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The Efficacy of SmartMusic® Assessment as a Teaching and Learning Tool

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Abstract of a Dissertation
Submitted to the Graduate Studies Office
of The University of Southern Mississippi
in Partial Fulfillment of the Requirements
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ABSTRACT

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This study examined the effects of SmartMusic® assessment on student music performance while integrating research-based teaching and learning components. Over approximately three weeks, 46 high school band students (N=46) received five 15-minute teacher-led music lessons, totaling 75 minutes of instruction. Two groups, teacher-led instruction or teacher-led instruction using SmartMusic® assessment, were determined by randomly splitting pairs of matched-subjects within woodwind, brass, or mallet percussion families. Constant for both groups, instruction and evaluation materials included teaching and learning practice rubrics, a criterion-referenced performance evaluation form, and short lyrical and technical etudes complemented with respective skill development exercises. Pre- and post-test measures of student music performance, survey information, and researcher observations provided quantitative, qualitative, and empirical data. Music performance scores (MPS) from three independent judges for lyrical and technical etude recordings provided data evaluating artistic and technical aspects of student performance. Similarly, the technical skills scores (TSS), a subset of the MPS, explored the effect of music instruction upon technical aspects of performance. Student survey data and researcher observations provided measures of student motivation and efficacy.

Separate analyses of covariance (ANCOVAs), with pretest music performance score covariates, explored the relationship of performance data relative to instruction group. The lyrical etude TSS and MPS were not statistically different between instruction groups. However, there were significant differences in the technical etude TSS and MPS between groups. The SmartMusic® assessment group showed larger mean score gains in all music performance measures for technical and lyrical etudes, though not all differences proved statistically significant. The data suggest that the SmartMusic® assessment program positively affected music performance skills, especially in technically oriented music passages. More study is necessary to determine the program's potential impact on lyrical musical passages.

Based on performance data and student survey results, SmartMusic® assessment is an appropriate tool for student assessment, facilitating integration of teaching and learning components. Combining education theory and pedagogical practice with technology remains an important and educationally sound step to enhance learning. Students' initial impressions of SmartMusic® assessment indicated motivation to use the program. More study is needed to explore the long-term appeal and effects on student achievement.

DEDICATION

To my wife, Wendi, and children, Elsa and Henry, for their love, support, and encouragement.

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Last, but not least, to my wife, mother of our two wonderful children, whose continuous sacrifices receive no fanfare, whose support remains steadfast and whose talents may not always be properly acknowledged, I truly could not have done this without you. You are with me always. Thank you!

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CHAPTER I

INTRODUCTION

Music is a performing art - a fact that should remain central to any pedagogical and technological discourse. Appropriate use notwithstanding, technology, properly placed as a tool in a diverse artistic and pedagogical arsenal, may alter the music education landscape. In contemporary techno-savvy society, empirical observations remain an often-cited justification for technology use. However, meaningful critique necessitates quantitative data regarding the use and effectiveness of technology. This study provides data on how one instructional technology, the assessment components of SmartMusic®, affect student music performance.

Study Significance

Technology is virtually inescapable in contemporary society. Though many educators remember life before scientific calculators, microwaves, computers or portable electronic music devices, today's students do not. In a 1996 survey, ninety percent of all teenagers felt comfortable using technology and utilized it a regular basis (Rudolph, 1996). The techno-wizardry our students employ is at our fingertips, but educationally justifiable reasons for integrating technology in the classroom must go beyond sheer availability and the "coolness" factor to the "entertain-me" generation. Conversely, as motivation is a key underpinning to learning, the observable appeal and pervasive influence of technology must be carefully considered.

A 1983 publication by the National Committee for Excellence in Education proclaimed the need for educational reform. Among the recommendations was the need to embrace technology. In 1994, the Consortium of National Arts Education Associations in collaboration with the Music Educators National Conference released the National Standards for Arts Education. As a result, many educational pundits created teaching strategies that integrate music technology with the national standards. To this end, many educators and professional organizations like the Music Educators National Conference advocate instructional and non-instructional technology use (Tredway, 1994).

