulsory, then students will probably use the program based upon how

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much enjoyment it can bring them.  

 Willett and Netusil taught bass clef note names to 4th grade students in either a classroom setting or using CAI. They tried to see if there was any interaction between instructional setting and learning styles of field dependency. The instructional approach between the classroom setting and the program was similar, but students using the program still performed better than those in the classroom. They did not find any interaction between instructional setting and field dependency, and field independent learners scored higher in either setting. They also concluded that the CAI group may have performed better due to fewer distractions in the CAI learning environment than within the classroom.

 Weintraub developed a curriculum for 6th grade students in a general music classroom setting that included CAI. His goal was to show that CAI could improve the retention of music fundamentals. Students met in group classes with two students per computer. Materials were also discussed as a class away from the computers. After three months, students demonstrated that they could retain the material taught, and the music education staff reported that student motivation had increased. Little statistical analysis was used since the students were only required to meet several instructional objectives. Although the efficacy of the CAI approach was not compared against another instructional model, it still showed that adding CAI to a theory curriculum can improve learning and motivation with late elementary students.

 Herzig found that CAI could save time spent on theory instruction in class. A basic music theory class for non-music majors was taught without CAI in a fall semester (control group,

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6 David Weintraub, "Improving Retention in Music Fundamentals through the Use of Computer Based Instruction" (Ed.D. diss., Nova University, 1991).
The CAI program used a drill and practice approach to reinforce note identification, aural skills, and identification of cadential patterns. Students in the experimental group were dismissed 20 minutes early during five different class meetings. These early releases accounted for 100 fewer minutes of classroom theory instruction over the semester, but the CAI group spent, on average, an additional 211 minutes of time at a computer lab. By comparing posttest and pretest scores, the two groups showed statistically similar performance. Herzig argued that by allocating theory instruction to the computer, more class time could be directed to skills acquisition (i.e., performance). However, although the program saved class time, students spent, on average, an additional 111 minutes at the computer compared to spending more class time on theory. Additionally, in this experiment, subjects in the CAI group did not spend significantly more class time on performance skills since they were dismissed early from the class to work at the computer. Considering the reallocation of time, one may argue that the instructional format for the CAI group was actually far less beneficial since it required more time from the students without noticeably better test scores. Students also did not receive additional performance instruction within the classroom. Even if the extra 100 minutes of class time had been spent on performance, the CAI group would have still spent an additional 211 minutes at the computer. Perhaps this tradeoff would be acceptable in some situations.

Young created a music theory curriculum for elementary students in private piano lessons that included a CAI component. Students were taught in a theory class separate from their regular lessons. There were two students in each class, and they used four different computer programs at two different computers. To evaluate the effectiveness of her curriculum, she used

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six students ages 7 and 8. At the conclusion of her 10 week program, students received posttests, and Young interviewed the students and their parents. Her results indicated that students learned the material and that the CAI component increased motivation.  

Arenson helped create a program at the University of Delaware to help college music majors develop harmonization, part-writing, and musical analysis skills. He argued that although many drill and practice programs for teaching fundamental music skills exist, few include these more complex tasks. Through a grant from the University of Delaware, he worked with software designers to develop and test a program over several years. The program allowed for theory instructors to customize certain aspects of the program. Instructors could adjust the number of correct responses students must provide and the amount of time each student was allowed to complete a task. Also considered by Arenson to be an important design feature, instructors could customize some aspects of the content itself. Specifically, instructors could adjust the number of chords in particular exercises, types of questions, key signatures used, pitch input method, types of harmonic labels, and which chords could be included in the exercises. Although most of the exercises were drill and practice, they also created customized feedback. Arenson argued against using non-specific feedback in favor of a system that described the errors students made in greater detail. For example, the system was able to tell students if they had constructed chords using non-chord tones or tones that were beyond the range of a voice type. Attitudinal surveys revealed that students enjoyed working with the program and it increased self-efficacy.  

Arenson’s project is one of the few to consider teaching part-writing skills with targeted feedback

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and additional customization features. His approach required extensive programming resources but also created a novel drill and practice method.

Parrish conducted two experiments with two groups in each to determine if CAI could help teach fundamentals to undergraduate students preparing for elementary music teaching. Both experiments lasted the entire 15-week semester. Class content between the two experiments differed although they both included theory fundamentals. In the first experiment, the control group \((n=77)\) used CAI only for drill and practice, and the treatment group \((n=71)\) used CAI for both the presentation of materials and drill. The control group also received written homework, but the treatment group did not. The treatment group gained 301 minutes of class time for answering questions and working on performance skills compared to the control group. When adding the amount of time spent on theory instruction in class to the average amount of time spent with CAI, the treatment group spent 329 minutes more than the control group over the semester. However, this number does not factor in the additional homework time for the control group, so the difference of total time spent on theory may have been less.

In the second experiment, the control group \((n=45)\) did not use CAI for any part of the work. The treatment group \((n=50)\) used the same CAI approach as the treatment group in the first experiment although less content was covered. They only used the program one hour a week for 10 weeks, and gained 136 minutes of class time by using CAI. With both experiments, there was no significant interaction between the use of CAI and test scores.\(^\text{10}\) These experiments show that drill and practice can be used as an effective supplement to traditional instruction or in combination with a program that also introduces theory concepts.

Auh’s study is one of the few that focused on teaching advanced musical skills. To

rationalize his approach, he used cognitive flexibility theory to guide the design of his implementation since it is more applicable to the ill-structured knowledge required for advanced analysis tasks. His final program included diverse features such as a way for students to share videos of their performances, an online dictionary, a concept mapping tool, a quiz authoring tool, timelines linked to additional information, and a method for teachers to review how students interacted with the program. Auh developed several guidelines for designing the program's interface. Most of his assessments of the program used usability testing methods that served as a formative evaluation. The program was not evaluated according to whether or not it increased student learning, but he did allow for students to work with the program and report their attitudes about the program and its ease of use. He determined that assessment of student learning outcomes was beyond the scope of his dissertation. Auh's project is unique since the main goal of his research was to rationalize the best design approach for this mode of instruction and then implement it. Additionally, Auh created several unique Web-based instructional tools that encouraged collaboration and exploration.

Baker compared the posttest scores of two groups after four weeks of instruction. There are problems with using the data from the posttest scores. There were only 15 students in each group, no pretest was administered (although students had been placed in the classes due to outcomes from previous assessments), and the posttest was only ten multiple choice questions with three possible answers for each question. The 2nd grade students learned clef names and note names in one of the two group classes that met for 30 minutes twice a week for the four week duration of the study. The control group learned the concepts using Koday, Orff, Dalcroze, Yoon-il Auh, "Designing and Creating an Interdisciplinary Learning Environment Using Cognitive Flexibility Theory for Knowledge Promotion Acquisition Among Advanced Music Students" (Ed.D. Thesis, Teachers College, Columbia University, 2000).
and no CAI, and the treatment group used Music Ace® with one computer connected to a large screen television. The treatment group took turns answering questions at the computer. The control group did not receive individual turns in front of the class. A t-test showed no statistically significant difference between the posttest scores of the two groups. The teacher did however report that students in the treatment group seemed to be more attentive and were "drawn in" to the lessons more quickly. From this study it is difficult to determine if those observations were a result of the software used or the increased student involvement since students in the control group did not take individual turns. One may note however that CAI may be used effectively in a group format even if there are not enough computers for each student to have their own.

Chuang researched and defined an approach for implementing Web-based instruction (WBI) to teach music fundamentals to pre-college students. He pointed out that there is a distinction between applying learning theories to instructional design, which are mainly descriptive, and using applied design approaches that outline specific procedures of development and implementation. His approach was primarily the latter. He included recommendations, but his research was limited to describing design and development phases. Chuang borrowed from instructional designers outside of the music field and synthesized the models in order to relate them to designing for teaching music fundamentals. For example, Chuang suggested that designers should begin by making very small modules first and testing them before designing the complete implementation. He also advocated conducting a task analysis by listing all required tasks in as much detail as possible, using as few sophisticated technologically-based features as

possible, and to conceptualize the course as a series of instructional modules so that students can see themselves meeting objectives.\textsuperscript{14}

Hopkins used CAI to help determine if an expository or discovery method of instruction was best for teaching aural recognition of four different kinds of variation: ornamental variation, figural variation, modal variation, and tempo variation. With the expository approach, the program first defined the four variation types then provided examples and practice exercises. With the discovery approach, examples and exercises were given first and students were allowed to work on them, and then the program provided the definitions. Hopkins used undergraduate students with 15 in the treatment group (discovery method) and 12 in the control. Students spent an average of 81.2 minutes to complete the instruction and were given posttests immediately following the instruction and retention tests six weeks later. The subjects were pretested using Gordon's Advanced Measures of Music Audiation, and a $t$-test for independent means revealed no significant difference between the groups. Both groups had no significant differences in posttest or retention scores. There was however a moderate and significant correlation between the practice exercise scores contained within the lessons, posttest scores, and retention test scores. In addition, the treatment group, on average, spent more time on the program, and their practice exercise scores had a larger standard deviation than the expository group. Hopkins also asked subjects to verbalize a definition of each variation technique immediately after the practice exercises contained within the lessons. He found a high and significant correlation between subjects' abilities to recognize variation types aurally and the ability to verbalize an accurate

\textsuperscript{14} Wen-Hao Chuang, “Formative Research on the Refinement of Web-Based Instructional Design and Development Guidance Systems for Teaching Music Fundamentals at the Pre-College Level,” In \textit{Annual Proceedings of Selected Research and Development Papers Presented at the National Convention of the Association for Educational Communications and Technology} (Vol. 1-2, Denver, CO, October 25-28, 2000), 64-75.
Hopkins' study has less to do with CAI for its own sake and more to do with determining an instructional approach that maximizes learning outcomes. Yet it does reveal that learning can occur with CAI since the posttest scores and retention test scores were significantly better than pretest scores for both groups. Pedagogically, this study shows that, for some instruction, expository approaches (i.e., direct instruction) may be as effective as discovery methods. Additionally, this particular discovery method might be less effective for some students (as suggested by the higher standard deviation of test scores in the treatment group). Since the discovery method also took more time, one may argue that it is less efficient. However, Hopkins' implementation of discovery approaches is not necessarily typical since many discovery approaches provide means for non-linear exploration, and Hopkins' lessons did not seem to use this format.

Donnelly interviewed 13 music teachers in her school district in the northwestern United States to see how they used CAI in their music classrooms. She then incorporated CAI into her own classroom and observed how her students interacted with the program. In all she observed 24 4th grade students and 47 3rd grade students over one year in a music classroom. The results from her survey and observations led her to conclude that one of the main reasons students enjoyed working with CAI was because they could learn by themselves and at their own pace. She also concluded that CAI is most beneficial when used in combination with other approaches such as group activities.16

Sterling outlined the design process for creating a CAI program to help college students

analyze musical form. She also had 11 students use the program and complete a questionnaire. She later evaluated usage data from their time with the program. Sterling reported that some features of the program were the most significant. Specifically the program provided a complete graph of the form of a piece and users could play each composition and follow along with the score. She also found that students tended to start their analysis by finding phrases first instead of finding major sections.\(^{17}\) Her study is one of the few that considered teaching more advanced skills using a novel user interface. Although the lack of a complete statistical analysis, due primarily to the small sample size, prevented her from making conclusions about the efficacy of her approach, it still outlines one possible computer-based solution for teaching analysis with CAI.

Musgrove and Musgrove created a Web-based course using WebCT\(^{18}\) for teaching K-5 students how to play the recorder. Their course was a pilot study designed to be "an example of good practice" using students in grades 3-5 in a group classroom setting. They did not conduct a statistical analysis of learning outcomes, but they did report that 98% of the students that took the course "had positive comments" on a survey. They discussed student cognitive capacities by referencing some literature from educational psychology and suggested, for example, that the instruction be broken down into very small units in order to accommodate the limited short term memory of the elementary students.\(^ {19}\) Their study is one of the few to consider using WBI with elementary students. They argued that WBI is a valid instructional medium for elementary students when used in combination with other instructional interactions.

\(^ {17}\) Jennifer Sterling, "Reinventing Music Theory Pedagogy: The Development and Use of a CAI Program to Guide Students in the Analysis of Musical Form" (Ph.D. diss., University of Maryland, College Park, 2002).
\(^ {19}\) Ann Musgrove and Glenn Musgrove, "Online Learning and the Younger Student-Theoretical and Practical Applications," Information Technology in Childhood Education Annual (2004): 213-225.
Owens and Sweller considered whether principles and effects described by cognitive load theory are equally applicable to music theory instruction. As such, this study is not primarily about developing CAI for music instruction but more about validating the applicability of broad theories of learning to diverse disciplines. Owens and Sweller conducted two studies to evaluate whether the split attention and modality effects also apply to music instruction. In the first experiment, 79 students ages 11-12 were taught to complete an incomplete measure with appropriate note values. The instruction was delivered in three different formats: musical notation with written explanations near the bottom of the page in a step-by-step setup (split-attention format), musical notation with written explanations immediately above and below the music with arrows pointing directly to relevant details in the music (integrated format), and written music with explanations presented aurally only (dual modality format). Problems presented during the instruction, immediately after, and transfer test problems all showed a significant difference between the split attention format and the integrated or dual modality formats in which students in both of the latter two groups performed much better than the first. There was no significant difference between the latter two groups.

In their second experiment, 77 students were placed in one of four instructional treatments (20 students in one of the groups and 19 in the other three) in order to learn about different kinds of musical variation. The first group was shown the notation, heard the excerpt, and viewed explanatory text all on one PowerPoint slide (simultaneous, with notation). The second group viewed the explanatory text on one slide, then saw the music and heard the excerpt on the second (successive, with notation). The third group saw the explanatory text and heard the musical excerpt on the same slide without viewing the notation (simultaneous, without notation), and the fourth group viewed the explanatory text on the first slide and then heard the
excerpt on the second (successive, without notation).

In the study by Owens and Sweller, the presence of musical notation did not prove to be significant when comparing test scores. However the temporal condition (i.e., simultaneous or successive presentation) did prove to be significant. The authors did not conclude that the presence of notation was facilitative or redundant and questioned if significantly different learning outcomes would be found as the complexity of the content increases.20 The primary purpose of this study was to validate the applicability of cognitive load theory principles to other disciplines. Designers of music instruction should consider these findings and the other effects from cognitive load theory when designing CAI.

Many of the studies cited above begin by justifying design choices from relevant research, often including research from educational psychology. Constructivism continues to play a major role in rationalizing instructional approaches in technologically-driven environments21 and the traditional classroom.22 Some of these studies grapple with larger issues of constructivist-driven approaches (e.g., Hopkins) while others look at specific design choices (e.g., Sterling), or broader practical issues of implementation (e.g., Bresler). Most of these studies use CAI as a supplement to other instructional methods. Some also use very specific models of learning such as Auh's application of cognitive flexibility theory. In order to help define a new pedagogical paradigm for integrating WBI within the private studio, applicable learning theories must be similarly considered.

22 For example, see Theodore Edward Buehrer, "An Alternative Pedagogical Paradigm for Aural Skills: An Examination of Constructivist Learning Theory and its Potential for Implementation into Aural Skills Curricula" (Ph.D. diss., Indiana University, 2000).
Discussion of Relevant Learning Theories and Instructional Strategies

Before describing specific methods for applying learning theory to the implementation of a Web-based theory program, a brief overview of relevant theories and instructional strategies should prove helpful. One of the main areas of discussion for many educational technologists deals with the degree of guidance offered by the learning system.\(^\text{23}\) On one end of the debate are approaches that gravitate towards minimal guidance and at the other end are those that gravitate towards maximum guidance. In the field of educational psychology, behaviorist, constructivist, and cognitivist oriented theories take different approaches in arguing for the degree of guidance instruction should provide. Yet polarizing the instructional debate into two extremes oversimplifies the learning process and may lead to erroneous assumptions such as the need to replace behaviorist approaches with constructivist ones.\(^\text{24}\) Although some of the discussion may be framed along these two extremes, describing the best use of educational technology may involve using multiple approaches depending upon the type of knowledge to be learned and the context in which it is to be used.

Many early applications of instructional technology from the 1960s and 1970s were based on behaviorist theories. Behaviorism assumes that ideas and knowledge are not innate mental precepts but result from sensory experiences of physical matter. Therefore only observable behaviors are important to understanding learning. Since animal and human behavior are governed by natural laws, an individual may not possess free will. Therefore the student


does not assume any responsibility for learning, and the author of the instruction directly controls learning outcomes.25

These beliefs about learning led to systems that contained maximum guidance and very few learner choices. One of the most influential behaviorists, B. F. Skinner, developed a “teaching machine” by applying his principles of “operant conditioning.”26 Similar examples of behaviorist instructional strategies include programmed instruction, tutorials, and drill and practice.27 In the early 1980s, computers were still most commonly used for drill and practice exercises,28 and many Web-based learning systems continue to use these approaches well into the twenty-first century.

The instructional strategies most relevant to the current discussion include programmed instruction, drill and practice, tutorials, and mastery learning. With programmed instruction, information is given in very small steps, and each step requires a correct response before proceeding to the next.29 Drill and practice requires learners to acquire a predetermined measure of proficiency using repetition of specific tasks. Generally drills may either be structured to loop continuously until sufficient scores are achieved or utilize branching scenarios with targeted feedback. Usually no initial instruction is provided with drill and practice since it is typically meant to reinforce material already taught.30 In a tutorial, students receive instruction and are

26 Ibid, 85.
30 Ibid, 4-5.
often required to provide some feedback during the instruction.\textsuperscript{31} Although many educational technology programs separate tutorials from drill and practice, drill might also be considered an integral part of most tutorial programs.\textsuperscript{32}

Somewhat similar to how many instructional designers implement tutorials, mastery learning frequently contains at least three main components: concepts and skills are organized into instructional units that define criteria for mastery, frequent brief formative assessments are made as students progress towards mastery, and corrective instruction is provided for concepts not mastered.\textsuperscript{33} Early implementations of mastery learning focused on low-level skills using very small segments of instruction with very little teacher interaction. However Bloom, one of the originators of mastery learning, had actually stressed using a more flexible application of mastery learning that included more involvement from teachers and greater focus on higher level learning.\textsuperscript{34}

For a substantial portion of the twentieth century, constructivist oriented views of education have led to numerous other ways of describing how humans learn. Constructivism is not one specific theory of learning but rather an epistemology that individuals construct their own knowledge.\textsuperscript{35} Learners use schemas to create their own mental representations of what they experience in their environment. This view of learning contrasts dramatically with the behaviorist paradigm that sees students as empty vessels to be filled by a teacher who deposits their knowledge, by modifying stimulus-response connections.

By considering how the learner processes information in a culturally constructed

\textsuperscript{31} ibid, 7.
\textsuperscript{34} ibid, 21-22.
\textsuperscript{35} Jonassen, "A Constructivist’s Perspective on Functional Contextualism," 43.
environment, the constructivist paradigm has prompted several other areas of investigation. Vygotsky and Piaget are possibly the most influential constructivists. Vygotsky's social constructivism describes the learner as one who acquires knowledge by continually interacting with the environment, and social cognitive theory similarly focuses on the role of culture in the learning process. It attempts to explain behavior by integrating the role of environment and cognition.\textsuperscript{36} Piaget's constructivism tends to focus more on constructing new knowledge structures from existing structures rather than the environment.\textsuperscript{37}

Writing in 1996, Jerome Bruner identified two major ideas about how the mind works. He believed that these two ideas led to fundamental changes in conceptions about the nature of the human mind. One of these views proposes that the “mind is both constituted by and realized in the use of human culture,” a view that is typically described as social constructivism. The other is the hypothesis that the “mind could be conceived as a computational device.”\textsuperscript{38} The latter view is usually considered an important aspect of cognitivism and described as the information processing model. Cognitive approaches typically focus on precise mental processes that occur during thinking and frequently reference models of human thinking that are influenced by the way information is organized and processed in computers.

Learning theories and instructional strategies based on social constructivism typically emphasize social participation, embedded learning with authentic activities, and tools to support learning.\textsuperscript{39} By focusing on how interactions with other people can affect learning, many instructional strategies insist on the fundamental importance of collaborative learning in an

\textsuperscript{39} O'Donnell, et al., \textit{Educational Psychology}, 323.
Asynchronous and synchronous modes of communication facilitate online learning using forums, chats, bulletin boards, e-mail, and other forms of exchange. Students may work in small or large groups or contribute to a larger community such as a Wiki. The degree of guidance offered by these instructional systems can vary greatly.

With situated cognition, learning happens during an activity that is contextually and culturally situated. Therefore the effect of contextual and cultural factors involved in the learning process often receives greater consideration than the learning tasks themselves. “Situated cognition is a characterization of how learning takes place not just where it takes place” (italics are original). Proponents of this approach argue that knowledge is situated by default: it is a product of the activity, context, and culture in which it is learned and used. Therefore instructional designers should create a learning environment in which the learner can engage in sustained exploration of authentic activities in order to help facilitate the development of usable knowledge. Providing an opportunity to collaborate and reflect collectively helps situate learning within a social context and can therefore enhance the authenticity of activities and help allow for competing solutions and diverse outcomes.

A related approach that emphasizes the situated nature of learning is cognitive apprenticeship. First described by Collins, Brown, and Newman in 1987, its main goal is to make the learning process visible. As the name implies, it is based on a fairly traditional view

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45 Allan Collins, et al., "Cognitive Apprenticeship: Teaching the Craft of Reading, Writing, and
of exchanging expert knowledge with the learner through a type of apprenticeship involving observation, coaching, and successive approximation. Using a view similar to situated cognition’s emphasis on authenticity of activities, cognitive apprenticeship tries “to enculturate students into authentic practices.” Brown, Collins, and Deguid had argued that different activities and situations can produce different results even if the target knowledge is the same, and that cognitive apprenticeship is at least one ideal approach that situates learning in a “social and physical context.”

The four main processes involved in most models of cognitive apprenticeship include modeling, scaffolding, fading, and coaching. During the modeling phase, the apprentice observes the expert in a task sequence appropriate for their ability. Then the novice attempts the task with expert help. With appropriate scaffolding, the learners are assisted by a “more knowledgeable other” to do the tasks more independently. As the fading process begins, the expert begins to transfer responsibility to the apprentice but is still available if help is needed. Throughout the entire learning sequence, the expert is constantly coaching the novice.

Possessing similarities with both cognitive approaches and social constructivist principles, various learning styles models have emerged over the last few decades of the twentieth century. These models are concerned with personal preferences for how information is perceived, processed, and remembered. Perhaps the most frequently discussed is the Dunn and Dunn model.

Dunn and Dunn define learning style as the way a person “begins to concentrate on,
process, internalize, and retain new and difficult academic information.”

Their model identifies five basic stimulus strands: biologically-imposed environmental elements, emotional elements, sociological elements, physiological elements, and global vs. analytic processing-style differences. The biologically-imposed environmental elements are concerned with elements in the learner's surroundings such as sound versus quiet and low light versus bright light. Many of these elements are most relevant to classroom teachers that are able to modify the student's environment. Emotional elements include considerations such as persistence versus needing breaks and therefore emphasize that a student's affective state can influence the quality of learning. Sociological elements situate learning in a cultural context and therefore focus on preferences such as working alone versus working in pairs.

The physiological elements are considered the most important by Lovelace and other authors. Dunn and Dunn identify four modalities: auditory, visual, kinesthetic, and tactile. Many authors choose to focus on auditory, visual, and kinesthetic and do not differentiate kinesthetic from tactile. Students and teachers are required to identify students' perceptual strengths, and the initial exposure of new concepts should start with the strongest perceptual strength. Then reinforcement should come through secondary or tertiary perceptual strengths within about one day.

Although the Dunn and Dunn approach has been used in classroom settings, many scholars are skeptical of its benefits. Many of the criticisms arise from pragmatic difficulties of its implementation. Other educators are pedagogically and philosophically uncomfortable with

the idea of defining students “too narrowly” so that their ability to make connections and be challenged is lost.⁵⁴ Perhaps most importantly, some scholars have questioned the validity of the research that Dunn and Dunn proponents cite to justify its efficacy.

Kavale and LeFever criticize Lovelace's meta-analysis of the Dunn and Dunn model.⁵⁵ They explain that Lovelace's analysis leaves out important information required in a meta-analysis and possesses a biased sampling using questionable sources.⁵⁶ By omitting studies that use models other than the Dunn and Dunn model, Lovelace does not provide a fair comparison between this model and others that should “vary across a number of dimensions to achieve generalizations across an entire research domain.”⁵⁷ Moreover, 96% of the included studies were unpublished dissertations and 70% of those were conducted at St. John's University where Rita Dunn teaches. Kavale and LaFever also argue that Lovelace even omitted some dissertations at St. John's that would have been appropriate to include.⁵⁸ Finally other vital statistical information, such as measures of variability, were left out.⁵⁹

By requiring prior assessments of student learning styles, many learning style implementations require more time upfront. If implementation of these approaches uses more planning time for the teacher and more class time for the students, and if the efficacy of models such as the Dunn and Dunn is questionable, then it becomes difficult to justify their use. Although these models can provide insights into human processing and perception, other approaches that address presentation modalities (described later) may be more appropriate for

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⁵⁶ ibid, 95-96.
⁵⁷ ibid, 94.
⁵⁸ ibid, 96.
⁵⁹ ibid, 95.
multimedia instruction.

Other constructivist theories address the precise sequence of instruction more directly. Instruction based on discovery learning principles usually guides students through various kinds of exploration, experimentation, and question generation activities so that they can discover the main concepts for themselves. Although discovery learning can be implemented in many different ways, most approaches provide some structure to activities. The main rationale for using this approach is that students who acquire knowledge on their own are more likely to possess a deeper understanding of it and apply it to different contexts than if the knowledge had been taught to them using direct instruction methods.

One of the primary issues with discovery learning is deciding how quickly the instruction should help students progress through the discoveries. The help given to students by many such approaches is frequently offered on a just-in-time basis providing extensive scaffolding in the form of direct instruction. Yet the main difference here between a discovery learning approach and a purely direct instructional approach is that the guidance comes after students have experienced the need to know important concepts in a less guided context. The process of discovering a need for the conceptual knowledge also frequently fosters increased intrinsic motivation to learn more about the concepts being explored. Perhaps the ideal balance between minimal guidance and maximum guidance makes important concepts clear while motivating students to find answers to authentically situated questions they have been led to ask.

The development of the information processing model was influenced by the way

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62 Hammer, "Discovery Learning and Discovery Teaching," 489.
63 Hmelo-Silver, et al., "Scaffolding and Achievement in Problem-Based and Inquiry Learning," 100.
information is organized and processed in computers. Processing of even the most elementary information is described in great detail, and although these models do not completely explain human processing, they do provide a useful framework for designing instruction.\(^{65}\) Two important principles that have come out of this model are the categorization of three kinds of memory systems and the limited capacity assumption. The three kinds of memory systems described in information processing models and earlier cognitive theories are sensory memory, short-term or working memory, and long-term memory. The limited capacity assumption asserts that not all available information can be processed simultaneously because of the limited capacity of the working memory system.\(^{66}\)

Built around the information processing model, cognitive load theory views human cognitive architecture as a model in which new material must be processed using a limited working memory that includes partially independent channels for auditory and visual information.\(^{67}\) The main goal of instruction is the construction and automation of schemas for solving problems.\(^{68}\) The emphasis is on the constraints of working memory, virtually unlimited capacity of long-term memory, and the assumption that intellectual skill comes from constructing increasingly sophisticated schemas with high degrees of automaticity.\(^{69}\) Cognitive load theory also assumes dual processing channels: auditory/verbal and visual.\(^{70}\)

Cognitive load theorists often argue that working memory capacity may be enhanced if

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\(^{65}\) Taylor and MacKenney, *Improving Human Learning in the Classroom*, 92-93.
\(^{69}\) ibid, 251, 258.
information is processed using both channels.\textsuperscript{71} Cognitive load theorists have also developed several “effects” that provide guidelines for creating effective instructional material.\textsuperscript{72} These various effects and their implications for the design of multimedia instruction will be referenced in greater detail later.

Although the information processing model can be applied to learning simple and complex knowledge, cognitive flexibility theory tries to specifically address learning in a complex, ill-structured domain. Spiro identifies two main properties of ill-structured knowledge domains. First, each “case” (i.e., a single instance of knowledge application) typically involves the simultaneous interactive involvement of multiple, wide-application conceptual structures (i.e., schemas, perspectives, and organizational principles), each of which is individually complex. Second, the pattern of conceptual incidence and interaction varies substantially across cases nominally of the same type.\textsuperscript{73} Therefore, one single generalization of a concept cannot apply equally well to all situations. As a result, students must see and interact with multiple cases that demonstrate similar applications of concepts.

The instructional approach described by cognitive flexibility theory emphasizes conceptual knowledge and situational learning\textsuperscript{74} while allowing for a sequencing that demonstrates the criss-cross nature of the ill-structured domain.\textsuperscript{75} These interrelationships are conveyed by presenting themes and cases in different contexts to highlight different shades of

\textsuperscript{72} ibid, 290-291.
\textsuperscript{75} ibid, 195-196.
meaning. Yet although the concept being taught may be ill-structured, each case and theme instance is a concrete example.

A recent instructional trend in higher education has emphasized the kinds of interaction between students and instructors that should take place in an ideal learning environment. Blended learning usually refers to a combination of face-to-face and online learning. It is a unique and deliberate integration of face-to-face and online methods in such a way that the strengths of both are optimized. It represents a “fundamental redesign that transforms the structure of, and approach to, teaching and learning.” Whereas earlier applications of educational technology might have sought to become a substitute for face-to-face interaction, the blended learning paradigm accepts the benefits of face-to-face and online learning and tries to define models of interaction that capitalize on both. Since private lessons already include face-to-face instruction, new kinds of online interaction between teacher and student and student and peers can be guided by the interaction models researched by blended learning approaches.

Graham describes three main categories of blended learning systems based upon how they change interaction and pedagogy. The most dramatic blend, “Transforming Blends,” creates a radical transformation of the pedagogy in a discipline that enables intellectual activity that was not practically possible without the technology. Most piano teachers use written theory materials in their studios, and many teachers use the theory books that supplement the lesson books used with younger students. Yet there seems to be a general consensus that most piano

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76 ibid, 189.
students do not enjoy written theory work, and this situation has led some teachers to even avoid it entirely. Although a Web-based system could still include written work printed from the student's computer, most of the work would be computer-based. For reasons later explored in greater detail, the interactive and multimedia characteristics of Web-based learning are by themselves a radical change from written theory work alone. By also changing the way private teachers interact with their students as they learn music theory, a Web-based approach to teaching theory in the private studio would be a “transforming blend” that needs to be defined using a research-based pedagogy.

As mentioned previously, one must not oversimplify the pedagogical model being described within this dissertation. The goal is not to simply migrate instruction to an online environment. Such a change would only create a modification of delivery mediums and not the creation of an integrated learning environment. The background information given above identifies many important pedagogical considerations. These considerations provide the fundamental impetus for this dissertation by providing the basis for outlining a dramatically different instructional model for theory instruction within the piano studio.

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DEFINING THE THEORETICAL BASIS OF THE WEB-BASED SYSTEM

Defining the Instructional Objectives

Since the primary goal of most piano instruction is to improve musical performance, the manner in which studying music theory can serve that goal helped guide the selection of instructional objectives for this Web-based system. By studying music theory, students can enhance their overall understanding of musical elements and use this understanding to facilitate more meaningful performances. Specifically, an understanding of music theory concepts can help students with the initial learning of new pieces,\(^1\) sight reading, memorization, composition and improvisation, and encourage more informed interpretive choices.

In order to communicate any message effectively, the substance of that message must have some meaning to the one communicating it. Similarly, comparisons between public speaking and musical performance have been made for centuries. For example, when recalling aspects of Chopin's teaching, Mikuli explained that “wrong phrasing would provoke the apt analogy that it seemed to him as if someone were reciting a laboriously memorized speech in an unfamiliar language."\(^2\) In this analogy the speaker must understand what he/she is saying in order to communicate effectively. To create a meaningful performance, it must be more than a mere imitation of an expert. Students must acquire a deeper understanding of the music, and studying music theory can contribute to this understanding.

To help transfer theory concepts to typical activities within the private piano studio, the design of any instructional sequence should first consider typical tasks for piano students. By

defining tasks typically used by piano students first, the relevance and authenticity of theory study can be enhanced. Merrill also advocates a task-centered approach that begins with identifying a whole task before describing component knowledge.\(^3\) He insists that by using this approach, component knowledge and skills are assured to be relevant and integrated. Using Merrill's model, real-world tasks (that later constitute much of the content) are first collected and organized by similar tasks of increasing complexity. Then component knowledge for each task is identified, and an instructional strategy is specified for the task-centered instruction.\(^4\) This approach differs significantly from one in which the objectives of a new instructional system are simply lifted from an existing curriculum. By considering whole, authentic tasks first, theory study is more likely to be relevant to and integrated with other musical activities.

As stated above, typical tasks that may benefit from an awareness of music theory concepts include learning new music, sight reading, memorization, composition and improvisation, and interpretation (see Table 1). Each of these authentic tasks were analyzed to determine the knowledge and skills required to complete the tasks. For example, theoretical analysis may enhance memorization by teaching students to look for phrases, identify melodic and harmonic intervals, and simplify polyphonic or decorative figures.\(^5\) Even if the Web-based system does not specifically teach memorization, students should be guided through tasks such as these to help improve memorization.

The scope of the learning system was deliberately limited to addressing only the tasks related to intervals, major scales, and major key signatures. The number of students involved

\(^4\) ibid, 7.  
with theory testing helped identify the grade level at which the largest number of students are actively studying music theory. According to the test numbers reported by a local theory test coordinator in the Dallas area, there are typically more 4th grade students taking local theory tests than in any other grade. The curriculum for these tests is determined by the Texas Music

Table 1. Relationships between Authentic Tasks, Sub-Tasks, Student Learning Outcomes (SLOs)

<table>
<thead>
<tr>
<th>Common Sub-Tasks and Relevant SLOs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>All authentic tasks share these sub-tasks:</strong></td>
</tr>
<tr>
<td>Identification of and ability to see patterns related to:</td>
</tr>
<tr>
<td>• Notes</td>
</tr>
<tr>
<td>• Rhythms</td>
</tr>
<tr>
<td>• Intervals</td>
</tr>
<tr>
<td>• Scales</td>
</tr>
<tr>
<td>• Key Signatures</td>
</tr>
<tr>
<td>• Musical Form</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Authentic Tasks and Additional Sub-Tasks and Relevant SLOs</th>
<th>(Above SLOs are not referenced below, but their continued use is understood)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authentic Tasks Aided by Theory Study</strong></td>
<td><strong>Theory-Related Sub-Tasks</strong></td>
</tr>
<tr>
<td>Learning New Music</td>
<td>• Interpretation (see below)</td>
</tr>
<tr>
<td></td>
<td>• Audiation (aided by ear training)</td>
</tr>
<tr>
<td>Sight Reading</td>
<td>• Automation of common sub-tasks (see above)</td>
</tr>
<tr>
<td></td>
<td>• Audiation</td>
</tr>
<tr>
<td>Memorization</td>
<td>• Process of using other sub-tasks to help encode material into long-term memory</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Composition and Improvisation</td>
<td>• Creative use of theory concepts</td>
</tr>
<tr>
<td></td>
<td>• Audiation</td>
</tr>
<tr>
<td>Interpretation</td>
<td>• Use understanding of theory concepts to justify interpretive choices</td>
</tr>
<tr>
<td></td>
<td></td>
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</tbody>
</table>
Teachers Association (TMTA) which is a state chapter of the Music Teachers National Association (MTNA). Each fall and spring, these state-designed tests are administered at the local level. The curriculum published by TMTA helped determine some of the limitations placed on this online system. For example, students taking the 4th grade test are only required to know the major scales C, G, D, A, E, and F.

Other practical limitations were placed on the objectives for the online system. Rhythm was not directly covered in the online system. Additionally, since this Web-based system was not designed for beginning students, certain prerequisite knowledge was expected (see Table 2). A complete system intended to be used in the private studio would also need to include rhythm and remedial work with notes and relevant musical terminology. By addressing the specific student learning outcomes identified below (see Table 3), the scope of this project was still significant enough to conduct a thorough investigation of Web-based instruction for private piano students.

The authentic tasks, theory-related sub-tasks, and specific student learning outcomes are outlined in Table 1. The authentic tasks are typical activities for private piano students in the later primary grades who may also benefit most directly from studying music theory. The

<table>
<thead>
<tr>
<th>Table 2. Practical Limitations Imposed on the Web-Based System</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Prerequisite Knowledge</strong></td>
</tr>
<tr>
<td>• Treble and bass clef notes, half-step, whole-step, sharps, flats</td>
</tr>
<tr>
<td>• Rhythm: whole, half, quarter, and eighth notes and rests using dots and ties</td>
</tr>
<tr>
<td><strong>Not Directly Addressed Within This System</strong></td>
</tr>
<tr>
<td>• Rhythm</td>
</tr>
<tr>
<td>• Some terminology, such as dynamics and articulations</td>
</tr>
<tr>
<td>• Specific musical forms (general observations of repetition and contrast were covered)</td>
</tr>
</tbody>
</table>
Table 3. Instructional Objectives for the Online System

<table>
<thead>
<tr>
<th>OEO 1 Students will be able to identify and construct intervals, major scales, and major key signatures in simple piano pieces and more isolated contexts.</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>OEO 1.1 Intervals: 2\textsuperscript{nd}, 3\textsuperscript{rd}, 4\textsuperscript{th}, 5\textsuperscript{th}</td>
<td></td>
</tr>
<tr>
<td>SLO 1.1.1 Student defines the terms “interval,” “harmonic interval,” and “melodic interval.”</td>
<td></td>
</tr>
<tr>
<td>SLO 1.1.2 Student identifies a melodic or harmonic interval, ascending or descending, when presented aurally.</td>
<td></td>
</tr>
<tr>
<td>SLO 1.1.3 Student listens to a piece or excerpt from a piece, then hears an interval extracted from the piece and identifies it.</td>
<td></td>
</tr>
<tr>
<td>SLO 1.1.4 Student identifies a melodic or harmonic interval, ascending or descending, when presented by letter name or on a keyboard or staff.</td>
<td></td>
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<tr>
<td>SLO 1.1.5 Student provides a melodic or harmonic interval, ascending or descending, by letter name or on a keyboard or staff when shown another note.</td>
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<td>SLO 1.1.6 Student identifies a melodic or harmonic interval, ascending or descending, when extracted from a simple piano piece.</td>
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<td>SLO 1.1.7 Student completes intervals worksheets printed from local computer and plays those intervals at the piano.</td>
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<td>OEO 1.2 Major Scales: C, G, D, A, E, F</td>
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<tr>
<td>SLO 1.2.1 Student defines the terms “major scale” and “scale degree.”</td>
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<tr>
<td>SLO 1.2.2 Student identifies a scale as a “major scale” or “Not a major scale” when presented aurally.</td>
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<tr>
<td>SLO 1.2.3 Student listens to a simple piano piece, then hears a scale extracted from the piece and identifies it as a “major scale” or “Not a major scale.”</td>
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<tr>
<td>SLO 1.2.4 Student finds the half steps and whole steps within the provided major scale.</td>
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<tr>
<td>SLO 1.2.5 Student constructs a one-octave major scale by letter names, using the keyboard, or on the staff.</td>
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<tr>
<td>SLO 1.2.6 Student identifies the major scale represented by a collection of notes extracted from a simple piano piece.</td>
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<td>SLO 1.2.7 Student constructs one-octave major scales using worksheets printed from a local computer and plays them at the piano.</td>
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<td>SLO 1.2.8 Student identifies altered scale tones as sharp or flat scale degrees.</td>
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<tr>
<td>OEO 1.3 Major Key Signatures: C, G, D, A, E, F</td>
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<tr>
<td>SLO 1.3.1 Student defines the terms “key signature,” “major key,” and “tonic.”</td>
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<tr>
<td>SLO 1.3.2 Student provides the order of sharps (FCGDAEB) and flats (BEADGCF) using letter names.</td>
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<tr>
<td>SLO 1.3.3 Student places the requested number of chromatic signs on the treble and bass staffs.</td>
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<tr>
<td>SLO 1.3.4 Student places chromatic signs on the staff for a corresponding key signature then adds the tonic note.</td>
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<tr>
<td>SLO 1.3.5 Student identifies the tonic note of a key signature shown on the staff.</td>
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<tr>
<td>SLO 1.3.6 Student constructs key signatures using worksheets printed from a local computer.</td>
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</tbody>
</table>

*table continues*
Table 3 (continued).

<table>
<thead>
<tr>
<th>OEO 2</th>
<th>Students will make reflective observations of simple piano pieces and concepts by applying their knowledge of intervals, major scales, and major key signatures.</th>
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</thead>
</table>
| OEO 2.1 Analysis of Simple Piano Pieces | SLO 2.1.1 Student views and listens to a piano piece then observes note groups, patterns, and relationships.  
SLO 2.1.2 Student views and listens to a melody then reduces it to a simplified framework.  
SLO 2.1.3 Student transposes a simple melody to a different key.  
SLO 2.1.4 Student views and listens to a piano piece then posts answers to questions requiring reflective analysis.  
SLO 2.1.5 Student views and listens to a piano piece, posts questions about the piece, and answers questions posted by others.  
SLO 2.1.6 Student prints a piano piece from a local computer, notes analytical observations, and discusses these during the private lesson.  
SLO 2.1.7 Student defines the term “transposition.” |
| OEO 2.2 Composition of Simple Piano Pieces | SLO 2.2.1 Student completes an incomplete composition or melody by applying their knowledge of intervals, major scales, and major key signatures.  
SLO 2.2.2 Student applies their knowledge of intervals, major scales, and major key signatures by composing a simple piano piece or melody.  
SLO 2.2.3 Student posts comments on compositions by other students.  
SLO 2.2.4 Student defines the term “composition.” |
| OEO 2.3 Collaborative Definitions of Concepts | SLO 2.3.1 Students define primary terms and concepts and identify ancillary terms and concepts and create definitions.  
SLO 2.3.2 Students collectively modify existing definitions. |

theory-related sub-tasks are general tasks that could be useful for accomplishing the authentic tasks. The student learning outcomes (SLOs) are the specific activities used by the Web-based system to teach the theory-related sub-tasks. By extension, the SLOs used within the online system help equip students to complete the authentic tasks. The SLOs and overarching educational objectives (OEOs) that grow out of the authentic tasks and sub-tasks are outlined in Table 3. These SLOs are not necessarily sequenced in order from easiest to most difficult.

Many of the authentic tasks possess both similar and distinctly different sub-tasks. For example, composition is a more creative activity than sight reading, but improved aural skills
may help students perform both tasks better. All of the authentic tasks are also aided by the student's ability to see patterns of notes, intervals, and scales. Therefore these shared sub-tasks are listed at the top of Table 1. There may also be an overlap between the authentic tasks and the sub-tasks of other authentic tasks. Interpretation is not only an authentic task but also a sub-task of learning a new piece since a student may make interpretive choices while working on a new piece.

Interpretation is perhaps the most complex and ill-structured of all the authentic tasks. Interpretation not only requires a thorough familiarity with all declarative knowledge (i.e., the explicit fundamentals such as visually identifying intervals and scales) but also an awareness of the relationships between that knowledge. When rationalizing interpretive choices, many decisions may be guided by insights from musical analysis. For example, in late 18th century piano music, non-diatonic dissonances might receive more emphasis than diatonic consonances. By helping students identify altered scale degrees (SLO 1.2.8), they are better equipped to discover these chromatic tones.