Instructional technology exists in a variety of formats. Typically, direct instructional software programs teach or reinforce specific knowledge and skills – educationally justifiable at the lower levels in Marzano's Taxonomy of Educational Objectives (updated from Benjamin Bloom's original work). Educational web-based technologies abound, ranging from information dissemination to interactive models. In his National Arts Centre biography, Pinchas Zukerman (2008) declares that he "pioneered the use of videoconferencing technology in music education to sustain the personal interaction with his students while performing around the world." Instruction through highly interactive models creates the potential to utilize higher-order thinking skills on the educational taxonomy. Yet another frequent use of technology is to supplement or differentiate instruction to meet the needs of diverse populations of learners. Of most relevance to this study, recent technological advances have made possible computerized evaluation of music performance.

Non-instructional technology, though commonplace today, permeates the music educators' daily existence. Word processing, database and spreadsheet software expedites routine tasks such as organizing the music library, managing uniform or instrument inventories, maintaining student personal information and completing progress reports, report cards, daily attendance, etc. Communication with parents through websites, email and list-servs has become expected protocol in many educational settings.

As Rudolph (1996) reports, record keeping and the evaluation process is often the largest obstacle in the implementation of music standards. He provides 143 ideas with detailed descriptions outlining how technology (instructional and non-instructional) can be used to implement the music National Standards.

Need for the Study

To date, the researcher found only one research study (Lee, 2007) which investigated the SmartMusic® assessment module. Other related studies focused on the music accompaniment portion of SmartMusic® and its predecessor Vivace®. Interest in technology remains prevalent, as evidenced by the amount of attention given to this topic in numerous professional education publications. It seems apparent that technology and computers will surround future generations. Music educators cannot afford to ignore these possibilities, though abandonment of traditional music pedagogy seems equally unwise. Of the relatively few studies available on SmartMusic® and Vivace®, all reviewed here listed the need for further research regarding its use and effectiveness. The melding of these thoughts, combined with the need for quantitative research on the assessment capabilities of SmartMusic®, charted the course for exploration in this study.

Research Questions

SmartMusic® is a multifaceted teaching and learning tool for music educators and music students. For research purposes, the focus of this experimental design study is the music performance assessment capability of the program. This study addresses the following questions:

1) Do students who use SmartMusic® assessment achieve greater technical skills and increase music performance ability?

2) Is SmartMusic® assessment an appropriate tool for examining student music performance, facilitating integration of applicable teaching and learning components?

3) Does SmartMusic® assessment provide an educationally justifiable medium, linked to motivation, for teaching knowledge and skills to music students?

About SmartMusic® and SmartMusic® Assessment

SmartMusic® is a computer program that utilizes a combination of software and hardware devices to assist a student's music performance. The main interface (figure 1) serves as the control center for the multifaceted program components.

Figure 1. SmartMusic® Main Interface.

The assessment section of SmartMusic® comprises one component of the much larger and sophisticated program. The assessment menu appears once a SmartMusic® file is opened (figure 2).

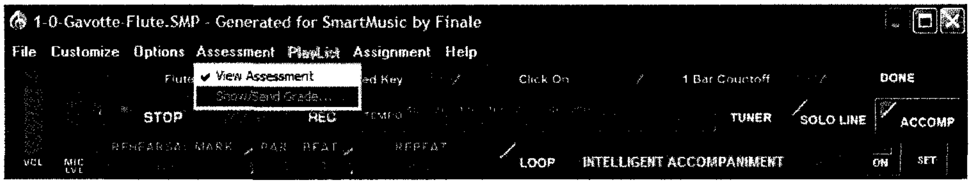


Figure 2. SmartMusic® Assessment Menu.