Since interpretation is a complex task, collaboration between the student's teacher and other students (SLOs 2.1.4, 2.1.5, 2.1.6, 2.2.3) can help students consider multiple interpretive possibilities and the reasons for accepting or rejecting one or more solutions. All of the SLOs associated with interpretation (2.1.1-2.1.6; 2.2.3; 2.3.1-2.3.2) are first modeled within the lesson modules. Then, as the student progresses through the lessons, less direct instruction is provided, and the student engages in more interactive collaboration amongst other students and their private teacher.

Most of the authentic tasks may also be aided by audiation processes. Gordon defines audiation as “the process of assimilating and comprehending (not simply rehearing) music we
have just heard performed or have heard performed sometime in the past. We also audiate when we assimilate and comprehend in our minds music we may or may not have heard, but are reading in notation or composing or improvising.”

Gordon also points out that, ideally, memorization happens with contextual audiation. When a piece is memorized in this way, the student can also sing exactly what they play or play a tonal melody in a different key, using a different fingering, or with a different meter. Gordon argues that meaning is given to music “by audiating the context and content of the music.”

In order to help students learn audiation processes, specific aural skills tasks, such as SLOs 1.1.2, 1.1.3, 1.2.2, and 1.2.3 were designed to help students hear and experience theory concepts in authentic and isolated ear training tasks. Audiation processes are further supported by continuously presenting concepts visually and aurally in multiple contexts using multiple examples. Then in order to apply these aural skills activities more independently, SLOs 2.1.1 and 2.1.2 help students identify patterns and other structures within provided musical examples. SLO 2.1.5 specifically requires students to post questions and answer questions by other students in such a way that they must make more complete analytical observations about the piece being considered. Together, these tasks encourage meaningful learning.

Composition and improvisation require one to use their knowledge of concepts in a novel way. Therefore composition and improvisation are also amongst the most complex and ill-structured tasks that students may attempt. In addition to the aural skills-oriented SLOs cited above, SLOs 2.2.1-2.2.3 help introduce students to composition and improvisation. As a first step (SLO 2.2.1), students are asked to finish an incomplete melody. Then SLO 2.2.2 has

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7 ibid, 11-12.
students compose their own complete melody or piece within provided guidelines. These compositions are then shared with other students and the student's teacher (SLO 2.2.3).

Sight reading also involves similar cognitive processes associated with other tasks. Sloboda has noted that many expert sight readers do not look at individual notes but rather see notes in groups, and that this process frequently requires little conscious effort.\(^8\) This process is similar to the automation described by Sweller, van Merrienboer, and Paas. They suggest that one of the main goals of instruction is the construction and automation of schemas that reside in long-term memory. Therefore intellectual skill, and, similarly, excellent sight reading ability, comes from “the construction of large numbers of increasingly sophisticated schemas with high degrees of automaticity.”\(^9\) Even though sight reading is an ill-structured process involving tacit or procedural knowledge, by developing a student's proficiency with recognizing musical groups and patterns, his/her sight reading skills may be improved. In this way, the automaticity described by Sweller, et. al. is similar to the lack of conscious effort required of expert sight readers as noted by Sloboda.

Sweller, et. al. also argue that any information a learner encounters is either processed consciously or automatically.\(^10\) Since conscious processing of individual notes and rhythms would be less efficient and result in poorer sight reading skills, an automatic process in which the student sees groups of notes and rhythms quickly (i.e., chunking) is preferable. SLO 2.1.1 specifically teaches students to see and understand notes in groups and relate them to one another. Reducing melodies to simplified frameworks also helps students group notes (SLO


\(^10\) ibid, 256.
2.1.2). By transposing simple melodies into different keys (SLO 2.1.3), students begin to understand note groups within a tonal framework. Although these activities do not specifically teach sight reading, developing the student's ability to see notes in groups and patterns will improve both their analytical and reading skills.

Most piano students are required to memorize for performances or as a regular part of weekly lessons. Students may use different tasks to help them memorize their music. Some of these tasks could include consciously memorizing groups of intervals, rhythmic patterns that repeat, the starting and ending points of phrases, tonal centers, and a reduction of polyphonic or decorative figures. SLOs 2.1.1-2.1.3 help prepare students for memorizing their pieces by having them practice grouping notes, simplifying melodies, and understanding melodies within a tonal framework.

After establishing the SLOs, they were organized based upon the concepts they addressed (see Table 3). For example, SLOs 1.1.1-1.1.7 cover intervals. Then the SLOs were broadly grouped into more concrete knowledge and ill-structured tasks. The first overarching objective addresses the more explicit tasks of interval, scale, and key signature recognition and construction. The second overarching objective provides students with an opportunity to make interpretive decisions about music based upon information drawn from theoretical analysis.

Some concepts may be taught by rote (i.e., as declarative knowledge) or as abstract ideas that may be exemplified in multiple contexts. For example, each major scale (OEO 1.2) is an instantiation of the scale concept. Each of these individual scales may be memorized (i.e., declarative knowledge). To understand the major scale concept however, students must be able to define the term and create an instance of that concept by building a major scale from any note.

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11 Bernstein, With Your Own Two Hands, 239-240.
One might argue that rote memorization of scales could facilitate this skill, but in order for the student to recognize altered or incomplete scales, the concept must be understood for transfer to these unfamiliar contexts.

Yet rote memorization is still desirable in addition to understanding the concept. In order to use knowledge of scales effectively in authentic tasks (Table 1), students must have each of the fifteen possible major scales (including enharmonic equivalents) memorized. These scales must be memorized well enough that students can recognize the scale very rapidly within a piece. Without this automaticity, making connections between concepts and recognition of note groups is more laborious. Therefore some concepts, such as scales, can and should be taught as both declarative knowledge and conceptual knowledge. Without directly teaching scales as declarative knowledge, each scale may not be sufficiently memorized. The scales may not be sufficiently memorized by only defining the concept, showing examples, and asking the students to produce a scale. The learning system should continuously test mastery of each individual scale (SLOs 1.2.5, 1.2.7).

After structuring the SLOs based upon the concepts they cover, an appropriate instructional sequence for each SLO needed to be determined. Most taxonomies of learning objectives suggest a progression from concrete and simple knowledge to abstract and complex knowledge. Both the original and the revised Bloom taxonomies possess this feature. The revised taxonomy offers a more precise classification methodology for the knowledge within this learning system. Other instructional designers have advocated the use of this taxonomy for

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planning multimedia learning systems.\textsuperscript{14}

The processes involved in satisfying an objective (i.e., "Cognitive Process") are sequenced from simple to complex in a similar way to Bloom's original taxonomy, but the

Table 4. Taxonomical Organization of Instructional Objectives

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<td>2.1.7</td>
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</table>

| B. Conceptual Knowledge       |             | 1.1.2         | 1.1.3    | 1.1.5      | 2.1.1       |
|                               |             | 1.1.4         | 1.1.6    | 1.1.7      | 2.1.8       |
|                               |             | 1.2.2         | 1.2.3    |            | 2.2.1       |
|                               |             |               |          |            | 2.3.2       |

| C. Procedural Knowledge       |             | 2.1.2         | 2.1.3    | 2.1.4      |
|                               |             |               |          |            |
|                               |             | 2.1.5         |          |            |
|                               |             |               |          |            |
|                               |             | 2.1.6         |          |            |

| D. Metacognitive Knowledge    |             |               |          |            |             |           |

The table is from “A Revision of Bloom's Taxonomy: An Overview,” (Krathwohl, David R., 2002).
*The numbers in the boxes correspond to SLOs listed in Table 3.

The revised taxonomy also adds a knowledge dimension. This knowledge dimension distinguishes between the different kinds of knowledge that can be used to complete the cognitive processes (see Table 4).\textsuperscript{15}

Within the cognitive process dimension, to "remember" is to retrieve "relevant knowledge

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\textsuperscript{15} Krathwohl, "A Revision of Bloom's Taxonomy."
from long-term memory." Students accomplish this process by first recognizing knowledge and then recalling it. To "understand" knowledge, a student must be able to determine "the meaning of instructional messages." Understanding can be demonstrated by interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining knowledge. A student may "apply" knowledge by "carrying out or using a procedure in a given situation." To "analyze," a student must break "material into its constituent parts" and detect "how the parts relate to one another and to an overall structure or purpose." This process involves differentiating, organizing, and attributing. To "evaluate" knowledge, a student must make "judgments based on criteria and standards." Finally, to "create" knowledge, the student must put "elements together to form a novel, coherent whole or make an original product."16

In the knowledge dimension, "factual knowledge" is "the basic elements that students must know to be acquainted with a discipline or solve problems in it." "Conceptual knowledge" involves knowing the "interrelationships among the basic elements within a larger structure that enable them to function together." "Procedural knowledge" is "how to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and methods." "Metacognitive knowledge" is "knowledge of cognition in general as well as awareness and knowledge of one's own cognition."17 Metacognition was not specifically addressed with the online system, but it is frequently used in private lessons when students are encouraged to monitor their own progress at home and adjust practicing strategies based upon personal assessments.

Each SLO was categorized within the revised Bloom taxonomy based upon its criteria of knowledge (see Table 4). By systematically evaluating and sequencing each of the task-based SLOs, all tasks and learning objectives were authentic, practical, and useful for piano students.

16 ibid, 215.
17 ibid, 214.
Then, using Bloom's taxonomy, the implementation of these SLOs within the learning system was logically sequenced.

Defining and Rationalizing the Research-Based Principles

As a first step to building a Web-based system for teaching music theory in the private piano studio, design choices were rationalized using relevant research. Although building a system based on intuitive choices could produce an effective learning system, after considering the wealth of research available from other disciplines, it seems unreasonable to design a system by simply using one's own experience. Too many multimedia programs have been driven by "the power of the technology" without appreciating that learning is a product of instructional methods more than of the media that deliver those methods.

Several research-based principles helped guide the design of this learning system (see Table 5). These principles were organized into two main categories: 1) content presentation and reinforcement; and 2) learning environment. Content presentation refers to the specific way in which the presentation is sequenced, shown visually, and presented aurally. Reinforcement includes review and student assessment. Learning environment refers to the way in which the system as a whole blends types of interactions. Students may interact with the content of the Web-based system, with their teacher online, with other students using the online system, and with their teacher during lesson time. Although the teacher is recognized as the primary mediator of these interactions, the way in which the online learning system facilitates these interactions.

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interactions is of primary interest here. Sources from the fields of educational psychology, educational technology, interaction design and children, and music education were used to guide the creation of the research-based principles.

Table 5. Research-Based Principles

<table>
<thead>
<tr>
<th>1. Content Presentation and Reinforcement.</th>
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<tbody>
<tr>
<td>1.1. Convey content as an integrated whole using multiple authentic contexts.</td>
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<tr>
<td>1.2. Deliver content through visual, auditory, and kinesthetic approaches.</td>
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<td>1.3. Teach the most essential information clearly without unguided or discovery methods.</td>
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<td>1.4. Provide students with a framework for creative thinking in a less guided environment.</td>
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<td>1.5. Consider unique characteristics of the student population.</td>
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<tr>
<th>2. Learning Environment.</th>
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<tbody>
<tr>
<td>2.1. Provide students with the means to communicate and collaborate with their teacher and peers outside of lessons.</td>
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<tr>
<td>2.2. Provide the teacher with a means to shape the online learning.</td>
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<tr>
<td>2.3. Provide feedback from the online system that may be used to shape the private lessons and practice time.</td>
</tr>
</tbody>
</table>

Research-Based Principle 1.1: Convey Content as an Integrated Whole Using Multiple Authentic Contexts

Many theory programs define musical concepts first with minimal context, and students are asked to complete worksheets with isolated exercises. Students are not usually given the opportunity to hear authentic instances of concepts using real musical examples. Students are also rarely given the chance to experience the concepts firsthand by playing music exemplifying the concepts. These instructional approaches are not adequately described as direct or expository since direct instructional methods can also include aural examples with pieces the student may perform. Instead, typical theory instruction in the private studio is better described as non-contextual drill. Although learning can still occur with this approach, students may not be given the opportunity to make meaningful connections between the theoretical concepts and authentic
musical experiences.

Explanations of theory concepts should be presented aurally using actual piano pieces whenever possible. Research in educational psychology has similarly stressed the importance of teaching and learning within an authentic environment that conveys content as an integrated whole. Some of this research has previously been discussed by music educators. Basing their conclusions largely on cognitive flexibility theory, Covington and Lord have argued that when teaching intervals, “single-contextual encoding” creates rigid schemas that inhibit transfer (i.e., using specific melodies to aid in recall of specific intervals). Instructors need an approach based on cognitive flexibility theory that presents multiple “case-based presentations” focusing on application of knowledge to new situations.20

According to cognitive flexibility theory, a “compartmentalization bias” may occur when “conceptual elements that are in reality highly interdependent are instead treated in isolation, missing important aspects of their interaction.”21 Although a private instructor may argue that isolating discrete concepts makes music analysis more manageable for novices, this approach may yield short-term gains at the cost of achieving more ambitious learning objectives. In order for students to create musically inspired performances, deeper musical meaning must be sought. To help students transfer analytical insights to typical music making activities, the learning system should match real-world activities as much as possible.

Authentic approaches may also lead to more accurate assessments if the presentation and assessments are handled in similar ways. For example, Willett and Netusil found that learners received lower test scores when test items were slightly changed from their original presentation.

They recommended using assessment presentations similar to the original presentation of information. In a study focusing more on recall of very specific information related to cues, Ackerman observed that recall can similarly be aided by using whole-context cues. By aligning presentation and assessment methods with the way concepts are applied, students can learn more deeply and assessments should reflect more relevant learning. Presentations and assessments should also be seamlessly integrated with one another. In this way, an entire learning sequence flows seamlessly through continuous iterations of presentation, practice, and assessment using a branching structure.

Literature on situated cognition can also help explain how the authenticity of learning is vital to meaningful construction of knowledge. Brown, Collins, and Duguid had argued that the activities through which knowledge is learned and used are inseparable from what is learned since the instructional situations themselves structure cognition. Although instruction that ignores the situatedness of cognition may still result in learning, the transfer of that learning to practical applications may not be optimal. Non-contextual drill can teach students to create intervals, but identifying intervals within an actual piece is a different task, and some students may be unable to make that connection. Additionally, the full depth of their meaning is missed without instances of interval use extracted from authentic pieces. Multimedia instruction can

help novices make connections between the musical examples and the corresponding concepts.

The cognitive apprenticeship model is also derived from situated cognition theory. Using cognitive apprenticeship, an expert guides the apprentice by modeling authentic activities, providing scaffolding to help novices complete tasks more independently, and then fading the guidance away as the apprentice becomes more skilled. In a similar way, a series of Web-based lessons can provide all of the initial modeling and guidance as the novice learns core concepts and their application. This process may not require direct intervention from the teacher since multimedia presentations can model the process. With this format, the learning system initially assumes the role of the expert. As the learner becomes more independent, analysis activities can be migrated to a collaborative medium in which the learner interacts with their peers and teacher to attempt more advanced, ill-structured analysis.

Therefore Research-Based Principle 1.1 states that concepts should be conveyed using authentic, whole-context examples. Then in order to reinforce concepts and make their application similar to typical musical activities, they should be demonstrated using multiple cases in multiple contexts that provide opportunities for social construction of meaning. The lesson modules of the learning system help students experience concepts with authentic contexts using real musical examples. The collaborative components then help students create deeper meaning within a social context.

Research-Based Principle 1.2: Deliver Content Through Visual, Auditory, and Kinesthetic Approaches

Another facet of content presentation involves the specific mode of delivery. Perhaps the

most common distinction described by many modality-driven instructional strategies is that of aural versus visual. As performers, piano students may also experience musical concepts in a tactile way by playing pieces or kinesthetically using larger body movements.

Of the several stimulus strands in the Dunn and Dunn model, Lovelace considers the fourth “stimulus strand” (“Physiological”) to be the most important aspect of learning styles (Lovelace 2005).²⁷ The fourth stimulus strand uses the AVTK (audio, visual, tactile, kinesthetic) model of learning modalities. Many researchers do not distinguish between tactile and kinesthetic modalities but instead use an AVK model in which physical experience may be whole-body or touch only. For example, Robert Dunn compared A, AV, or AK presentation modes for presenting musical excerpts and found that using two or more modes helped gain learner attention and more easily focus them on tasks.²⁸ He also found that the majority of students prefer the AV presentation mode. Persellin considered different combinations of AVK teaching methods for teaching rhythm patterns to elementary students and found that visual-only instruction was especially problematic for students younger than 2nd grade. She found that multiple modality approaches were not confusing for students but did not find that any one combination of multiple modalities was superior across all grades.²⁹ Though somewhat inconclusive, these two studies seem to suggest that the AV approaches are viable.

With a Web-based learning system, using all modalities is difficult, if not impossible. Although auditory and visual modes are easily included, the kinesthetic and tactile modalities are much more difficult to utilize. Students can be encouraged to perform pieces they study within

²⁸ Robert Edwin Dunn, "Perceptual Modalities in Music Learning Listening Among Third-Grade Students" (Ph.D., diss., Northwestern University, 1994), 369.
the online system, but the system itself cannot require these performances without using more robust assessment tools. For example, the teacher could assess student performance and report those assessments to the online system. The benefits of this much interaction may not justify its use within this system's learning objectives. Simply encouraging students to perform pieces on their own and for their teacher was sufficient for this system.

Perhaps in the near future a system that integrates all subjects typically covered in piano lessons could include not only theory but also repertoire. Such a system could replace lesson books for beginning and intermediate students. Detailed teacher assessments could help the online system dynamically determine the next most appropriate piece for study. However these features are far beyond the scope of this system. Therefore this system focused on aural and visual modalities but also provided students with sheet music that could be downloaded, printed, and studied at the piano.

In order to utilize a multi-modal approach, some content authors may be tempted to create unique ways of visually representing aural material even if such a representation is not absolutely required for understanding the concept. Although this strategy may be helpful for certain learners, it can be misleading for others. For example, Reynolds found that when 5th and 6th grade students used computer programs to help them compose by manipulating graphical representations of the music, the graphical representations often became more important than the music itself. In this example, the graphical representations were meant to help students compose without the difficulties of notation. Although Reynolds argued that there is some value to students creating unique musical pieces based upon visual effects, many composers and performers might argue that such an approach is antithetical to most musical goals. Music is

sound, and any other derivative of music (i.e., analysis, formal models or maps, subjective narratives, etc.) should begin with the aural musical experience. Robert Dunn similarly observed that additional stimuli can skew the learner's perception.\textsuperscript{31} Although these inventive multi-modal approaches can be clever teaching aids, care should be taken to not allow the novelty of the instructional technique to overshadow the defining characteristics of the concept. Any additional stimuli should help enhance musical meaning and authenticity.

In the cognitive sciences, some researchers have dealt with the use of multi-modal presentation methods. Richard Mayer and several of his colleagues have developed a multimedia theory of learning based largely upon empirical studies guided by information processing models of learning applied to a multimedia learning environment. Their investigations have produced several research-based effects or principles that describe how different instructional phenomena can affect learning. These principles are described using cognitive models of learning.

Some of the most important features of cognitive models of learning deal with working memory. Earlier models describe working memory as a unitary mechanism, but more recent models possess two partially independent processing channels. Baddely's dual-channel model distinguishes between a “visual-spatial sketchpad” for processing visual information and a “phonological loop” for handling auditory information.\textsuperscript{32} Mayer identifies this dual-channel assumption as one of the “most relevant elements in a science of learning” for multimedia instruction.\textsuperscript{33} By using both visual and auditory working memory, “effective working memory

\textsuperscript{31} Dunn, "Perceptual Modalities in Music Learning Listening," 372.
capacity can be increased” compared to using only one modality.\textsuperscript{34}

The modality in which concepts are initially presented should also be considered. Frances Clark had advocated a specific sequence in which concepts should be taught. First, concepts are presented aurally. Then the learner should be allowed to experience it, be shown the corresponding symbol, and then provided the name of the concept.\textsuperscript{35} Jordan-DeCarbo has also suggested that concepts should be presented aurally first.\textsuperscript{36} Hopkins had found that when teaching aural recognition of variation types, hearing the variation before labeling it produced higher mean posttest scores compared to students that were given the definition first.\textsuperscript{37} By presenting concepts aurally first, students can experience the sound in an authentic musical context, and learning outcomes may be enhanced.

There are other ways in which the presentation of material may be handled using different combinations of visual and aural methods. For example, important text from an aural narration may be displayed prominently on the screen alongside printed musical examples. Instructional designers may include the written text in an attempt to appeal to both visual and aural learners, but there is reason to doubt the efficacy of this approach. The research of Mayer and his colleagues addresses this formatting issue.

According to the redundancy principle of multimedia learning, instruction should not use additional information when its use results in learning decrements compared to the presentation of less information.\textsuperscript{38} This additional information may include showing printed text with

\textsuperscript{34} John Sweller, et. al., "Cognitive Architecture and Instructional Design," 281.
\textsuperscript{35} Robert Fred Kern, "Frances Clark: The Teacher and Her Contributions to Piano Pedagogy" (D.A. diss., University of Northern Colorado, 1984), 124.
\textsuperscript{38} John Sweller, “The Redundancy Principle in Multimedia Learning,” in \textit{The Cambridge Handbook of}
narration although Mayer applies this principle more exclusively to narration accompanying printed text and an animation.\textsuperscript{39} Sweller cites many studies, some of which involve elementary age children, demonstrating that the elimination of redundant instructional information produced learning improvements.\textsuperscript{40} Similarly, including written text with musical notation may be unnecessarily redundant if the narration already includes the information from the text.

The modality effect “occurs when information presented in a mixed mode (partly visual and partly auditory) is more effective than when the same information is presented in a single mode (either visual or auditory alone).”\textsuperscript{41} As noted above, simply adding material to an additional modality may end up hindering learning if the addition is redundant, but if redundancy is avoided, learning may be enhanced. Instructional designers must evaluate if the information contained in both auditory and visual modes is essential for most learners to understand the concept. Then if some of the content can be communicated aurally, doing so may reduce cognitive load and therefore accelerate learning.

Research-Based Principle 1.2 not only builds on 1.1 by supporting performances of musical examples, but it also aims to reduce cognitive load and help students experience the concepts from multiple perspectives. Cognitive load is reduced by splitting information across the aural and visual channels. Care must be taken however to ensure that this split is not redundant and that the choice of one modality over another is appropriate for the content being studied.

\textsuperscript{39} Mayer, "Applying the Science of Learning," 764.
\textsuperscript{40} Sweller, "The Redundancy Principle in Multimedia Learning," 161-164.
Research-Based Principle 1.3: Teach the Most Essential Information
Clearly Without Unguided or Discovery Methods

Some instructional approaches have students explore resources provided within a less structured learning environment. Sometimes learning may be enhanced using this approach, and at other times less guided environments are detrimental to learning. The learning system under consideration here will use both direct instructional approaches and less guided methods depending upon the student's mastery of the material and the applicable educational objectives.

Some of the learning impediments caused by pure discovery learning include inconsistent or misleading feedback, causal misattributions, inadequate practice, and insufficient elaboration.\(^{42}\) Klahr and Nigam taught a control of variables strategy to 3rd and 4th grade science students. They found that discovery learning improved learning, but direct instruction was still superior, and students mastering concepts through direct instruction performed transfer tasks as well as those mastering concepts using discovery learning.\(^ {43}\)

Depending upon the prerequisite knowledge of the learner, timing within the instructional sequence, and nature of the knowledge, using an ideal mixture of direct and less guided instructional strategies could lead to an optimal learning experience. Pure discovery learning is only successful when the learner has prerequisite knowledge and has undergone some prior structured experiences.\(^ {44}\) Many problem-based learning and inquiry learning environments also include direct instruction though on a just-in-time basis and usually after students experience a need to know. Therefore one must consider the conditions in which discovery driven learning or

\(^ {43}\) ibid, 666.
more direct instruction are best.  

Every discipline has fundamentals that are central to that discipline. Experts are typically individuals that not only know these fundamentals but are also able to apply them in novel ways. Cognitive psychologists have sometimes used chess experiments to understand the acquisition of these expert skills. These experiments have shown that long-term memory is a more important indicator of expertise than working memory. Sweller, et. al. argue that all information is either processed consciously using working memory or automatically with sufficient schemas in long-term memory. Without this automaticity new and unique tasks may be impossible.

Piano teachers interested in developing a student’s autonomous creative processes must similarly convey core concepts using multiple concrete cases situated in authentic musical practices. Students should be carefully guided through activities that present essential information clearly and show its application using many different examples from many different perspectives. These examples provide the schemas that later automate many of the tasks required in ill-structured activities. For example, self-directed musical interpretation often requires expert knowledge. When making interpretive choices, an expert performer might describe one approach to shaping a phrase without citing a specific reference to another piece, composer, or performer. In this situation, the expert is relying on their experience with phrases

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of similar contour, length, character, and other factors. Their experience therefore consists of multiple cases that are different yet share similarities with one another, and this expertise resides in long-term memory.

Although learning may occur in some less direct approaches, these approaches may not work equally well with all students. For example Hopkins found that discovery methods may work better for some students than others for teaching aural recognition of types of musical variation. He found that hearing the variation type before labeling it improved mean scores but with higher deviation of scores than when definitions were given first.\footnote{Hopkins, "The Effects of Computer-Based Expository and Discovery Methods of Instruction."} However Hopkins' discovery approach was also much more direct than most discovery learning systems since students had to navigate through the program sequentially without choosing which activities they would like to explore first. In this way Hopkins allowed the students to hear the concept in a musical setting before providing the definition. His approach therefore helped retain aspects of authenticity and direct guidance while not being a strictly expository approach that presented the definitions first.

Therefore an ideal instructional sequence could be one in which students first experience the need to know information using authentic examples and possibly some guided exploration. Then direct instruction could be included until core concepts are mastered. Finally, after additional structured experiences (i.e. modeling of complex tasks), students could finally begin working in a discovery driven environment.

Several instructional approaches advocate a priming process at the beginning of an instructional session in which the learner's prior knowledge is stimulated or the learner is somehow enticed into learning more. Rosenshine's description of direct instruction prescribes a
first step of reviewing previous material so that schemas for the task at hand may be activated.\textsuperscript{50}

The first three steps of Gagne's nine instructional events similarly help prepare students for learning. According to this sequence, the first step is to gain the learner's attention. Next the learner is told the lesson objectives, and third, prior knowledge is recalled.\textsuperscript{51}

Although all of these beginning steps could allow for remedial instruction if the learner has forgotten crucial information, the goal is usually to just remind students of material previously mastered. Prior assessment procedures should have made sure that the learner is ready for the next unit of instruction. With the Web-based system being proposed here, prerequisite knowledge is identified but not tested. Since it may be unwise to assume that the piano teacher has completed a thorough assessment of the student's mastery before directing them to the online system, an additional assessment tool would need to be designed for a more complete implementation of this system.

During a priming phase of instruction, relevant information can be recalled and demonstrated using musical examples. Additionally, the need for new information can be presented. During this presentation, students may be asked about solutions to unanswered questions. This Socratic approach does not have to be minimally guided however since answers to these questions could be immediately provided. Using this approach the musical concepts may also be experienced aurally before being defined or labeled, but students will not be required to discover the definitions for themselves. Since the students are still novices with the material, the instruction should be explicit. Kirschner, Sweller, and Clark insist that experiments

\textsuperscript{50} O'Donnell, et al., \textit{Educational Psychology}, 297.
\textsuperscript{51} Jerome Feldman, Doug McPhee, \textit{The Science of Learning and the Art of Teaching} (Clifton Park, NY: Thomson Delmar Learning, 2008), 44.
almost uniformly indicate that with novices, learning must be explicit.\footnote{Kirschner, Sweller, Clark, "Why Minimal Guidance During Instruction Does Not Work," 79.} Research-Based Principle 1.3 therefore requires that the most essential information be communicated clearly.

**Research-Based Principle 1.4: Provide Students With a Framework for Creative Thinking in a Less Guided Environment**

Soon after initial mastery of the core concepts, students can begin learning how to apply these concepts to less structured problems. Many discovery approaches provide some scaffolding during this stage in order to help the learner find an appropriate method for answering a question or solving a problem. However, as an intermediate step, worked examples were used in this instructional system. Kirschner, Sweller, Clark argue that worked examples are better for novices than less-guided problem solving,\footnote{ibid, 80.} and that instruction and pedagogy should not exclusively focus on methods and processes used by experts in the discipline.\footnote{ibid, 78.}

Novices are not yet capable of solving problems in the same way as an expert. Additional direct guidance is needed so that the student can learn how to solve a problem before attempting to do so on their own. This direct guidance can be modeled, and the specific processes of the tasks should be made clear to the student.

Cognitive apprenticeships are one way in which the learner may begin practicing the application of knowledge in an authentic setting. The first step in this process is modeling. Here the novice observes an authentic task appropriate for their ability. Later they attempt the task with expert help.\footnote{Brown, et al., "Situated Cognition and the Culture of Learning," 39-40.} The cognitive apprenticeship model applies more directly to OEO 2: it seeks to pair students with a more knowledgeable other and therefore also applies equally to Research-
Students must receive some guidance as they begin working on less-structured tasks. The Web-based system provided this guidance by first showing worked examples. These examples were complete authentic tasks that modeled the task and therefore prepared the student to complete the task more independently. For example, an understanding of intervals can help students see patterns and simplify melodies. In Figure 1, the melody outlines a stepwise descent from C to G with repeated Cs in between. Showing students how to reduce this melody and observe the expanding intervals can develop audiation processes and memorization skills. The process of simplifying melodies in this way was first modeled within the lesson modules. Then the student was later asked to complete this task on their own and present their solution to their teacher. These authentic tasks fulfill SLOs 2.1.1 and 2.1.2. By first modeling this melodic reduction process, Research-Based Principle 1.3 was fulfilled, and then by asking students to complete a similar task with little or no help from their teacher, Research-Based Principle 1.4 was also realized.

Figure 1. Reducible Melodic Fragment

However, simply providing one worked example of a complex task is not sufficient

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preparation for self-directed problem solving. Cognitive flexibility theory offers one possible approach for addressing this issue. Cognitive flexibility theory emphasizes conceptual knowledge and situational learning. This approach sequences different applications of the concept in a way that demonstrates the criss-cross nature of multiple concrete examples. Several of these examples present the concepts in different contexts in order to highlight the concept's different shades of meaning. In order to show the interrelationships between different concepts, it is also desirable to use the same example for multiple concept instances. Using the example cited above, students may practice melodic reduction and also interval identification. Then other concepts can be demonstrated using other excerpts from the piece.

When trying to create authentic activities within an instructional program, the designer must take special care to ensure that performance of the task is not too strongly connected to the learning system itself. This predicament could inhibit transfer and decrease the relevancy of the instruction. Even though learning may still occur in this situation, important concepts may be misconstrued. Reynolds describes one such scenario in which the learning environment exerted too much influence over the learner's creative process. Fifth and 6th grade students created unique compositions using special software that provided graphical representations of their music. Unfortunately many of the student's choices were primarily influenced by a desire to change the graphic representation instead of a desire to change the music.

In order to help counteract the potential ill effects of this situational bias, this Web-based

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58 ibid, 195-196.
60 Spiro and Jehng, "Cognitive Flexibility and Hypertext," 188-189.
61 ibid, 187-188.
system used a blended learning environment. Using this approach, students were encouraged to present their analysis and composition assignments to their teacher. SLO 2.1.6 has students print a piano piece from their computer, make analytical observations as they were previously guided to do in the lesson modules, and then discuss those observations with their teacher. The student may show their work to their teacher using the online system (e.g., uploading the manuscript of their composition) or during the private lesson. Used in conjunction with SLOs 2.1.4 and 2.1.5, these tasks help students explore multiple perspectives and allow the teacher to keep students focused on what they believe is important. This blended format helps enhance the authenticity of the activities\textsuperscript{63} and therefore also supports Research-Based Principles 2.1 and 2.3.

Composition provides another opportunity for students to explore unique applications of theory concepts. There seems to be a renewed interest with incorporating composition into piano lessons. A recent series of articles published in the May/June 2009 issue of Clavier Companion exemplify this point. Sale's and Osborn's articles both insist that composition should be included in every lesson, and Goldston describes composition as “an invaluable tool for reinforcing theory concepts.”\textsuperscript{64} These authors also observe that including composition in lessons is problematic because of time constraints. As noted in previous chapters, composition is an important authentic task in piano study, and SLOs 2.2.1-2.2.3 require students to engage in composition activities. By using the online system for some of the initial work with composition, lesson time may also be saved.

Composition is a creative and ill-structured activity that can be difficult for many


students. As noted previously, the cognitive apprenticeship model provides some ideas about how students can be prepared to complete complex tasks. Within the lesson modules, composition activities are modeled as students are learning the various theory concepts from OEOs 1.1-1.3. As students become more independent, the collaborative components of the Web-based system provide a means for the students to continue receiving some guidance by posting questions and comments.

Although a blended approach may place a heavier load on the teacher than if all instruction was Web-based, this setup is still favored since it blends the best of Web-based instruction with face-to-face learning. Also the teacher is still able to guide the activities of the student more directly when it is not practical for the Web-based system to do so. If a Web-based system were designed to assess the student's original compositions, an assessment algorithm would need to be written. Although creating a program flexible enough to evaluate nearly any composition may be possible, developing such a program would probably exceed the development resources of most instructional designers. To the best knowledge of this author, a commercial or open-source program of this type that may also be dropped into a Web-based system does not currently exist. Yet the development of such a program may not even be pedagogically desirable. The rationale for using a blended learning environment is explored in more detail below.

Although some structure may still be lacking within a collaborative environment, a collaborative approach has worked with other implementations for teaching composition. For example, an open-ended composition project was successful for secondary students using software to synthesize excerpts into unique compositions. Dillon found that the main task did
not need to be explicitly stated as students were working in groups of two or three. Although Dillon's approach of synthesizing existing musical excerpts does provide some built-in structure, the Web-based system described below (within the collaborative components) only allowed guidance from the teacher when the teacher chose to do so. Additionally, students are encouraged to bring their compositions to the private lesson after sharing it with their peers or their teacher online.

Many authentic musical activities involving theory concepts are ill-structured tasks that require students to identify problems, consider relevant material, and develop solutions. In order to prepare students for these tasks, the Web-based system should also include a means for the student to begin working in a less guided environment. After the most essential information has been integrated into long-term memory, the creative use of that information should become the next major task. Research-Based Principle 1.4 states that the Web-based system should provide a framework for this creative activity.

Research-Based Principle 1.5: Consider the Unique Characteristics of the Student Population

Most of the research on Web-based instruction has used college age students. However, there seems to be a growing trend towards investigating applications of Web-based technology in the elementary classroom. The field of interaction design and children has evolved out of this growing interest in researching the best use of computer-based instruction for children. Any thorough consideration of Web-based instruction for piano students in the later primary grades

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66 For a very brief overview of this evolving discipline, see Allison Druin and Juan Pablo Hourcade, "Interaction Design and Children," *Communications of the ACM* 48:1 (2005): 33-34.
must also examine this research.

Since a large portion of the research discussed here uses adult learners, whether or not this research applies equally well to late elementary students must be considered. This author was unable to find studies on multimedia instruction that had been replicated between adult and elementary student populations. However, one can consider the cognitive capabilities of most students in this younger group. Additionally, some studies with children are similar enough to studies using adults that one may infer the extensibility of some of these findings to late elementary students.

Piaget's stages of cognitive development are frequently used to describe the cognitive capabilities of children. Later elementary students are typically in the concrete operational stage. Important features of this stage include changes in reasoning, reversibility, classification, and seriation. Children develop a better understanding of cause and effect relationships by deducing causality regardless of whether or not two events happen at the same time. Children also become more aware of others' perspectives, even if they are different from their own. Reversibility refers to the child's capacity to mentally undo or reverse an action just witnessed. Seriation is the ability to order or arrange sets of objects along a quantifiable dimension. Adolescents in the formal operation stage are capable of inductive and deductive reasoning.67

Most late elementary students are more capable of understanding that which is readily visible instead of imagining generalities from observations. Therefore some of the adult studies that used ill-structured problem solving tasks are less applicable to late elementary students without additional concrete guidance. The cognitive apprenticeship model may apply if sufficient modeling of concrete examples is used. When students are asked to engage in analysis

67 O'Donnell, et al., *Educational Psychology*, 40-44.
tasks, the directions must be more explicit than they might be with adolescents or adults. By using collaborative approaches with most of the ill-structured tasks, the teacher is able to offer the guidance appropriate for the individual student. This approach is helpful since the private teacher is probably aware of the mental capacities of the student and can provide additional modeling and guidance when the student is attempting tasks within OEOs 2.1-2.3.

Some of the experiments using children seem to suggest similarities with adult students. For example, the Dunn\(^{68}\) and Persellin\(^{69}\) studies show that multiple modality approaches can work with children, and that most children also prefer AV approaches. Dunn's study used 3rd grade students, and Persellin used 1st, 3rd, and 5th grade students. Mayer argues that the dual-channel (i.e., visual and auditory) assumption with working memory is one of the “most relevant elements in a science of learning” for multimedia instruction.\(^{70}\) As previously discussed, research with adults shows that multimodal instruction that splits non-redundant information across the aural and visual channels leads to more effective instruction. Although the similarities between these two approaches are tenuous, it does seem to suggest that insights provided by research on multimodal instruction with adults could offer beneficial guidelines for designing instruction for children.

Some of the research in the field of interaction design and children investigates the design of the user interface. Hourcade, et. al. found icons with a 64-pixel diameter seemed to be a sufficient size for children as young as 4.\(^{71}\) Students in the later primary grades are usually 9-11 years old so a smaller object should be acceptable for them since a student's hand-eye

\(^{68}\) Dunn, "Perceptual Modalities in Music Learning."

\(^{69}\) Persellin, "Responses to Rhythm Patterns."


coordination improves significantly from ages 4 to 9.

Another significant consideration of any Web-based system is the navigational structure. For example, designers must decide if all pages of a site should be accessible within one click of the main page. Depending upon the complexity of the site, this structure may produce a cluttered home page, and too many choices on one screen could overwhelm an elementary student. Some researchers have found that late elementary students are capable of understanding two navigation levels. With this nested menu setup, any page could be reached within just two clicks of the main page. Most importantly, any chosen menu structure must be clearly organized and placed prominently on the screen so that students have little difficulty understanding what items link to different pages.

Few elementary students are proficient with typing, and it should therefore be kept to a minimum. A vast majority of the interactions with this Web-based system involved pointing and clicking with a mouse. Students were only required to type while posting comments or questions within the collaborative components. With this setup, the student could type as much as he/she felt comfortable.

If students wanted to upload a composition, the means to do so were clearly indicated within the collaborative components. However, in order to transfer handwritten compositions to an electronic format, some help from a parent or teacher could be required. The student would need to either edit their composition in a notation program such as Finale and then convert it to an image file format or scan their handwritten manuscript into the computer. Depending upon the student’s hardware and software configurations, these tasks may be too complicated for late

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73 Hutchinson, Druin, Bederson, "Supporting Elementary-Age Children’s Searching and Browsing." 1620.
elementary students.

Many users interact socially with the computer. This interaction is similar to when someone makes comments to an inanimate object such as a car or anything else that acquires special personal significance. Instructional designers should be aware of this social dimension and design instruction to capitalize on it. For example, the instructional system should use a natural, conversational style of communication.

Other social effects such as praise can affect the learning environment. Dispositional praise (i.e., general praise that is not task-specific) has been found to increase learning outcomes and perceived ability compared to neutral feedback. Bracken and Lombard theorized that this kind of praise is effective with 8-10 year old students because it increases the amount of personal attention they receive. They also observed that the benefits of dispositional praise diminish significantly with older children. Since the positive effects of dispositional praise diminish with an increase in age, using this method of praise too much may make the Web-based program too age-specific. Older students may not want to use the system even if educational objectives are appropriate for their level of understanding. More task-specific praise could be accepted better by older students. Therefore instructional designers should consider how to balance dispositional and non-dispositional praise within instructional feedback.

Instructional designers may also consider other age-dependent features such as humor and graphics. Graphics that portray some kind of action may spark the interest of some children, but the way in which it is used may be more appropriate for some age groups than others. Similarly, humor preferences can vary considerably between students that are only two years

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76 Bracken and Lombard, "Social Presence and Children."
apart in age. Therefore the use of humor and action-driven graphics should be limited since personal preferences may vary too much with students only a couple years apart or possibly even within the same age group.

Several researchers have considered gender differences as a factor in designing technology-driven instruction. Some of this research has suggested that gender may not be a significant variable when considering elementary students’ attitudes towards computer-based instruction. Ho found that Chinese boys and girls in primary and secondary schools had similar attitudes towards instructional technology and music. Bracken and Lombard also found no correlation between praise and gender with 8-10 year olds. Although it may be possible to design one system geared towards boys and another geared towards girls, the benefits of designing such a feature may not adequately justify the required commitment of developmental resources. Perhaps some aspects of the program (e.g., colors, fonts) could be modified dynamically based upon user preferences and would provide a sufficient dimension of personalization.

Using many of the observations and general guidelines outlined above, instructional designers have some research-based suggestions that may guide certain design choices. Much of the research in Web-based instruction is directed at older students, but the availability of research involving younger students is growing, and a thorough implementation of Web-based instruction for elementary-age students must consider the special characteristics of this age group.

77 Fisch, "What’s So ‘New’ About ‘New Media’?,” 108-109.
79 Bracken and Lombard, "Social Presence and Children."
The Final Three Research-Based Principles

2.1 Provide Students With the Means to Communicate and Collaborate with Their Teacher and Peers Outside of Lessons.

2.2 Provide the Teacher With a Means to Shape the Online Learning.

2.3 Provide Feedback From the Online System Which May Be Used to Shape the Private Lessons and Practice Time.

The last three research-based principles that helped shape the design of this Web-based system primarily deal with the nature of the interactions between the student, their teacher, the Web-based program, and other students. Depending on how a teacher sets up their student's account preferences, the student may be able to communicate with other students in the piano teacher's studio or all students registered with the site. The interactions between these individuals may have a significant effect on learning outcomes.

When designing a collaborative system, designers should clearly outline the instructional objectives for each collaborative component. To say that knowledge is constructed within culture does not mean that every learner should simply be placed in a group discussion. There are some situations in which group interaction is beneficial and other situations in which this format may result in a decrease in learning outcomes.

With a Web-based system, many technologies are available to help students and teachers stay in contact with one another. Asynchronous communication may involve e-mail, bulletin boards, forums, wikis, and other means to post or send a message that can be read at a later time. Some of the most common forms of synchronous communication are video conferencing, instant messaging (which may include a Web camera), and chat rooms. The online system developed

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for this project included the use of forums, chats, e-mail, and wikis. Additionally, teachers and parents were provided ways in which they could monitor student progress by checking access time, comments in the forums and other areas, and grades.

Web-based interactions can help students feel free to explore ideas and therefore develop a deeper understanding of the content. Many students prefer interacting socially with their peers as opposed to only interacting with a computer. Donnelly found that music teachers and students in the 3rd and 4th grades valued human interactions more than interactions with the computer.\(^8^1\) Yet the online community is often viewed by the learner as being less threatening than face-to-face interaction.\(^8^2\) So perhaps social interactions online can provide a beneficial balance between the desire for social interaction and the need to feel free to be creative, especially if the opportunity for regular interaction amongst a student's musical peers is not possible.