The assessment feature began as a stand-alone product, called Finale Performance Assessment®, using the familiar SmartMusic® interface. The ability to assess only user-created music examples – excepting the relatively narrow array of pre-programmed exercises – remained a limitation. Through beta testing, market research and emergence of a competitor's product – Interactive Pyware Assessment System® - the usefulness of this technology and the need to expand its capabilities became evident. These facts likely ushered the integration of both programs under the SmartMusic® umbrella. Assessment of user-created files as well as method book exercises and other copyrighted material (where on-screen notation appears) became a decided advantage of this merger, but the evolving complexity of SmartMusic® remains a potential obstacle.

Though originally designed as a music accompaniment system for vocal and wind instrument soloists, SmartMusic®, and its predecessor Vivace®, include an array of music tools. Figure 3 shows several tools under the Options menu – practice loop, tuner, warm-up (exercises), (technical) exercises, method (books) and metronome.

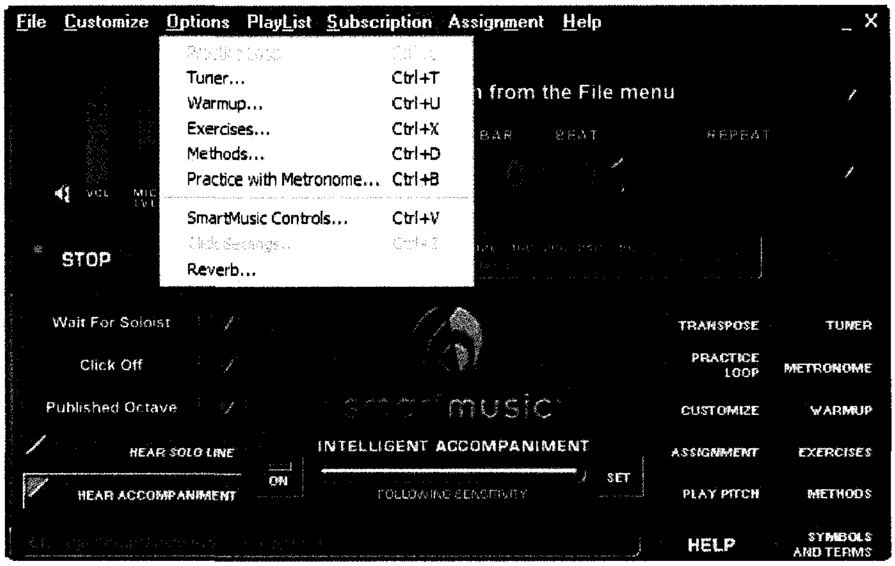


Figure 3. SmartMusic® Tools – Practice Loop, Tuner, Warm-up, (technical) Exercises, Method (books), Metronome, etc.

Another tool available through the main interface, the nuanced "intelligent accompaniment" feature, responds to expressive tempo fluctuations employed by the soloist. Continued product development brought additional features to the program, ushering in the transition from Vivace® to SmartMusic®. Increased computer processing capabilities improved greatly the performance of the "intelligent accompaniment" feature and welcomed orchestra and percussion instruments to the fold. Additional features of the most current version (SmartMusic® 10.1 at the time of this study) included recording capabilities, a larger collection of warm-up/practice exercises, a series of pre-programmed beginning band and orchestra methods, a coordinated grade book/assignment module (SmartMusic Impact®), play-along (imported) recordings and an increasing number of published full band and jazz ensemble (eventually orchestra and choir) selections.

The SmartMusic® assessment module yields new depth to the program. These features provide feedback to the performer using a combination of audio, visual and evaluation components. Music performance recordings allow the performer to self-assess, archive, email, etc. his or her performance. For many music selections found in SmartMusic®, the software provides visual feedback. It analyzes music performance, considering the elements of pitch and rhythm (also, extreme intonation and tempo fluctuations). Upon completion of the music selection, the computer displays the music notation using green, red or black notes (figure 4).

Figure 4. SmartMusic® Assessment Feedback – Red, Green & Black Notes.