In order to encourage productive online interactions, the teacher should either be actively involved in the discourse or at least aware of the discussions. Jonassen, et. al. recommended using an “online tutor” format in which the teacher helps guide discussions. The authors cited a paper by Veerman, Veldquis-Diemanse that found students guided by a tutor created more messages and critical argumentation than those without a tutor.\(^8^3\) As noted previously, the lesson modules can model basic tasks that are later performed by the students more independently. As the students are attempting these tasks without direct guidance from the online system itself, the private teacher may continue to model the tasks until the student becomes more autonomous. Additionally, students may need help understanding how to interact socially within this

environment, and by modeling appropriate discourse, teachers can help students learn how to communicate.\textsuperscript{84}

Any Web-based system should not be designed to completely replace instruction within the private studio. Similarly, a choice to omit technology-enhanced learning from the curriculum also removes a pedagogically beneficial instructional medium. Web-based instruction is best used to augment traditional instruction within the private studio. This approach capitalizes on the strengths of both traditional face-to-face instruction and online delivery.\textsuperscript{85} The teacher's continuous involvement is also desirable because he/she ultimately determines the success of the instructional system.\textsuperscript{86}

Although some teachers may feel threatened by the idea of relinquishing some control to a Web-based system, the process of allowing students to learn through another teacher's method (e.g. a theory workbook) is certainly not novel. By using a blended approach, the teacher is directly acting within the instructional materials (using the collaborative components) and is actually able to exert more influence using that medium than with a static workbook. Future iterations of this Web-based system could even include additional customization features. These features could allow the teacher to select pieces that will be used as examples, dynamically insert their own definitions within the lesson modules, and choose their preferred method of sequencing lesson materials. Printed materials rarely offer these options.

Yet the main reason to use a Web-based system as a supplement to instruction within the private studio is that such an approach is more effective. According to a survey of lecturers in

\textsuperscript{84} Hutchinson, Druin, Bederson, "Supporting Elementary-Age Children’s Searching and Browsing," 1620.  
higher education, about 94% believe that blended learning is more effective than classroom-based teaching alone and that the primary interest in blended learning is to benefit the educational process. Private piano instructors should be equally confident in the potential of a blended approach for enhancing theory instruction. The last three research-based principles address situating student activities within this blended learning environment.

CHAPTER 4
IMPLEMENTATION OF THE WEB-BASED SYSTEM

Development and Implementation Overview

This Web-based program was implemented on a remote server using an array of software. The development of the program also required the use of many different programs and occasional coding. Although a complete description of how this program was implemented would be too exhaustive for this document, the major components are outlined below.

The program was deployed on a remote server through a virtual private server (VPS) container. The server had dual Intel® Xeon® Gainestown\(^1\) processors for eight total cores and SATA RAID-10 hard disk drives.\(^2\) Parallels® Virtuozzo Containers\(^3\) were used to create the virtual container for the VPS. The VPS account was guaranteed 512MB of SLM RAM\(^4\) and came with cPanel® WebHost Manager® (WHM)\(^5\) and the Apache®\(^6\) web server preinstalled on the CentOS\(^7\) operating system. Additional modules, such as PHP\(^8\) and MySQL,\(^9\) were also preinstalled and required little additional configuration.

The domain name "northtexaspianostudy.org" had been secured for this project. The main URL contained files for providing study participants with details about the review process (see chapter 5). The Web-based program itself was placed at the subdomain "course." It was implemented as a course using Moodle® version 1.9.5. Moodle is a free and open-source course management system (CMS) designed around a "social constructionist framework of

\(^{1}\) Intel Corporation, \url{http://www.intel.com}.
\(^{2}\) SATA RAID: serial advanced technology attachment, redundant array of independent/inexpensive disks.
\(^{3}\) Parallels Inc., \url{http://www.parallels.com}.
\(^{4}\) SLM RAM: service level management, random access memory.
\(^{5}\) cPanel, Inc., \url{http://www.cpanel.net}.
\(^{6}\) Apache Software Foundation, \url{http://www.apache.org}.
\(^{7}\) CentOS Project, \url{http://www.centos.org}.
\(^{8}\) The PHP Group, \url{http://www.php.net}.
\(^{9}\) MySQL AB, \url{http://www.mysql.com}.\n
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education. Moodle delivers roughly 3.2 million courses to nearly 33 million users from approximately 208 countries around the world. Moodle is a rich and robust platform for delivering a Web-based course programmed in PHP and using a MySQL database. Some modifications to the source code were required to customize some functionalities such as removing the ability of study participants to access internet protocol (IP) addresses of course users. The main purpose of using Moodle was to provide a framework for deploying learning objects (LOs) or shareable content objects (SCOs) as SCORM packages and to utilize Moodle's grade reporting and role functionalities. This setup allowed for the creation of student, teacher, and parent accounts that could monitor different aspects of the student's progress while working through the online system.

The LOs were exported as zipped SCORM packages using the Adobe® Captivate 3 software. These SCORM packages included SWF files viewable with the Adobe Flash® Player. Various other programs were used to develop the materials used within the Captivate files. Adobe Flash® CS3 was used to create SWF files imported into Captivate. Images were edited using Adobe Illustrator® and Adobe Photoshop® Professional CS3. The musical

examples were created using Finale® 2009.\textsuperscript{15} The sound files were created using Adobe Soundbooth® and ACID® Music Studio 7.0\textsuperscript{16} for MIDI editing. Most of the coding was completed using Macromedia® Dreamweaver® MX 2004.\textsuperscript{17} The online program was tested using multiple browsers including Mozilla® Firefox® 3.5.5,\textsuperscript{18} Microsoft® Internet Explorer® 8,\textsuperscript{19} Safari® 4,\textsuperscript{20} and Opera™ 10.\textsuperscript{21}

The online program was tested on three different machines during development. Processing power was found to be a significant factor on one of the machines. The development system had an Intel Core™2 Duo processor running at 3.0 GHz with 8 GB of RAM, on the Windows® 7 platform. The second system was a laptop with an Intel Core™2 Duo processor running at 2.1 Ghz, 3 GB of RAM and Windows Vista. Neither one of those systems ever had problems running the online program. The third system had a single core, Intel Celeron® D Processor 320 running at 2.40 GHz with 256 KB of L2 cache, 2 GB of RAM, and Windows XP. Some animations maxed out the central processing unit (CPU) on the third machine, and the audio and video of the animations went out of synch. The CPU-intensive animations were also tested on a newer, yet low end, desktop running Windows 7 with an AMD Athlon™ processor 2850e (1.8GHz, 512KB L2 cache) and 2 GB of RAM. This machine was able to keep pace with the animations with only a slight occasional delay. As a result of these tests, it seemed likely that some study participants would have problems with the animations but most would not. Therefore this situation was considered acceptable for this kind of review. If students had been used in this study, the program would have needed to been optimized so that it could run

\textsuperscript{15} MakeMusic, Inc., \url{http://www.makemusic.com}.
\textsuperscript{16} Sony Creative Software, \url{http://www.sonycreativesoftware.com}.
\textsuperscript{17} Adobe Systems Incorporated, \url{http://www.adobe.com}.
\textsuperscript{18} Mozilla Foundation, \url{http://www.mozilla.org}.
\textsuperscript{19} Microsoft Corporation, \url{http://www.microsoft.com}.
\textsuperscript{20} Apple Inc., \url{http://www.apple.com}.
\textsuperscript{21} Opera, \url{http://www.opera.com}. 
smoothly on older machines as well.

On the main course page, students could see two main columns (see Figure 2). On the left side, the calendar, administration block, and forum search block are visible. The calendar allowed for scheduling of course activities such as teacher chat sessions. The administration block is where students and teachers could check grades and view usage reports. The forum
The right column contains most of the course content. The top section includes information to help guide the reviewers of the program. Then the intervals, major scales, and major key signatures sections contained all of the lessons, quizzes, and forums for the students. The bonus activities included a chat module and a wiki. Each of these sections also began with introductory information to guide the reviewers with their assessments. At the end of the top section was a questionnaire for the study participants. Then each of the intervals, major scales, and major key signatures sections concluded with an evaluation of each section. The bonus activities concluded with a video that showed the reviewers how to complete their assessment of the program in the teacher and parent roles. The complete assessments are listed in Appendix D and described in greater detail in chapter 5.

Implementation of Research-Based Principles 1.1-1.5

Each section contained four or more lessons and a forum. These lessons contained most of the content for presenting and reinforcing concepts taught using the online system. Within these lessons, the more ill-structured tasks were also modeled so that students could complete them with less guidance within the forums. Research-Based Principles 1.1, 1.2, 1.3, 1.4, and 1.5 are most relevant to the lessons since they apply more directly to content presentation and reinforcement. Research-Based Principle 1.4 applies primarily to the forums since they allowed students greater freedom, but the lessons are also affected by Research-Based Principle 1.4 since they modeled the ill-structured tasks first.

In order for Research-Based Principles 1.1 and 1.3 to be effectively implemented, examples that are fairly complete (i.e., complete phrases or other musical ideas, but not
necessarily complete pieces) must be used while still allowing for concepts to be clearly communicated. To accomplish these goals, students were first shown the need for understanding a new concept using a whole musical excerpt. For example, in the first lesson of the major scales section, the Can Can was presented in G major and A major using accidentals instead of a key signature. For each key, students could listen to the piece while following along with the music. They were asked to consider what was different with the second performance in A major. Then notes from each excerpt were collected on a separate staff, and the student observed the pattern of whole steps and half steps for each collection. Then the term "major scale" was defined, and the G and A major scales were explicitly presented. In later lessons, the G and A major scales were reinforced by requiring students to identify them in multiple contexts.

Although students had been led to understand the pattern of whole and half steps, they were also required to memorize the actual note names for each scale. In the second through fourth scales lessons, students had to build the G, D, and A major scales using the onscreen keyboard. In lesson 5, they built each scale by note name, and then in lesson 6, they constructed the scales by selecting notes on a staff. The keyboard was presented first since it is easier to see the whole and half steps on the keyboard. Then by requiring students to identify the note names before placing them on the staff, students were shown the need for changing the name of the note as they move up the scale.

Concepts were presented in isolation only when absolutely necessary to make the concept clearer, and concepts were always presented multiple times in multiple contexts using whole musical examples (as noted above). For example, after working on memorization of all six covered major scales, additional activities in the lessons required students to identify scales used within the first 28 measures of Diabelli's Sonatina in C Major, op. 151, no. 2. Students were also
instructed to identify altered scale notes and explain how the notes were altered. For example, in ms. 7, students were asked to identify that the A-flat was a flatted sixth scale degree in the C major scale (see Figure 3).

Students were sometimes asked to print off the music and perform it. These tasks not only helped make the musical concepts more meaningful (Research-Based Principle 1.1) by encouraging musical performance, but they also utilized multi-modal approaches (Research-Based Principle 1.2). These multi-modal approaches were used by showing the excerpt visually with animations to highlight relevant features, by hearing the excerpt, and by providing

![Figure 3. Diabelli Sonatina Excerpt](image)

a means for the student to explore the applicable concepts at the piano using a printed excerpt (see Figure 4). Additionally, students were encouraged to perform the non-diatonic note slightly louder than the surrounding notes. The interpretive concept exemplified here was that dissonances should be emphasized and the resolution of those dissonances deemphasized. By relating the theory concepts to some interpretive choices, the students could learn additional information and also develop an appreciation for how theoretical analysis can enhance performance. Although interpretation is not one of the less-structured tasks taught by the online system, it is a typical task for many piano students (see Chapter 3).
Practice playing all of the articulations (slurs, staccatos, accents) very clearly. You may want to write in a good fingering. Then ask your teacher to see how you are doing.

![Music notation]

Figure 4. Image of the worksheet for emphasizing dissonances

The program also used multimodal approaches by presenting nearly all verbal information using spoken narration alongside visual animations. Though the forums did require more reading than the lessons, most lesson material communicated the descriptions of the content aurally so that students would not be constantly reading. This approach could accelerate instruction since students would be able to view the visual examples while hearing the narration instead of reading the narration while also needing to process the visual example.

When multimodal approaches were used, the material was structured or paced in such a way to try and avoid redundancy and not overload the learner's working memory. For example, near the end of the first scales lesson, the half steps of the major scales were highlighted using red boxes on a staff and arrows on a keyboard while the notes were heard one at a time. The notes of the scale were played slowly enough that students should have sufficient time to view the staff and keyboard for each note. Letter names were not used since this information would be redundant (the staff and keyboard should sufficiently indicate the note names). No additional visual or aural cues were used during the performance of the scale. By presenting both the staff and the keyboard, the student should be better prepared to make the connection between whole and half steps on the keyboard, on the staff, and aurally.

All of the relevant musical terms were clearly defined, and students were encouraged to elaborate on those definitions. Terms explicitly defined within the online system included:
interval, melodic interval, harmonic interval, major scale, scale degree, key signature, major key, tonic, composition, and transposition. The definitions for each of these terms were shown onscreen within the lessons and described using multiple examples. The wiki also provided students with the opportunity to reiterate these definitions and contribute their own definitions under teacher guidance. The students could then collectively contribute their own examples of these terms since the teacher and all of the students had editing privileges to the same wiki.

Some of the definitions were reiterated multiple times, and their application was reinforced and extended in later lessons. For example, scale degrees were reviewed when teaching transposition in the fourth major keys lesson (SLO 2.1.3). In this case, Beethoven's Russian Dance was seen and heard. Then scale degrees were assigned to each of the notes within the excerpt. The scale degrees were retained as the G major notes were removed, and then, using the scale degree numbers, the piece was rewritten in the key of A major. Finally students were allowed to select different keys in which they would like to hear the piece. Then, for each of those keys, students could print off the transposed music and perform it at the piano. The final task in the lesson was to print off a guide (that contained only the key signature and scale degree numbers) in which students transposed the piece to one other key.

An important instructional objective and research-based principle was to find ways for students to engage in less-structured creative tasks (see OEO 2 and Research-Based Principle 1.4). Research-Based Principle 1.4 describes a "framework" that the online system must also provide. The framework did not exist exclusively within the less-structured tasks found in the forum but also within the lessons themselves. The cognitive apprenticeship model (see Chapter 3) provides ideas for structuring tasks in a way that a more knowledgeable other helps novices with complex tasks. One of the ways in which this structure is accomplished is through
The lessons contained most of the modeling for the less-structured tasks. For example, to teach composition, students were first shown how a melody could be created by starting with a melodic outline. In the intervals lesson, this process was related to the study of intervals by giving students a choice of selecting a note either a 2nd or 5th above or below a previous note (see Figure 5). During this process, students had the option of hearing the melody using either of the two possible choices. After completing the melody by filling in missing notes, students listened to their melody and could print it out or start over (see Figure 6). Then in the intervals forum, students could perform the same kind of activity to compose a different melody (see Figure 7).

![Guided composition exercise within the lessons](image)

Figure 5. Guided composition exercise within the lessons
Figure 6. Final page of a guided composition exercise

Figure 7. Guided composition exercise within a forum, example 1
In later lessons, composition was modeled again and then even less guidance was provided. For example, the process of composing a melody from an outline was modeled in the final major scales lesson, and then the student was asked to complete a longer melody within the major scales forum (see Figure 8). Later assignments asked students to compose a melody without a provided guide. They were only asked to use a major scale previously studied.

Figure 8. Guided composition exercise within a forum, example 2

SLO 2.1.2 (reducing a melody to a simplified framework) was taught using an iterative strategy. First, in the final intervals lesson (see Figure 9), students were shown how interval patterns could repeat by comparing the repetition of 2nds in ms. 1 with ms. 3. This instruction helped students begin to see how melodic patterns could be summarized using more generalized
descriptions. Later in the same lesson, they were walked through the process of constructing the outline of a melody and then adding to the outline to compose a melody. Then they could compare the original outline and the finished melody by seeing both next to each other and by being able to hear either one (see Figure 10). By showing the reverse process of melodic reduction (i.e., starting with the outline and then proceeding to a more elaborate melody), two tasks, composition and melodic reduction, may be exemplified simultaneously, and their application made clearer. On the next screen of the same lesson, students saw and heard the right hand melody of the first four measures of *Little Dance* by Türk. Students were then asked to select which of the highlighted notes were part of that melody's outline (see Figure 11). Then in
the intervals forum, students were required to find the melodic outline for the rest of *Little Dance* (see Figure 12) by completing a worksheet with a blank staff below each line of the right hand melody (see Figure 13).

![Find the Melodic Outline](image)

**Figure 11.** Exercise for highlighting a melodic outline

![Forum activity for outlining a melody](image)

**Figure 12.** Forum activity for outlining a melody
In order to make the instruction appropriate for late elementary students (Research-Based Principle 1.5), ill-structured problem solving tasks must also utilize concrete instructional guidance, typing should be minimal, navigation should be clear, interactions with the Web-based system should be personable, and humor should be used. As described above, the implementation of Research-Based Principles 1.3 and 1.4 helped provide the necessary concrete guidance for this age group. If students were asked to type, they could choose whether they preferred to type their responses or upload scanned images of their work as attachments to a reply in the forum (see Figure 14).

Most of the navigation was clear using Moodle’s default navigational schemes, and most tasks were only two to three clicks from any given page. Videos showed the reviewers (see chapter 5) how to navigate through the program, and similar videos would be provided for students. The grade reporting features could possibly be the most confusing for some students,
but those features would more likely be used by teachers and parents rather than students. One of the main drawbacks to Moodle 1.9.5 is the lack of progress indicators on the course home page for the SCOs (see Figure 2). The links to the individual lessons do not change when a student completes a lesson. This functionality is reportedly one of the many improvements coming in Moodle 2.0. However, ideally, since Moodle is geared more towards college-age students, a different learning management system could utilize more intuitive navigation and reporting features.

In order to make the course more personable and humorous, the language was mostly casual and conversational. The program used dispositional praise, such as "hey, great job," in addition to more highly targeted feedback. Some instructional strategies also capitalized on opportunities to make learning more enjoyable. For example, when teaching the placement of sharps on the staff for key signatures, the verbal reminders "high, low, high, low, low, high, low," were used. Then the narrator seemed to be intrigued by the possibility of saying these words in
rhythm. Drums and bass faded in, and the narrator began chanting "high, low, high, low, low, high, low," to the jazzy accompaniment. While the music and chanting were playing, highlight boxes were bouncing on the staff as each position was mentioned. This approach is not only fun but also provides a multimodal mnemonic device for memorizing how the sharps are placed on the staff. A similar method was used for memorizing the placement of flats.

Implementation of Research-Based Principles 2.1-2.3

Research-Based Principles 2.1-2.3 primarily involve the manner in which students interact with the online system and with their teacher, parents, and other students in the same studio. Though the extent to which these principles are fulfilled is largely dependent upon how each private teacher uses the online system, the goal is to provide the means by which these principles can be implemented. Since individual teachers could manage their forums and other collaborative features differently, the learning outcomes could be very different from studio to studio even if the same Web-based system is used.

In order to provide students and their teacher with a method for communicating outside of lessons (Research-Based Principle 2.1), features that extend beyond e-mail had to be used. Forums allow students to communicate with their teacher and peers online. Within each forum, different discussion topics presented an array of questions and problems that the students could solve on their own and by working with one another. Even if students would choose to print out their assignments and take them to their teacher without posting their solution to the forum, the capability to share their work with other students could lead to more divergent solutions and increased intrinsic motivation. For example, within this Web-based system, students could scan in their own compositions, upload that file to the server as an image, and attach it to a reply. If
they would also like to include a performance of their work, they could attach an audio file to a separate reply. Students could also start new discussion topics for assignments or questions that they create. Students could be subscribed to a forum so that when a new question or reply is posted, they are automatically notified of the update through e-mail. Parents could also monitor their child's postings.

The online system's chat module provided a synchronous communication method in which teachers could conduct an online chat session. This chat session could be an extra question and answer time for students having difficulty with some of the material or an opportunity to debate more advanced topics. Multiple students could be logged in to the chat session simultaneously. The teacher need not be present for a chat session if students want to schedule their own sessions. If the teacher suspects that students are abusing the system, he/she could also view the logs of all communications within the chat module.

The program's wiki module provided a means by which students could provide definitions for important concepts. The default definitions provided by the learning system may be confusing for some students. Once students develop an understanding of a concept, they may provide a different explanation of the concept that could benefit other students. Additionally, students could elaborate on definitions by providing helpful examples. The interrelatedness of concepts could also be reinforced since definitions for one term may contain other terms, and these terms could be automatically linked to one another. Then if students identify new terms, they could be added to the wiki as well.

By moderating the intervals, scales, and keys forums, and by guiding interactions within the chat and wiki sections, the teacher could shape much of the learning within the online system (Research-Based Principle 2.2). Typical to most wiki designs, the default Moodle wiki contains
an editing history for each wiki page that tracks changes made to the page. If a teacher would like to revert the page back to a previous version, doing so is quick and easy. Additionally, the teacher could edit or comment on all students' entries or add their own material.

Future implementations of a similar Web-based system could also provide a means by which the teacher could control the lesson content more directly (e.g., the definitions used within the lessons or the sequencing of the lessons). Although teachers were not given course editing privileges in this implementation, this capability exists in Moodle. Using this feature, teachers could have full control over the course material although editing the SCOs (i.e., the actual SWF files that constitute the lesson content) would still require additional authoring software such as those described at the beginning of this chapter. Such editing is extremely time and resource intensive. However, using Moodle's rather intuitive editing interface, teachers could add additional lessons with static content or multimedia files, branching lessons, quizzes, and other resources.