Green notes indicate performance of the correct note, begun at the correct time (relative to the metronome setting). A red note indicates a "wrong" note – either pitch or rhythm –

displayed proportionate to the indicated notation, i.e. actual pitch and rhythm performed (red) is superimposed over the original notation (black). Black notation, with the absence of surrounding red or green notes, indicates an absence of music performance (or a technical recording issue). In addition to the above feedback, but not utilized in this study, percentage scoring of pre-programmed lesson book exercises and music selections administered using SmartMusic Impact® is possible. The percentage score indicates the number of correct notes performed (green), respective of the rhythm, divided by the total number of possible (black) notes.

Some assessment features are not available on all music selections found within the SmartMusic® program. Currently, a performer may record his or her performance using any of the SmartMusic® program components (with or without music accompaniment, when available). Generally, the visual assessment features are available on music selections where the music notation appears "on-screen." Finally, the percentage score evaluation (in SmartMusic® version 10.1) is available only for assignments administered through SmartMusic Impact®.

Definition of Terms

This study utilizes the following operational definitions:

<u>Applicable teaching and learning components</u> – a research study construct used to explore the feasibility and effect of integrating relevant educational learning theories and time-honored instructional strategies through SmartMusic® assessment. Student survey and music performance data are used to investigate this topic.

Appropriate tool – the usefulness of the SmartMusic® assessment program based on student survey and music performance data.

Assessment – the process of gathering information to provide feedback and aid learning.

blind recording – the method of gathering a digital audio recording of participant performances using SmartMusic®, without the use of real time visual feedback to the performer (which is a feature available in the software), even though students were cognitively aware that audio recording was in process.

Composite score – the numeric score obtained using the three-judge average for any respective measure.

Control group – the study participants randomly assigned to receive teacher-led music instruction assisted by a Student Practice Rubric and Chart (Appendix A).

Countoff – a feature of SmartMusic® in which metronome clicks or numbers are audible prior to the start of the music selection. Countoffs can be selected for 1, 2 or 4 measures, respective of the tempo, time signature and partial measure beginnings (pick-up notes). One measure countoffs were used in this study.

Error detection – a sub-component of assessment; with relation to SmartMusic® assessment, this strategy is used to gather information and provide feedback about music performance.

Evaluation – the process of comparing information to reach a judgment or assign a value based on specified criteria, e.g. grading.

Experimental or treatment group – the study participants randomly assigned to receive music instruction using teacher-led techniques assisted by a Student Practice Rubric and Chart (Appendix A) and SmartMusic® assessment.

Music instruction – the independent variable – a series of five 15-minute teacher-led music lessons with (experimental group) or without (control group) the SmartMusic® assessment program. Instruction included the use of the Instructor Progress Chart and Rubric (Appendix B) - incorporating research-based teaching and learning theories and strategies.

Music performance – the dependent variable – evaluated by three independent judges using a solo performance evaluation form (Appendix C) and performance evaluation rubric (Appendix D). The form contains six categories requiring the adjudicator to assign a point value of 1 (low) to 5 (high) within each category. The categories include tone, intonation/pitch accuracy, rhythm, technique, interpretation/musicianship and articulation (winds) or execution (percussion). The rubric delineates scoring criteria respective to the evaluation categories.

Music performance score (MPS) – a measurement of the dependent variable – from an independent judge using a solo performance evaluation form, the "total score" of a music performance obtained by adding the values of all six categories.

SmartMusic® - by MakeMusic, inc. formerly Coda Music, inc. – a music accompaniment and assessment program that uses a combination of software and hardware to assist music performance.

SmartMusic® assessment – a component of the SmartMusic® program used to evaluate music performance. Available tools used in this study include error detection (red and green notes), recording, metronome (with clicks, cursor or both), fingering charts, tuner and practice loops (separated by one measure countoffs).

SmartMusic Impact® - a fully integrated, web-based grade book program used to assign, manage and collect SmartMusic® performance assessments.

Technical skill score (TSS) – a sub-component measure of the dependent variable; a performance assessment score, calculated using the values from four categories – pitch, rhythm, facility and articulation – found in the solo performance evaluation form.