In addition to the interaction provided by the forums, wiki, and chat, the online system could also keep the teacher and parents aware of the student's progress using Moodle's grading functionalities. This feedback (Research-Based Principle 2.3) could help the teacher and parents determine if the student is spending an appropriate amount of time using the online system and identify possible problem areas. The quiz for the intervals lesson allowed the teacher to see precisely how the student answered each question while also viewing the question and the corrective feedback that the student received. Unfortunately, the reporting features for the SCORM modules are not fully implemented in Moodle 1.9.5. Again, the 2.0 release should contain more detailed navigation reporting features found in the SCORM 2004 specification. Currently the data reported to Moodle from the SCO is difficult to read and not practical for use
in determining precisely how a student is interacting with each lesson. Ideally, within the grading section, the teacher would simultaneously see the questions from each lesson and how the student responded.

Sequencing of the Instructional Objectives

The specific sequence of the instructional objectives was determined by balancing several factors. First, before introducing each concept, students were shown the need to learn about the concept. Second, as much as possible, tasks and concepts were ordered in difficulty as determined by their classification in the revised Bloom taxonomy (see Table 4). Third, the learning management system itself, usually because of navigational considerations, sometimes made a specific sequence more appropriate.

Tables 6, 7, and 8 outline the sequencing of tasks within the lessons and forums. Relevant SLOs and the categorization of the SLOs according to the revised Bloom taxonomy are described in the third and fourth columns. In addition to Bloom's taxonomic categorization in the fourth column, the task is described according to whether it is being initially presented to the student, the student's performance is being assessed with the help of corrective feedback, or the student is simply being reminded of the concept.

As noted in chapter 3, some instructional design models have students see the need for knowing about a concept before explicitly defining it. This sequencing can generate intrinsic motivation to learn more about the concept and also remind students of previous knowledge. To satisfy this design format, explicit definitions were usually delayed until important features of the concept were considered within authentic contexts. Therefore upon examining Tables 6, 7, and 8, one may notice that the SLOs do not always proceed along the Cognitive Process Dimension.
and Knowledge Dimension in strict sequential order. For example, in the first major scales lesson, tasks categorized as 2B and 4A occur before instances of 1A tasks. This sequence is appropriate here since students are discovering the need to know about major scales. In this example, the same piece was played in two different major keys, and the online system guided the student through the process of extracting the note collections from each key. Then the collections were compared, and the student could see that they both contained the same pattern of whole and half steps. At that point, the term major scale was defined.

Most of the assessments were already built into the lessons themselves. However, limitations of Moodle's SCORM module (as noted above) made detailed reporting of the lesson interactions impractical to implement for this study. The separate quiz within the intervals section was included so that the reviewers could see how a reporting feature could be included, but this approach is not ideal since the interactive functionalities of the SWF-based SCOs are more flexible. For example, to practice building a key signature, students can hover their mouse over a spot on the staff to place the flat or sharp (see Figure 15). This feature is not possible in Moodle's quiz module. Instead the quiz questions were multiple choice. The assessments within the lessons (indicated in Tables 6, 7, and 8 by the letter "a" in the far right column) also had corrective feedback, usually because of the lesson's branching structure. Sometimes concepts were simply reviewed (indicated in the tables by the letter "r") without a branching assessment.

The forums usually contained the most difficult SLOs. These tasks had been previously modeled within preceding lessons. For example, composition had been modeled in the intervals and scales lessons. Then the student could compose in the intervals and scales forums. Additionally, the composition activities from one forum to the next increased in difficulty.
Table 6. Sequencing of the Intervals Section

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Task</th>
<th>SLO</th>
<th>Category*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Listen to <em>Autumn Evening</em>. Whole note moves up and down onscreen as RH melody moves up and down. First 2 measures, RH only, extracted from previous piece and difference between 2nds and 5ths examined aurally and using letter names.</td>
<td>1.1.2, 1.1.3, 1.1.4</td>
<td>2B.p</td>
</tr>
<tr>
<td>2</td>
<td>2nd and 5th explained using letter names. Define interval. Student identifies interval on keyboard.</td>
<td>1.1.4</td>
<td>2B.p</td>
</tr>
<tr>
<td>3</td>
<td>Student identifies interval on keyboard. Intervals on the staff explained (according to line-space, line-line, etc.) Brief melody heard aurally, 2nd extracted, student identifies interval aurally. Student places a note on the staff that is a specified interval above/below a given note. Brief melody heard again, different interval extracted, student identifies interval aurally. Brief melody heard again, different interval extracted, student aurally identifies interval between highest and lowest notes. Explain/define harmonic and melodic intervals. Student hears two harmonic intervals and must identify if 1st or 2nd is a harmonic second.</td>
<td>1.1.4, 1.1.3, 1.1.1</td>
<td>2B.a, 2B.a</td>
</tr>
<tr>
<td>Quiz</td>
<td>Practice Quiz - shown completely only in intervals lessons so that reviewers can observe grade reporting functionality.</td>
<td>1.1.2, 1.1.4</td>
<td>2B.a</td>
</tr>
<tr>
<td>4</td>
<td>Student hears and sees original piece (from lesson 1) and identifies 2nds and 5ths in both hands. Melodic patterns in first 4 ms. of RH explained. Student hears and views all of <em>Autumn Evening</em>. Student completes worksheet by providing notes 2nd/5th above/below given notes. Composing a melody from a melodic outline modeled. Student views first 4 ms. of RH melody for Türk’s <em>Little Dance</em> and identifies its outline. Student composes a melody by selecting three missing notes either a 2nd or 5th above/below provided notes then hears and prints result.</td>
<td>1.1.6, 2.1.1, 1.1.7, 2.1.2, 2.2.1, 2.2.2, 2.2.3</td>
<td>2B.a, 4B.p, 3B.a, 4C.p, 6B.p</td>
</tr>
<tr>
<td>Forum</td>
<td>Student finds other 2nds and 5ths within <em>Autumn Evening</em>. Student finds 2nds and 5ths in <em>Canario</em> (new piece). Student composes a melody with a guide. Student comments on compositions by other students. Student finds the RH outline for Türk’s <em>Little Dance</em> using a guide.</td>
<td>1.1.6, 1.1.6, 2.2.1, 2.2.2, 2.2.3</td>
<td>2B.a, 6B.a, 5A.i/a</td>
</tr>
</tbody>
</table>

*p = present the concept/task;  a = assess (with corrective feedback);  r = review (no feedback)
## Table 7. Sequencing of the Major Scales Section

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Task</th>
<th>SLO</th>
<th>Category*</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Can Can in G major, A major (with notation). Students asked what is different. All notes used in each key are extracted and compared according to patterns of whole/half steps (at this point, notes are called &quot;collection&quot;).</td>
<td>1.2.3 1.2.6</td>
<td>2B.p 4A.p</td>
</tr>
<tr>
<td></td>
<td>Define major scale.</td>
<td>1.2.1</td>
<td>1A.p</td>
</tr>
<tr>
<td></td>
<td>Define and G and A major scales.</td>
<td>1.2.5</td>
<td>1A.p</td>
</tr>
<tr>
<td></td>
<td>Build (using WWhWWh/WWH pattern) and then define D major scale.</td>
<td>1.2.5</td>
<td>1A.p</td>
</tr>
<tr>
<td></td>
<td>Define scale degrees and point out that there are half steps between scale degrees 3/4 and 7/1 while hearing aurally, showing on staff and keyboard.</td>
<td>1.2.4 2A.p</td>
<td>1A.r</td>
</tr>
<tr>
<td>2</td>
<td>Build G major scale using the keyboard.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>3</td>
<td>Build D major scale using the keyboard.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>4</td>
<td>Build A major scale using the keyboard.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>5</td>
<td>Build G, D, and A major scales by note name.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>6</td>
<td>Build G, D, and A major scales using the staff.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>7</td>
<td>Review definition of major scale.</td>
<td>1.2.1</td>
<td>1A.r</td>
</tr>
<tr>
<td></td>
<td>Hear and see Pastoral Sonatina in F major. Hear chromatic scale extracted - student asked if it is or is not a major scale.</td>
<td>1.2.2</td>
<td>2B.a</td>
</tr>
<tr>
<td></td>
<td>Hear and see note collection extracted from Pastoral Sonatina</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Identify major scale by seeing and hearing 7 possible tonics (interactive).</td>
<td>1.2.2</td>
<td>2B.a</td>
</tr>
<tr>
<td></td>
<td>Define F major scale.</td>
<td>1.2.1</td>
<td>1A.p</td>
</tr>
<tr>
<td></td>
<td>Extract C major collection from a different part of Pastoral Sonatina</td>
<td>1.2.6</td>
<td>4A.r</td>
</tr>
<tr>
<td></td>
<td>Define C major scale.</td>
<td>1.2.5</td>
<td>1A.p</td>
</tr>
<tr>
<td></td>
<td>Hear and see entire Pastoral Sonatina again and observe scale locations.</td>
<td>1.2.6</td>
<td>4A.r</td>
</tr>
<tr>
<td></td>
<td>View and hear entire Pastoral Sonatina again and observe scale locations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Review G, D, A, F, C major scales.</td>
<td>1.2.5</td>
<td>1A.r</td>
</tr>
<tr>
<td></td>
<td>Student hears scale (E major) and is asked if it is or is not a major scale</td>
<td>1.2.2</td>
<td>2B.a</td>
</tr>
<tr>
<td></td>
<td>Define E major scale.</td>
<td>1.2.5</td>
<td>1A.p</td>
</tr>
<tr>
<td>8</td>
<td>Build C major scale using the keyboard.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>9</td>
<td>Build F major scale using the keyboard.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>10</td>
<td>Build E major scale using the keyboard.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>11</td>
<td>Build F, E, and C major scales by note name.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>12</td>
<td>Build E, F, and C major scales using the staff.</td>
<td>1.2.5</td>
<td>1A.a</td>
</tr>
<tr>
<td>13</td>
<td>Review definition of major scale.</td>
<td>1.2.1</td>
<td>1A.r</td>
</tr>
<tr>
<td></td>
<td>View and hear first 4 ms. of Diabelli’s Sonatina in C Major, op. 151, no. 2. Student is asked to identify scale used.</td>
<td>1.2.6</td>
<td>4A.a</td>
</tr>
<tr>
<td></td>
<td>View and hear 4 different ms. of Diabelli containing non-diatonic notes. Student identifies notes that do not fit.</td>
<td>2.1.1 1.2.8</td>
<td>4B.p 4B.i/a</td>
</tr>
<tr>
<td></td>
<td>Student builds collection of different 4 ms. of Diabelli, identifies scale used.</td>
<td>1.2.6</td>
<td>4A.a</td>
</tr>
<tr>
<td></td>
<td>Different 4 ms. of Diabelli containing non-diatonic tones are shown and heard. Convention of emphasizing dissonances is explained, demonstrated. Student attempts this expressive gesture by printing it and playing for their teacher.</td>
<td>2.1.1</td>
<td>4B.r</td>
</tr>
<tr>
<td></td>
<td>Non-diatonic tones from same excerpt are described as altered scale degrees (#1). Student must identify other tone as flat 6.</td>
<td>1.2.8</td>
<td>4B.p 4B.a</td>
</tr>
<tr>
<td></td>
<td>Student prints and completes worksheet for building major scales.</td>
<td>1.2.7</td>
<td>3A.a</td>
</tr>
<tr>
<td></td>
<td>Composing melody from outline using D major scale modeled.</td>
<td>2.2.1</td>
<td>6B.r</td>
</tr>
<tr>
<td>Forum</td>
<td>Student identifies major scales, altered scale tones of Mozart’s Minuet in C major.</td>
<td>2.1.1 1.2.8</td>
<td>4A.a 4B.a</td>
</tr>
<tr>
<td></td>
<td>Student composes 8 ms. melody by adding C Scale notes to a guide.</td>
<td>2.2.1 2.2.3</td>
<td>6B.a 5A.r/a</td>
</tr>
<tr>
<td></td>
<td>Student comments on compositions by other students.</td>
<td>2.2.2 2.2.3</td>
<td>6C.a 5A.r/a</td>
</tr>
<tr>
<td></td>
<td>Student composes melody without any guide.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*see Table 4 for taxonomy

p = present the concept/task;  a = assess (with corrective feedback);  r = review (no feedback)
Table 8. Sequencing of the Major Key Signatures Section

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Task</th>
<th>SLO</th>
<th>Category*</th>
</tr>
</thead>
</table>
| 1      | Student hears and views first 10 ms. of Sonata in A major, L. 483 by Scarlatti - key signature not provided - uses accidentals. major scale used is identified. Need for "shorthand" explained.  
Key signature and A major key signature defined.  
Pastoral Sonatina shown and E major key signature added and defined.  
C major key signature defined.  
Student is asked to identify sharps in G major scale.  
Key signature of G major defined.  
Same procedure as above for D major and E major.  
5th relationship of keys and addition/subtraction of flats/sharps a 5th away explained. Also noted - flats/sharps always come in same order. | 1.3.1 | 1A.p       |
| 2      | Order of #/b and their 5th relationship explained (letter names only).  
Order of sharps/flats tested using only letter names. | 1.3.2 | 1A.p       |
| 3      | Present order of sharps on staff using chant.  
Test placing sharps on staff.  
Present order of flats on staff using chant.  
Test placing flats on staff.  
Test recognizing key signature when shown on staff.  
Test building key signature by placing flats/sharps on staff.  
Worksheet for writing complete order of flats/sharps and also writing all 6 major key signatures covered. | 1.3.3 | 1A.a       |
| 4      | Student hears/sees Beethoven's Russian Dance (in G). Scale degrees added for 8 ms. Tonic defined. Student sees/hears piece in choice of three keys (C, F, D) and can print music (scale degree numbers remain).  
Transposition defined.  
Transposition using scale degrees modeled by transposing last 8 ms. of Russian Dance to A major.  
Student prints off worksheet/guide to transpose last 8 ms. to F major. | 2.1.3 | 4C.p       |
|        |                                                                        |       | 1A.p       |
|        |                                                                        | 2.1.7 | 1A.p       |
|        |                                                                        | 2.1.3 | 4C.r       |
|        |                                                                        | 2.1.3 | 4C.a       |
| Forum  | Student transposes one of the melodies they composed in previous composition exercise to 2 new keys covered (they choose).  
8 ms. melody in A major provided. Student composes LH and transposes both hands to E major.  
Student comments on compositions by other students.  
Student views/hears Musette by Couperin and Bagpipe (anonymous) and finds similarities and differences between the two pieces. | 2.1.3 | 4C.a       |
|        |                                                                        |       | 2.2.1       |
|        |                                                                        |       | 2.1.3       |
|        |                                                                        |       | 2.2.3       |
|        |                                                                        |       | 2.1.1       |
|        |                                                                        |       | 2.1.4       |
|        |                                                                        |       | 2.1.6       |
|        |                                                                        |       | 4B.a       |
|        |                                                                        |       | 4C.a       |
|        |                                                                        |       | 4C.a       |

*see Table 4 for taxonomy  
p = present the concept/task;  a = assess (with corrective feedback);  r = review (no feedback)
SLO 2.2.3, "student posts comments on compositions by other students," was implemented exclusively in the forum, and the teacher would be entirely responsible for guiding its instruction. The teacher could choose to model these tasks first by providing a sample composition and critique. Then the teacher should continue monitoring and guiding student comments. If a student does not want the other students to view their work, the composition could be discussed in the private lesson. Then the teacher could create a forum discussion topic to post finished compositions without student comments. However, the task of students working together on their own compositions is desirable and should be included (see chapter 3).

OEO 2.3, "collaborative definitions of concepts," was implemented using Moodle's wiki module, as noted above. Here again, the teacher could guide this process as much or little as he/she sees fit. Also, students, or their teacher, may add new terms to the wiki as a different kind of assignment.

Though there are many possible ways to structure these SLOs, the sequence described in this chapter outlines a balanced approach not solely based on intuitive choices. Nearly every
aspect of the design had been outlined and categorized in detail, and the final implementation was guided using an interdisciplinary research methodology. The research-based principles, categorization of the tasks according to Bloom's revised taxonomy, and the intrinsic design features of Moodle all contributed to the final implementation.
CHAPTER 5
EVALUATION OF THE IMPLEMENTATION AND CONCLUSIONS

Introduction

The purpose of this dissertation is to define, design, and implement a Web-based program for teaching fundamentals to piano students in the later primary grades. This process will help outline a new pedagogical paradigm for integrating Web-based instruction (WBI) within the piano studio. The goal of this dissertation is not to evaluate the efficacy of this approach but rather to use integrative and formative research for considering the best use of Web-based instruction within this context. The research-based principles provided several guidelines for implementing this Web-based program. The previous chapter described how the principles were realized through the Web-based program. Piano teachers then evaluated the implementation of these principles within the online program, and these principles were further refined. These principles, and the method of their implementation described in the previous chapter, help outline a new pedagogical paradigm for the integration of WBI within the piano studio.

Method

The evaluation process was first approved by the Institutional Review Board (IRB) at the University of North Texas. Since this study occurred entirely online, participants only needed to accept a consent notice (see Appendix B). The recruiting procedures and e-mails, consent notice, and survey items were all submitted to the IRB for approval.

I recruited piano teachers by contacting local music teacher associations and other piano teachers that had listed themselves on Websites that I own. Approximately 13 presidents of local associations affiliated with the Music Teachers National Association (MTNA) were contacted by
e-mail (see Appendix C) and asked to forward the researcher’s request to their members.

Membership in each of these organizations varied considerably from approximately 30 members to 140. The four Websites are online directories of piano teachers devoted to specific geographic regions (i.e., New York, Chicago, Dallas, Kansas City). Approximately 150 teachers were contacted through those e-mails. Participants could also view the information about the study at the site's main URL (www.northtxpianostudy.org). Of those contacted, 31 teachers agreed to participate in the study. Teachers were given approximately three weeks to complete their review of the program which took between approximately two to five hours. The teachers were allowed to complete their review in multiple sessions. Of the 31 teachers that initially agreed to participate, 14 completed the study within the allotted time.

Demographic information was collected from the subjects at the outset of the review (see Table 9) using the survey (see Appendix D) at the top of the course homepage (see Figure 16). The survey also asked questions concerning weekly teaching hours, theory teaching methods, and computer use (see Table 10).

Each participant was assigned a primary user ID (eg., a1111) for starting their review, four IDs for use within the actual course (eg., a1111-student1, a1111-student2, a1111-teacher, a1111-parent), and a password. A separate course was created for each subject. Participants received their IDs and login information in a PDF file sent via e-mail. They were first prompted to login and accept the consent notice. After viewing and accepting the consent notice, they were taken to the course index page to view a video explaining how to begin (see Figure 17).1 Subjects were also provided with the option of printing a PDF handout detailing how to proceed to the next location within the course. After viewing this video, subjects were instructed to close

1 Readers interested in reviewing the course materials as the study participants did should contact the author for temporary accounts.
the video and login using their unique student ID. Then they viewed a video at the top of their respective course homepages that described the research-based principles (see Figure 16).

Figure 16. Course homepage screenshot
Table 9. Demographic Information of Study Participants

\( n=14 \)

<table>
<thead>
<tr>
<th>Gender</th>
<th>Age (years)</th>
<th>Experience (years)</th>
<th>Education</th>
<th>Teaching Locations*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>Mean 55</td>
<td>Mean 27</td>
<td>Some College 4 (29%)</td>
<td>Teacher's Home 13</td>
</tr>
<tr>
<td></td>
<td>SD 11</td>
<td>SD 11</td>
<td>Bachelors 5 (36%)</td>
<td>Student's Home 3</td>
</tr>
<tr>
<td></td>
<td>Min 35</td>
<td>Min 11</td>
<td>Masters 3 (21%)</td>
<td>Church 1</td>
</tr>
<tr>
<td>Male</td>
<td>Max 80</td>
<td>Max 45</td>
<td>Doctorate 2 (14%)</td>
<td>College 1</td>
</tr>
</tbody>
</table>

*Some taught at more than one location. 11 listed teacher's home as their primary teaching location. The other three listed one of the other options.

Table 10. Teaching Materials and Computer Use Reported by Study Participants

\( n=14 \)

<table>
<thead>
<tr>
<th>Theory Materials Used*</th>
<th>Total Computer Hours**</th>
<th>Computer Use within the Studio***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Workbook 13</td>
<td>Mean 20</td>
<td>E-mail 12</td>
</tr>
<tr>
<td>Handouts 7</td>
<td>SD 12</td>
<td>Microsoft's Word or similar 10</td>
</tr>
<tr>
<td>Assignments 6</td>
<td>Min 3</td>
<td>CAI - owned by teacher 6</td>
</tr>
<tr>
<td>CAI 7</td>
<td>Max 50</td>
<td>CAI - owned by student 5</td>
</tr>
<tr>
<td>Internet 4</td>
<td></td>
<td>Internet 5</td>
</tr>
<tr>
<td>Other 1</td>
<td></td>
<td>Audio Editing Programs 4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Graphics Editing Programs 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Never use the computer 2</td>
</tr>
</tbody>
</table>

*Most subjects listed more than one kind of teaching material. 12 indicated that a workbook was their primary teaching method, 1 indicated that the internet was, and 1 selected "other."

**The total number of hours spent using the computer for any purpose.

***Subjects could select more than one option.

The subjects worked through nearly all of the course materials and features in three different roles. First, they viewed most of the course content as a student. This role allowed them to view all the course lessons, forums, collaborative components, their grades, and the reviewer materials (i.e., videos and surveys). While viewing the course materials in the student role, the subjects reviewed the main three content areas (intervals, major scales, and major key signatures) immediately after working through them.

Then they logged out of the student role and logged back in as a teacher. Subjects never used the second student role. It was created so they could see how the teacher could track the
progress of more than one student but the parent could only view the progress of their child. After reviewing some of the features in the teacher role, they logged out and logged back in as a parent. In the parent role, they were able to view the grades of only one of the two students. After viewing the available reports in the parent role, they completed one final survey.

Figure 17. Screenshot of the index page for the course

Since the subjects were recruited to evaluate the extent to which eight research-based principles were implemented within the online program, that task had to be more carefully
defined. When evaluating software, one may feel inclined to consider usability issues and software bugs as primary issues to be addressed, but this kind of assessment was not the purpose of this evaluation. Subjects were specifically instructed to not let minor software bugs and a lack of polished visual appearance affect their review. They were told that this program was not a complete polished product intended to be used by students "as is" and that some parts of the program were deliberately left out in order to accelerate the review process (e.g., there is only one quiz instead of several for each subject area). Subjects were instructed to consider the overall approach used within the online system and the extent to which the Web-based program fulfilled the research-based principles.

After describing their role as a reviewer, the introductory video described the research-based principles and provided more detailed explanations and examples of these principles. For Research-Based Principle 1.1 (Convey content as an integrated whole using multiple authentic contexts), subjects were told this meant that "theory concepts should not be taught in isolation without using real musical examples. For example, when teaching intervals, theory instruction shouldn't include only intervals shown on a staff but also intervals extracted from actual pieces of music." Two separate animations clarified this point. The first animation showed two intervals on a staff, and the second animation showed an interval being extracted from an excerpt onto a separate staff.

For Research-Based Principle 1.2 (Deliver content through visual, auditory, and kinesthetic approaches), subjects were told that this "means that content should be shown visually onscreen, performed with audio, and use hands-on techniques as much as possible." Kinesthetic approaches were not elaborated upon any further. For Research-Based Principle 1.3 (Teach the most essential information clearly without unguided or discovery methods), subjects
were told that this principle leaves room for creative activities (e.g., composition), but it also "emphasizes that, at some point, terms and concepts should be articulated as clearly as possible so that there is less room for confusion." For Research-Based Principle 1.4 (Provide students with a framework for creative thinking in a less guided environment), subjects were told that this principle builds on the previous one by allowing for some structure (i.e., framework) while still encouraging creativity with little guidance. For Research-Based Principle 1.5 (Consider the unique characteristics of the student population), subjects were told that this "principle is deliberately vague. Many considerations could fall under this description." However, they were not to consider the color scheme of the interface but rather the extent to which "the overall approach this system uses for presenting, teaching, and reinforcing concepts and tasks is appropriate for the cognitive skills of late elementary students."

For the last three Research-Based Principles (2.1 Provide students with the means to communicate and collaborate with their teacher and peers outside of lessons; 2.2 Provide the teacher with a means to shape the online learning; 2.3 Provide feedback from the online system that may be used to shape the private lessons and practice time), subjects were told to consider the Web-based program as a whole and consider if the collaborative tools provided a means to "create an online community of learning within their piano studio."

After explaining the research-based principles, the video defined the student population for which this program was targeted. Specific prerequisite knowledge included a familiarity with all the note names on the grand staff, chromatic signs, whole steps and half steps, and basic rhythms up to the eighth note division of the beat in simple meters. Subjects were also told that the intervals lessons would introduce intervals as if the student had never learned about them previously. They were then told that aural skills would be included in the program. A printable
handout containing the main pre-requisites for students that would use the program was also provided.

Subjects were also instructed to complete each section (i.e., intervals, major scales, and major key signatures) all at once. If they wanted to take a break after reviewing a section, they could do so. They then viewed animated screenshots explaining how to navigate through the lesson content.

The implementation of each research-based principle was rated using a 10-point Visual Analogue Scale (VAS) and an open-ended text box. The surveys were coded using HTML, CSS, PHP, and JavaScript. The scales were created using a free collection of JavaScript code (see Figure 18). Minor modifications of the VAS code were required for appropriate operation. The scales used a numerical range from 0-10 with the words "NOT AT ALL" on one end of the scale and "COMPLETELY" on the other (see Figure 18). Subjects viewed an animation of how to manipulate the VAS by dragging an "X" over the scale. They were then instructed to complete the first questionnaire and proceed to the explanatory video under the intervals section.

When beginning each of the different sections, subjects were provided with introductory materials that reminded them what they were to consider when viewing the materials. For each of the intervals, major scales, and major key signatures sections, subjects were asked to evaluate seven of the eight Research-Based Principles: 1.1-1.5 and 2.1-2.2. The surveys at the conclusion of each of those three sections were therefore identical.

At the beginning of the intervals section, subjects viewed a video explaining how each principle applied to this section. They were told that Research-Based Principles 1.1, 1.2, 1.3, and 2.1-2.2 were evaluated using the VAS created using JavaScript code from the free VAS Generator available at http://www.vasgenerator.net.

---

2 The VAS was created using JavaScript code from the free VAS Generator available at http://www.vasgenerator.net.
1.5 applied more directly to the lessons, and that Research-Based Principles 1.4, 2.1, and 2.2 applied more directly to the forum, its provided discussion topics, and its capabilities for students to generate their own discussion topics. They were also directed to a video that showed them how to operate the forums. Subjects were instructed to view all of the discussion topics and, if they wanted to, respond to the forums and post new discussion topics. Then the introductory video described the Research-Based Principles again.

For the major scales section, subjects viewed a textual explanation of what they were to do. They were told that they could "skip lessons 3, 4, 8, 9, and 10 since they are nearly identical to lesson 2." The content within each of the lessons was briefly outlined using a chart so that subjects could see which lessons they were skipping and why. They were also told that they could skip lessons 11 and 12 since they were nearly identical to previous lessons (see Table 7 for a description of the lesson content). They were also told that the scales section did not have a quiz like the intervals section in order to accelerate their reviewing process. The purpose of including only one quiz was to allow the reviewers to see how student progress could be tracked.
using such an assessment. Therefore the subjects did not need to see that specific functionality multiple times. At the bottom of the major scales introductory materials, subjects were provided with a means to print out a handout that outlined the materials on that page.

The introductory materials for the major key signatures section were very similar to those for the major scales section. Subjects only needed to view text reminding them which principles applied more directly to the lessons or forums. Then they were reminded to proceed to the bonus activities after completing the major scales activities and read the introduction for those materials.

The bonus activities included a chat module and a wiki. Subjects were told that they did not need to use the chat module since doing so would require either multiple users or multiple sessions in different browser instances. They were instructed to try out the "Musical Terms" wiki, and explanatory text on the first page of the wiki described how to do so. They were provided with several terms to get them started: interval, melodic interval, harmonic interval, major scale, scale degree, key signature, major key, tonic, composition, and transposition.

The final video at the end of the bonus activities section did not contain a survey for the subjects but rather explained how to complete their review in the teacher and parent roles. They were told to consider Research-Based Principles 2.1-2.3 while using these roles. Then animated screenshots showed subjects how to navigate through the teacher and parent roles in order to check student progress. They were able to see that the student1 role had completed most of the materials and view the grade student1 received for the quiz. In the teacher role, they were also able to see exactly which questions were missed, if any, and see what answer the student had provided. Then they were shown how to find the final review.

The final review contained only three VAS and text box items evaluating Research-Based
Principles 2.1-2.3 and five final open-ended questions. The first three questions in this final survey related specifically to the teacher and parent roles, and the last five questions concerned the program as a whole. After completing this survey, subjects were told that they were finished.

Results

The survey results were collected in a MySQL\(^3\) database, exported using phpMyAdmin,\(^4\) and opened in Microsoft® Excel® 2007.\(^5\) Excel's calculation functions were used to analyze the quantitative data. Only mean, standard deviation, minimum score, and maximum score were calculated. Open-ended comments provided specific and general feedback on which principles seemed to be most successful within the implementation and offered suggestions for modifications.

Tables 11, 12, and 14 show the results from the scales. Table 11 shows the overall scale ratings from all 24 scales. Table 12 organizes the scales by Research-Based Principle and course section. Table 13 lists the Research-Based Principles evaluated by the surveys in Table 12. Table 14 shows the scale results from the final survey.

The comments in the text-entry boxes contained general observations and specific recommendations. Some reviewers provided very little, if any, explanation for their rating choices although they were encouraged to explain each choice using additional comments. Most

<table>
<thead>
<tr>
<th>Table 11. Overall Evaluation of the Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean: 8.53</td>
</tr>
<tr>
<td>Evaluated using a Visual Analogue Scale with a range of 0-10.</td>
</tr>
</tbody>
</table>

\(^3\) MySQL AB, [http://www.mysql.com](http://www.mysql.com).
Table 12. Evaluation of the Research-Based Principles within Each of the Content Sections

<table>
<thead>
<tr>
<th>Applicable Principle*</th>
<th>Intervals mean (SD) min-max</th>
<th>Scales mean (SD) min-max</th>
<th>Key Signatures mean (SD) min-max</th>
<th>Total mean (SD) min-max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1**</td>
<td>8.50(2.06) 2-10</td>
<td>8.50(1.55) 5-10</td>
<td>9.21(0.97) 7-10</td>
<td>8.74(1.59) 2-10</td>
</tr>
<tr>
<td>1.2**</td>
<td>8.64(2.09) 2-10</td>
<td>8.42(2.31) 2-10</td>
<td>8.85(2.17) 2-10</td>
<td>8.64(2.15) 2-10</td>
</tr>
<tr>
<td>1.3**</td>
<td>8.28(2.52) 1-10</td>
<td>8.28(2.52) 1-10</td>
<td>9.21(0.89) 8-10</td>
<td>8.59(2.12) 1-10</td>
</tr>
<tr>
<td>1.5**</td>
<td>8.07(2.64) 1-10</td>
<td>7.50(2.71) 0-10</td>
<td>8.07(1.89) 5-10</td>
<td>7.88(2.40) 0-10</td>
</tr>
<tr>
<td>1.4***</td>
<td>8.35(2.40) 2-10</td>
<td>8.57(1.65) 5-10</td>
<td>8.57(1.55) 5-10</td>
<td>8.50(1.86) 2-10</td>
</tr>
<tr>
<td>2.1***</td>
<td>8.50(1.50) 5-10</td>
<td>8.92(1.54) 5-10</td>
<td>8.92(1.43) 5-10</td>
<td>8.79(1.47) 5-10</td>
</tr>
<tr>
<td>2.2***</td>
<td>8.71(1.20) 7-10</td>
<td>8.42(1.78) 5-10</td>
<td>8.57(1.60) 5-10</td>
<td>8.57(1.52) 5-10</td>
</tr>
<tr>
<td>Total:</td>
<td>8.44(2.07) 1-10</td>
<td>8.38(2.04) 0-10</td>
<td>8.78(1.56) 2-10</td>
<td>8.53(1.90) 0-10</td>
</tr>
</tbody>
</table>

* The implementation of the principles was evaluated using a Visual Analogue Scale with a possible range of 0-10.
** These principles were more applicable to the lesson materials.
*** These principles were more applicable to the forum materials.

Table 13. Applicable Research-Based Principles for Course Content

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Convey content as an integrated whole using multiple authentic contexts.</td>
</tr>
<tr>
<td>1.2</td>
<td>Deliver content through visual, auditory, and kinesthetic approaches.</td>
</tr>
<tr>
<td>1.3</td>
<td>Teach the most essential information clearly without unguided or discovery methods.</td>
</tr>
<tr>
<td>1.4</td>
<td>Provide students with a framework for creative thinking in a less guided environment.</td>
</tr>
<tr>
<td>1.5</td>
<td>Consider unique characteristics of the student population.</td>
</tr>
<tr>
<td>2.1</td>
<td>Provide students with the means to communicate and collaborate with their teacher and peers outside of lessons.</td>
</tr>
<tr>
<td>2.2</td>
<td>Provide the teacher with a means to shape the online learning.</td>
</tr>
</tbody>
</table>
Table 14. Evaluation of Teacher and Parent Roles

<table>
<thead>
<tr>
<th>Applicable Research-Based Principle*</th>
<th>mean(SD)</th>
<th>min-max</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Provide students with the means to communicate and collaborate with their teacher and peers outside of lessons.</td>
<td>9(1.12)</td>
<td>7-10</td>
</tr>
<tr>
<td>2.2 Provide the teacher with a means to shape the online learning.</td>
<td>8.21(2.04)</td>
<td>5-10</td>
</tr>
<tr>
<td>2.3 Provide feedback from the online system that may be used to shape the private lessons and practice time.</td>
<td>8.29(2.30)</td>
<td>3-10</td>
</tr>
</tbody>
</table>

* Evaluated using a Visual Analogue Scale with a range of 0-10.

of the comments were not specific but rather provided more general affirmation. Each reviewer did provide some specific observations at some point during their review. Most of the comments were related to collaborative features of the program, interactive features, and personal preferences for teaching specific concepts. The personal preferences were usually reviewers describing how they teach within their own studio.

Conclusions

The mean score of all the survey scales, combined with the comments from the text-boxes, seem to indicate that reviewers largely believed the implementation of the Research-Based Principles was successful. Since the Research-Based Principles were based on empirically-driven research and not directly contradicted by any of the results from this study, they seem to be an appropriate starting place for designing WBI that may be integrated within the private piano studio. The research within this dissertation is however not conclusive and possesses notable limitations that make the applicability of this research to the broader population somewhat tenuous.

Although the reviewers that completed the study were not meant to be representative of
the population of private piano teachers, some potential biases must still be pointed out. Additionally, the nature of this study may have made it difficult for subjects to understand their role as a reviewer. The study also does not attempt to determine if the principles outlined within this dissertation can enhance learning outcomes with actual students. Technical problems may also have affected the results of the study.

Subjects were recruited using e-mail lists that were not representative of the population. The sample was not randomly selected since only contact information conveniently available was used, and only teachers that felt inclined to participate did so. Additionally, the precise number of individuals that received the e-mail solicitations could not be determined since the request was sent to presidents of local associations for forwarding to their members. However, the purpose of this study was not to make generalizations applicable to the population but rather to solicit feedback from practitioners.

Some subjects may have been biased to respond either in favor of the implementation or against it for reasons not directly related to the program. In e-mails from study participants, some subjects indicated a desire to complete the review because they either knew the researcher or appreciated the purpose of the project. For example, one reviewer wrote that he/she would like to complete the review because the researcher's Website had brought them so many new students. E-mails from other reviewers suggest a different bias. One reviewer noted that he/she would never find an approach other than their own to be worthwhile, and that any Web-based program is not able to match his/her approach.

Some reviewers also seemed troubled by technical problems and were inclined to ascribe these difficulties to some error within the program. For example, some of the animations were known to max out CPU usage on lower end processors (see chapter 4). Some reviewers
described similar technical issues and commented that "the program" was not able to keep up. Additionally, other differences (e.g., screen size, speaker sound quality, etc.) between client systems could have affected the survey outcomes.

The reviewers may have had difficulty understanding precisely what they were supposed to do. In one of the final surveys, one reviewer stated that he/she did not "really understand" how to evaluate a specific principle (Research-Based Principle 2.3). The videos that the reviewers watched at the beginning of their review were provided to help them understand exactly what they were supposed to do and what the principles meant. However, it is also possible that the explanation provided by the videos used examples too similar to the actual implementation, possibly priming the reviewers with a bias favoring the implementation.

Many reviewers provided fewer comments towards the end of their review. Since the entire review session took many reviewers close to three hours to complete (and some even longer), they may not have given as much thought to the implementation of the principles in later lessons as they did in earlier lessons. This scenario would make comparisons of mean scores and comments between sections less appropriate.

Every instructional method must eventually be tested with students in order to determine its efficacy. Piano teachers were an appropriate choice for evaluating this program since they are in a better position to critique instructional design than students. Yet it is possible that these principles may require additional modification once an implementation based on them is used with students. Therefore this formative research is certainly incomplete and needs validation using actual students.

The entire implementation was conceived with late elementary students in mind, and this focus may make broader application to different age groups more difficult. Reviewers were told
to consider if the program was appropriate for late elementary students. Therefore many of the reviews did not directly consider if such an approach might work with earlier elementary students or older students.

Discussion

The survey results indicated that reviewers consistently believed the implementation of the Research-Based Principles was quite successful. Most of the scores on the scales were very close (an overall range of only 7.5-9.21), so the highest and lowest scores are perhaps the best indicator of the most and least successfully implemented sections. The open-ended text boxes provided additional insights necessary to form substantive conclusions from this research. Since most of the comments provided by the reviewers also refer to these upper and lower limits, they may be the best indicator of the most or least successfully implemented principles.

To most of the reviewers, inclusion of the forums was enough to successfully implement Research-Based Principle 2.1. Few reviewers made specific comments on the default assignments provided within the forums. Since the principle only suggests a provision for collaboration, perhaps reviewers saw little need for additional explanation of their rating.

Some reviewers did however make additional comments on the implementation of this principle. One appreciated the capability for students to print their projects and worksheets to be taken to the teacher while two others pointed out that this capability encourages additional collaboration with the teacher at the lesson. Another reviewer suggested that students could collaborate on compositions while another simply observed that the capability for students to write about whatever interested them was advantageous. One reviewer did think that the directions on one of the worksheets could have been clearer. Another reviewer thought that the
forum setup was too rigid but seemed to miss that students and teachers could create their own discussion topics. This functionality had been described to the reviewers in previous videos.

Some reviewers stated that the open-ended nature of the forum encouraged creativity and was a big advantage to the program, but a few also seemed to miss how the forum could bring about new creative processes. The implementation of Research-Based Principle 1.4 did receive the second lowest mean score (see Table 12), and some of the comments also suggest that reviewers missed this connection. For example, one reviewer considered only the more guided composition activities provided in the lessons by noting that they could "not choose their own rhythms" even though the forums included free composition without any guides. The reviewers had been directed to relate the implementation of Research-Based Principle 1.4 more to the forums instead of the lessons. Perhaps the forums could have been referenced more frequently within the lessons.

Most reviewers did however note that the forums allowed for creative activities. For example, one reviewer said they "love the fact that this program takes students to the next steps...finding more scales, etc., and even composition." Another reviewer observed that "the activities in the forum truly support this principle." Another reviewer explained that "this is my favorite" while many others did observe that "the forum supports this principle." Based on the comments overall, the reviewers believed that the collaborative capabilities of this implementation were its strongest feature.

The scales (see Table 12) and some of the comments suggest that reviewers thought the implementation of Research-Based Principle 1.5 left the most room for improvement, but many reviewers were also pleased with the implementation of this principle. Several reviewers noted that the language was appropriate for late elementary students and that most students would
probably find the program very enjoyable. Other reviewers observed that the unique interfaces and combination of visual and aural components would appeal to many different students.

The more critical comments for the implementation of Research-Based Principle 1.5 seemed related to technical problems, visual aesthetics, and pacing. Although the reviewers were explicitly told not to consider technical problems or the color scheme in their reviews, some seemed unable to disassociate these considerations from the appropriateness of the program for late elementary students. The reviewers were also told to expect some minor bugs in the program. Testing before the study began had suggested that some of the SWF animations would max out CPU usage on computers with lower end processors causing the audio and video to go out of synch (see chapter 4). This problem apparently occurred with at least two of the reviewers. One of the reviewers commented multiple times that the animation problems would prevent students from understanding concepts. While this is certainly true, that factor should not have been considered in the review since the problem is more technical than pedagogical. This particular reviewer also seemed to have problems with the download speeds, and his/her ratings of the principles containing those comments were similarly low (0-1).

Reviewers were similarly instructed to not consider polished visual aesthetics in their review. They were told that this implementation was not a polished final version intended to be used with students "as is." Instead they were to evaluate the overall approach of the system. Regarding the look of the program, they were only to consider the visual layout and interactive features of the interface. Although one of the reviewers thought that the minimalist look of the interface was actually a plus, two others thought that this alone would deter students from interacting with the system. Most of the reviewers thought that the way in which concepts were shown visually was a real asset of the program. However the reviewers who expressed their
dislike of the color scheme gave the implementation of Research-Based Principle 1.5 a rating of 0, 1, or 5 across multiple sections. When removing these lower ratings that seem to be affected more by technical difficulties and visual appeal, the ratings of the implementation of Research-Based Principle 1.5 are more in line with those of the other principles (mean of 8.4, standard deviation of 1.7).

There were however some critical comments of the implementation of Research-Based Principle 1.5 that did not seem to be directly related to technical problems or visual aesthetics. Three reviewers noted either that the pacing of the program sometimes seemed slow or that the lessons contained too much talking. These observations could be related. The lessons contained most of the explanations using the authentic musical examples that were described through narration, performances, notation, or animations of features within the music (e.g., concept instances were often extracted from the score using animations). Also, the process of describing these concept instances often took more time than simply providing a definition. One reviewer indirectly hinted at a possible solution by suggesting that "quick learners" might become bored. One way to address all of these issues would be to add additional branching and student testing earlier in the lessons so that the students capable of handling more complex situations could be taken to those activities more quickly.

Within the key signatures lessons, reviewers consistently indicated that the implementation of Research-Based Principles 1.1 and 1.3 were particularly successful (see Table 9 and note the mean rating of 9.21 on both and the standard deviation of only 0.97 and 0.89 respectively). These lessons contained somewhat elaborate animations that helped clarify abstract concepts such as transposition and composition. By using scale degrees for explaining transposition, the major scale concept was also related to transposition. The approach used
within the key signatures lessons should therefore be retained with little modification.

The final evaluations were similarly positive (see Table 14), and the implementation of Research-Based Principle 2.1 received the highest score again. The final evaluation also included additional open-ended questions that gave reviewers the opportunity to reflect on the overall advantages and disadvantages of the implementation. Two different reviewers noted that students are often quite busy. One of these reviewers explained that students frequently complete their theory assignments in the car on the way to activities but that "it would be impossible to do that with a Web based program." Using a mobile device, students could still work on theory while in the car. Another reviewer specifically said that the online system would be more difficult to use than a workbook unless it would also work on an iPhone®. Perhaps a future implementation could also include activities specifically designed for use on mobile devices.

The final question about additional ways to present concepts in visual, auditory, or kinesthetic formats (VAK) contained some of the references to the color scheme similar to those noted above. Specifically, although one reviewer liked the "spartan-ness" of the program and how it was not saturated with "cutesy pictures," three other reviewers suggested that the program needed more color. Although most of the activities within the lessons and forums encouraged students to perform the concepts at the piano using various handouts or other methods, one reviewer noted that this feature should be included. The need to keep directing students to the piano was reiterated by other reviewers in responses to other questions.

Several other observations on later questions offered additional ideas. Two reviewers suggested that the program specifically direct students to sing in addition to playing at the piano.

\[^{6}\text{Apple Inc., \url{http://www.apple.com}.}\]
Several of the reviewers would have liked to see a competitive game included in the program. Most of those responses suggested that competition against oneself or other students is very motivating, and that an online program like this could include it. Three reviewers referenced the importance of always considering social aspects of any instruction, specifically stating that face-to-face communication must always be included. Another reviewer suggested integrating the program with Facebook® or by some other means to help the student "pay attention to doing the homework." All of these observations are also strongly supported in the research referenced in previous chapters.

The ability to customize instruction is perhaps the greatest advantage of the forums and was also described most frequently in the final questions as a requirement for ideal instruction. One reviewer mentioned that some assignments must always be designed on an individual basis. The one-on-one interaction inherent with private piano instruction is certainly one of the benefits to having a private tutor of any kind, and WBI should similarly encourage face-to-face interactions. Another reviewer mentioned that he/she likes to observe "the understanding of [a] student." If WBI can provide the teacher with sufficient feedback, a Web-based program may actually enhance a teacher's ability to see how a student is constructing their understanding of the concepts. Another reviewer noted that he/she would prefer to use a Web-based program such as this one "because valuable contact time in the lesson could be spent listening to the student play" and "the teacher can monitor the learning throughout the week." Since musical performance instruction must be individualized even more than theory instruction, perhaps WBI could support the individualization of instruction by allowing more time to be spent on that which natively requires more individual attention. Additionally, if WBI can help the teacher stay updated on

student progress during the week, very short interventions that guide student learning (i.e., forum posts, e-mails, or chats) could create more frequent and more meaningful interactions.

Many reviewers also mentioned the program's interactive features as a great asset. Two reviewers specifically noted that workbooks are not able to interact with and respond to students. Another reviewer however noted that the ability to illustrate concepts on paper was not possible with a computer. However, teachers could still use lesson time for this task or even upload scanned paper to a forum so that students could receive additional interaction between lesson times.

By considering the comments and scale ratings in combination with the research from earlier chapters, new insights on the best use of Web-based instruction within the piano studio begin to emerge. The research-based principles had outlined important considerations for an effective implementation of WBI. The implementation based on these principles offered one possible approach. Formative research resulting from the implementation and subsequent reviews highlight important considerations for integrating WBI within the piano studio.

These considerations have been amended to the existing research-based principles in order to clarify their application, and this clarification should be useful for future implementations. In order to keep additional recommendations concise and general enough for broad application, each principle will be revisited briefly with additional suggestions for successful implementation of each principle within a Web-based environment (see Table 15).

For Research-Based Principle 1.1 (convey content as an integrated whole using multiple authentic contexts), instructional designers should use musically complete portions of excerpts for examples, relate concept application to interpretation, encourage student performance, and include aural skills, musicianship skills, and composition. Musically complete portions include
phrases, sections, and complete pieces. Students should have the opportunity to hear and see excerpts performed. These performances should be expressive, and students should similarly learn how an understanding of these concepts can affect musical interpretation. Students should then be encouraged to perform these interpretive choices for their teacher. Instruction should continuously include aural skills and seek to develop musicianship skills through performance.

Table 15. Amended Research-Based Principles

1. Content Presentation and Reinforcement within the Online System.
   1.1. Convey content as an integrated whole using multiple authentic contexts.
       1.1.1. Use complete phrases or sections and complete pieces for extracting concept instances.
       1.1.2. Encourage students to play excerpts at home and for their teacher.
       1.1.3. Include aural skills, musicianship skills, and composition.
       1.1.4. Detail real-world tasks before determining instructional activities.
   1.2. Deliver content through visual, auditory, and kinesthetic approaches.
       1.2.1. Students should constantly hear concepts performed and view the notation if other visual stimulus is not more appropriate.
       1.2.2. Visually highlight salient musical features within a complete musical score.
       1.2.3. Directions and other text should usually be delivered aurally instead of in written format.
       1.2.4. Integrate requisite knowledge components visually and temporally.
       1.2.5. Continually direct students to play at the piano and sing.
   1.3. Teach the most essential information clearly without unguided or discovery methods.
       1.3.1. Make essential knowledge presentation explicit and test using measurable assessments.
       1.3.2. Reinforce factual knowledge acquisition using drill and practice, mastery-driven or competition-driven games, or similar activities in multiple contexts.
       1.3.3. Before design phase, outline component and prerequisite knowledge, then outline appropriate sequences and create mastery-based assessments at appropriate intervals.
   1.4. Provide students with a framework for creative thinking in a less guided environment.
       1.4.1. Model complex, ill-structured tasks first.
       1.4.2. Use forums and other asynchronous collaborative tools to encourage creativity and variable teacher interaction.
       1.4.3. Include musicianship skills and composition.

(table continues)
and analysis. Composition should also be included at all stages of instruction. To help
instructional designers identify appropriate methods for teaching concepts in authentic situations,
real-world tasks should be defined in great detail before designing instruction.

For Research-Based Principle 1.2 (deliver content through visual, auditory, and kinesthetic approaches), the online system should constantly perform concepts aurally and show its notation if other visual stimulus is not more appropriate, visually highlight salient musical features within a complete musical score, deliver directions and other text aurally, integrate requisite knowledge components visually and temporally, and continually direct students to play at the piano and sing. One of the advantages of multimedia instruction is the ability to include musical performances. These performances can enhance learning and should therefore be included as much as possible. The extractive techniques described in chapter 4 should be used to visually highlight important musical features so that students are always viewing concepts within authentic contexts (i.e., showing a more complete musical score and hearing its performance). By delivering directions aurally, students are able to focus on other visual stimuli and are more likely to process both verbal information delivered aurally and visual information. Requisite knowledge components should be integrated visually (i.e., place critical pieces of information close to one another so that their interaction is clearer) and temporally so that students are better able to make necessary connections between knowledge components. Students should also be directed to play concepts at the piano whenever possible and sing so that information can be realized in meaningful musical contexts and experienced kinesthetically.

For Research-Based Principle 1.3 (teach the most essential information clearly without unguided or discovery methods), instructional designers should make essential knowledge presentation explicit, test this knowledge using measurable assessments, and reinforce factual knowledge acquisition using drill and practice, mastery-driven approaches, or competition-driven games. Before beginning to design instruction, component and prerequisite knowledge
should be outlined, then appropriate sequences should be described and mastery-based assessments should be created at appropriate intervals. By defining prerequisite and component knowledge first, designers should determine precisely what information must be explicitly understood by students. Then designers can systematically determine the most appropriate means for presenting, assessing, and reinforcing this information.

For Research-Based Principle 1.4 (provide students with a framework for creative thinking in a less guided environment), complex, ill-structured tasks should be modeled first, forums and other asynchronous collaborative tools should be used to encourage creativity and variable teacher interaction, and instruction should include musicianship skills and composition. Creative tasks frequently require procedural knowledge that can be modeled in previous lessons. As students become more adept at engaging in these tasks, teachers can provide a level of feedback that they deem appropriate for each individual student. Forums provide an easy and efficient means (in combination with the private lesson) for engaging in these tasks.

For Research-Based Principle 1.5 (consider unique characteristics of the student population and individual students), a minor modification to the original principle has been made. Since one of the main benefits of WBI is the potential individualization of instruction, this feature should similarly be highlighted by the principle and considered in all phases of design. More specifically, this principle specifies that some features should be customizable for individual students, the visual design of the interface should be appealing but not distracting, social elements should be considered (e.g., vocal inflection and variable feedback of narration), additional input methods for students not adept at typing should be offered, most site pages should be kept within one to three clicks from the main site page, videos that show students how to interact with the system should be provided, students should be provided with games for
competition against themselves and their peers, and designers should consider including activities for mobile devices.

An additional principle was also added to clarify the need for the customization of instruction on multiple levels. Specifically, Research-Based Principle 1.6 (allow content to be sequenced dynamically based upon student performance and teacher input) suggests that the online system should continually assess student learning to identify when students are ready for new tasks or targeted remediation and provide a means for teachers to assess written work, enter their evaluation of that work online, and have the online system determine subsequent instruction using those evaluations. By continually assessing student performance and adjusting the instructional sequence based upon those assessments, the pacing of the instruction can adjust for each individual student and remedial interventions can be inserted as required. Since students also need to be adept at notating musical concepts by hand, these activities must be included, and the results from teacher assessments of those activities should also determine the next most appropriate activity. Although this level of flexibility requires significantly more upfront programming resources, such features are very likely to be expected by teachers (as evidenced by reviewer comments) and can certainly create more individualized instruction for the students.

For Research-Based Principle 2.1 (provide students with the means to communicate and collaborate with their teacher and peers outside of lessons), instructional designers should use a combination of asynchronous and synchronous collaborative tools (i.e., forum, wiki, chat), make collaborative tools immediately accessible to students within all instructional content, and provide printable worksheets for students to practice notation and performance at the piano which is later reviewed at subsequent lessons. The collaborative tools are an easy and effective way for teachers to interact with students, encourage creativity, and encourage interaction with
other students. Since these tools can be so helpful, they should also be one click away from all instructional content. The printable worksheets also encourage additional interaction with the teacher at subsequent lessons. WBI should never seek to replace face-to-face interaction entirely but rather encourage it.

Principle 2.2 (provide the teacher with a means to shape the online learning) directs instructional designers to provide teachers with a way to view detailed progress reports, include pre-built instructional content that may be customized, and provide a means for teachers to assess written work. Teachers should then be able to enter their evaluation of that work online and have the online system determine subsequent instruction using those evaluations. The more information that teachers have, the better equipped they will be to address learning shortfalls either using the online system or within the private lesson.

For Research-Based Principle 2.3 (provide feedback from the online system that may be used to shape the private lessons and practice time), instructional designers should provide teachers and parents with detailed progress reports in which questions and specific responses can be viewed. These progress reports should include quantitative analyses of overall student progress and more specific student usage reports. For example, teachers and parents should be able to quickly look at a report and see that their child is performing 20% lower in one area over others. Teachers and parents could also view exactly when students are logging into the system and what they are doing while they are using it. These reporting features can help parents and teachers encourage productive use of the online system in addition to answering questions.

The research-based principles and other guidelines that emerge from this dissertation may help guide future implementations of WBI for use within the piano studio. These principles are not based on intuitive choices but rather result from a synthesis of research from various fields of
study and a review of an implementation based on those principles. This dissertation rationalizes a method by which piano teachers may similarly consider the best use of Web-based instruction within their studios.
APPENDIX A

PROCESS FOR REALIZING THE DISSERTATION PURPOSE
PROCESS FOR REALIZING DISSERTATION PURPOSE

Primary Purpose
To use an integrative research methodology for defining, designing, and implementing a Web-based program to teach music theory fundamentals to private piano students in the primary grades.

DEFINE (chapter 3)
Define the theoretical basis
- Overarching Educational Objectives (OEOs)
- Student Learning Outcomes (SLOs)

Practical Limitations
Integrative Research
Research-Based Principles (RBPs)

IMPLEMENT (chapter 4)
Develop and deploy on remote server.

EVALUATE (chapter 5)
Piano teachers evaluate the extent to which the implementation fulfilled the RBPs.

MODEL OF INTEGRATION
Amended RBPs
Description of the precise methods of:
- determining instructional tasks
- implementing the instruction within the studio

DESIGN (chapter 4)
Specify how the Web-based program realizes the OEOs, SLOs, and RBPs
APPENDIX B

CONSENT NOTICE FOR STUDY PARTICIPANTS
University of North Texas Institutional Review Board

Informed Consent Notice

Before agreeing to participate in this research study, it is important that you read and understand the following explanation of the purpose, benefits and risks of the study and how it will be conducted.

Title of Study: Using Web-Based Instruction to Teach Music Theory in the Piano Studio: Defining, Designing, and Implementing an Integrative Approach.

Principal Investigator: Robert Carney, a graduate student in the University of North Texas (UNT) College of Music.

Purpose of the Study: You are being asked to participate in a research study that involves evaluating the extent of which a web-based music theory course fulfills general pedagogical principles.

Study Procedures: You will be asked to interact with the program by working through all of the course material in the student, teacher, and parent roles then evaluate the program which will take about 1-2 hours of your time.

Foreseeable Risks: No foreseeable risks are involved in this study.

Benefits to the Subjects or Others: Although this study is not expected to be of any direct benefit to you, it will contribute to an increased understanding of developing web-based instructional materials for piano students. IRB studies cannot guarantee results.

Procedures for Maintaining Confidentiality of Research Records: Your interactions with the web-based program will be stored on a secure server that only contains your participant number. The document that matches your participant number to your personal information will be stored on a local machine in an encrypted file. The confidentiality of your individual information will be maintained in any publications or presentations regarding this study.

Questions about the Study: If you have any questions about the study, you may contact Robert Carney at telephone number (817) 691-2399 or the faculty advisor, Dr. Kris Chesky, UNT College of Music, at telephone number (940) 565-4126.

Review for the Protection of Participants: This research study has been reviewed and approved by the UNT Institutional Review Board (IRB). The UNT IRB can be contacted at (940) 565-3940 with any questions regarding the rights of research subjects.

Research Participants’ Rights: By checking the box to the left and clicking submit below, you indicate that you have read all of the above and that you confirm all of the following:
• You have read about the study and all of your questions have been answered. You have been told the possible benefits and the potential risks and/or discomforts of the study.
• You understand that you do not have to take part in this study, and your refusal to participate or your decision to withdraw will involve no penalty or loss of rights or benefits. The study personnel may choose to stop your participation at any time.
• You understand why the study is being conducted and how it will be performed.
• You understand your rights as a research participant and you voluntarily consent to participate in this study.
• You are aware that you can print off or save a copy of this form by clicking here.
APPENDIX C

E-MAIL TEMPLATE FOR INITIAL CONTACT WITH STUDY PARTICIPANTS
Dear __,

As a component of my doctoral dissertation, I would like to see if you can help me evaluate a web-based theory program for private piano students in the primary grades.

The purpose of my dissertation is to use an interdisciplinary approach to identify research-based principles for a web-based program that teaches music theory fundamentals to private piano students in the primary grades. After identifying these principles, the program will be designed and implemented online for piano teachers to evaluate. You can help evaluate the extent of which this web-based course fulfills these general research-based principles.

If you are able to help, you will be asked to work through all of the course material. Then you may evaluate the program using a brief survey. Your participation is expected to take a total of about 1-2 hours of your time. You can complete this evaluation from any computer with Internet access and a basic web-browser (such as Internet Explorer or Firefox). The program is designed to be used by anyone with very basic web browsing experience. Using the program should be easy, and to participate, you only need to have some experience as a private piano teacher. Additionally, helpful videos will be provided to show you how to interact with the program.

Additional information is also available at the main website for the program: http://www.northtexaspianostudy.org

Please let me know if you have any questions. I look forward to hearing from you.

Thank-you,
Robert Carney
DMA Candidate in Piano Performance, UNT College of Music
817.691.2399
robert@northtexaspianostudy.org
www.northtexaspianostudy.org
APPENDIX D

SURVEYS FOR EVALUATING THE IMPLEMENTATION OF THE PRINCIPLES
INITIAL QUESTIONNAIRE

Please answer the following questions as completely as possible.

Age (Options: 18-85+)

Gender:
- [ ] male
- [ ] female

Total years of private piano teaching experience (Options: 1-60+)

**Educational Background.** Please indicate your highest earned music degree or training:

(Options: No College Coursework; Some College Coursework; Bachelors; Masters; Doctorate)

On average, how many hours do you teach private lessons each week? (Options: 1-50+)

Where do you teach private piano lessons? Please check all that apply and then indicate where you do most of your teaching.

- [ ] Out of my own studio/home.
- [ ] At a music school.
- [ ] In the students' homes.
- [ ] Other. Please specify.
At which of the above locations do you do most of your private piano teaching?

- [ ] Home
- [ ] Music School
- [ ] Student's Home
- [ ] Other (describe above)

How do you currently teach music theory to your piano students? Please select all that apply and then indicate your preferred method.

- [ ] Workbook that students purchase.
- [ ] Handouts that are copied or printed for students to complete.
- [ ] Assignments completed with manuscript paper.
- [ ] Computer-based program.
- [ ] Internet resources.
- [ ] Other. Please specify

Which of the above is your primary means of teaching theory in the private piano lesson?

- [ ] Workbook
- [ ] Handouts
- [ ] Assignments
- [ ] Computer-based program
- [ ] Internet resources
- [ ] Other

On average, how many hours do you use a computer each week for any purpose? (Options: 1-50+)

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Please check which options best describe your use of computers in your piano studio. Please check all that apply.

☐ I have never used the computer to directly assist with piano teaching.
☐ Basic word processing (Microsoft Word, etc. for making handouts and other materials used as a part of lessons).
☐ Graphics Editing Programs (Photoshop, etc. for making materials with graphics).
☐ Audio Editing Programs (computer-based MIDI and digital audio editing programs such as Audacity, Cubase, Pro Tools, etc.).
☐ E-mail (if you communicate with your students and/or their parents via E-mail).
☐ Computer-Assisted Instruction: I recommend students purchase software for use in their home.
☐ Computer-Assisted Instruction: I have a computer in my studio with educational music software for students to use.
☐ Web-based resources. I have students use materials from the Internet.
☐ Other. Please specify:

If you indicated above that you use a computer program or web-based resource to assist you with your piano teaching, please list the program(s) and/or website(s) and describe the way that you use them.

Please double check your responses. After clicking "submit" below, you may review your responses one final time before closing this window.
SURVEY 1 - INTERVALS

Answer the following Questions for the Intervals-Related Activities.

For the Research-Based Principle: 
"Convey content as an integrated whole using multiple authentic contexts."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ........................................... COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle: 
"Deliver content through visual, auditory, and kinesthetic approaches."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ........................................... COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle:
"Teach the most essential information clearly without unguided or discovery methods."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL  ___________________________________  COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle:
"Consider unique characteristics of the student population."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL  ___________________________________  COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle:
"Provide students with a framework for creative thinking in a less guided environment."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ______________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle:
"Provide students with the means to communicate and collaborate with their teacher and peers outside of lessons."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ______________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle: "Provide the teacher with a means to shape the online learning."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ------------------------------- COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

Please double check your responses. Once you click "submit" below, you may review your responses one more time, but if you find mistakes, you will need to redo the slider scales.
SURVEY 2 - MAJOR SCALES

Answer the following Questions for the Major Scales-Related Activities.

For the Research-Based Principle:
"Convey content as an integrated whole using multiple authentic contexts."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ______________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle:
"Deliver content through visual, auditory, and kinesthetic approaches."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ______________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle:
"Teach the most essential information clearly without unguided or discovery methods."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ----------------------------------------- COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle:
"Consider unique characteristics of the student population."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ----------------------------------------- COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle:
"Provide students with a framework for creative thinking in a less guided environment."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ______________________________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle:
"Provide students with the means to communicate and collaborate with their teacher and peers outside of lessons."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ______________________________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle:
"Provide the teacher with a means to shape the online learning."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL .................................................. COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

Please double check your responses. Once you click "submit" below, you may review your responses one more time, but if you find mistakes, you will need to redo the slider scales.
SURVEY 3 - MAJOR KEY SIGNATURES

Answer the following Questions for the Major Key Signatures-Related Activities.

For the Research-Based Principle:
"Convey content as an integrated whole using multiple authentic contexts."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL __________________________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle:
"Deliver content through visual, auditory, and kinesthetic approaches."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL __________________________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle:
"Teach the most essential information clearly without unguided or discovery methods."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ____________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle:
"Consider unique characteristics of the student population."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ____________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle:
"Provide students with a framework for creative thinking in a less guided environment."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ____________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle:
"Provide students with the means to communicate and collaborate with their teacher and peers outside of lessons."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ____________________________ COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle:
"Provide the teacher with a means to shape the online learning."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ----------------------------------------- COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

Please double check your responses. Once you click "submit" below, you may review your responses one more time, but if you find mistakes, you will need to redo the slider scales.
FINAL SURVEY FOR TEACHER AND PARENT ROLES

Answer the following Questions for the Teacher and Parent Roles.

For the Research-Based Principle:
"Provide students with the means to communicate and collaborate with their teacher and peers outside of lessons."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ---------------------------------------- COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

For the Research-Based Principle:
"Provide the teacher with a means to shape the online learning."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL ---------------------------------------- COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?
For the Research-Based Principle:
"Provide feedback from the online system that may be used to shape the private lessons and practice time."

Did the web-based program accomplish this pedagogical goal in this context?

NOT AT ALL   COMPLETELY

Why do you believe the web-based program did or did not implement this principle, and how could the program be improved in this specific area?

Please answer the following questions

1. How else could concepts be handled visually, aurally, and/or kinesthetically?

2. Please identify any other projects students could do in order to apply concepts in a meaningful way.

3. Please identify any reasons that you think using this program as the exclusive means to teach music theory in weekly piano lessons might be difficult.
4. Would you prefer to use this program or a workbook to teach music theory? Why?

5. Please describe any ways in that you believe this program could be improved.

Please double check your responses. Once you click "submit" below, you may review your responses one more time, but if you find mistakes, you will need to redo the slider scales.
WORKS CONSULTED


Kumar, Muthu. "Organizing Curriculum Based upon Constructivism: What to Teach and What Not To." *Journal of Thought* 41, no. 2 (Summer, 2006): 81-93.


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