Technology – Listed from broad to narrow and depending on context within this paper: 1) physical devices, electronic or mechanical, that improve efficiency for activities of daily living – either personal or professional; e.g. computer, metronome, iPod, wax cylinders (circa 1890), etc. 2) knowledge or process, often involving a physical device, used to more efficiently accomplish tasks; 3) computer software (and related peripheral hardware).

Instructional technology – 1) computer software (and related peripheral hardware) or other physical device designed specifically for teaching knowledge or skills; 2) adaptation of existing computer software (and related peripheral hardware) or other physical device to teach knowledge or skills.

Non-instructional technology – computer software (and related peripheral hardware) for general public use such as word processing, database, spreadsheet, etc.

Theoretical Basis

A growing body of literature regarding teaching, learning, assessment and technology shaped study design components. Heller and O'Connor (2006, p. 39) exclaim, "research should be theory driven." Theory, in turn, drives educational design "that may clarify practice in the music education enterprise" (Ibid, p. 40). Highlights of specific literature regarding variables, methods and controls appear below followed by rationale behind the conceptual design of this study, based on these findings. A comprehensive review of literature follows in Chapter II.

Pre- and Post-test Design

When used in experimental design research, pre- and post-test comparisons allow straightforward assessment of treatment effects between two points in time. Similar in concept though different in application, multiple measure assessments track performance outcomes over time. These methods are frequently used in educational research. Random assignment of participants remains crucial to ensuring reliability of results. Many pedagogical or technological music research studies use pre- and post-test designs (e.g. Bennett, 1994; Henry, 1991; Lee, 1997; Ouren, 1997; Sheldon, Reese, & Grashel, 1999).

Music Performance Assessment

In efforts to obtain objective assessment, music educators often employ an external observer to analyze and critique musical performance using a criterion-referenced evaluation form. Many studies explore the categories used to evaluate music performance (Tamte-Horan, 1989; Dixon, 2000; Stanley et al., 2002). McPherson and Schubert (2004) reviewed music performance assessment criteria and produced an extensive list of commonly utilized assessment categories. Numerous national and regional organizations employ criterion-referenced adjudication forms for music contests and festivals. Evaluation categories differ somewhat based on the source and type of performance (solo, large ensemble, vocal, instrumental, etc.). One category, intonation, remains an item of interest in studies too numerous to mention here.

Validity and Reliability of Performance Assessment Tools

Several researchers conducted studies to develop valid and reliable performance assessment tools. In one of the first studies of this type, Abeles (1973) created a Clarinet Performance Rating Scale. He identified six categories - articulation, interpretation, intonation, rhythmic continuity, tempo, and tone – for performance evaluation using a facet-factoral approach. Abeles reported high factor reliability and strong criterion and construct validity. Expanding Abeles' work, Bergee (1988) created a Tuba-Euphonium Performance Rating Scale which demonstrated equally strong reliability and validity. Categories for performance evaluation obtained from this study include interpretation/musical effect, tone quality/intonation, technique, and rhythm/ tempo. In a study to develop an orchestral string performance assessment tool, Zdzinski and Barnes (2002) identified five factors - interpretation/musical effect, articulation/tone, intonation, rhythm/tempo, and vibrato – with strong corresponding reliability and construct validity ratings.

Saunders and Holahan (1997) developed a rating most similar to the one used in this study. The factors used for performance evaluation include tone, intonation, technique/articulation, melodic accuracy, rhythmic accuracy, tempo, and interpretation. Accompanying the factors were specific performance descriptions delineating scoring criteria in five gradations (a 10-point scale counting by twos was used in this study). Consistent with that line of thought, Zdzinski and Barnes (2002) suggest that criteria-specific rating scales increase the reliability of performance evaluations.

The researcher utilized the above information to construct a performance evaluation form and criteria-referenced scoring rubric. Validity of the specific performance evaluation tool used in this study was not assessed, but similarity to above constructs and established protocols is evident. The validity of the performance assessment tool and rubric used in this study was assumed, based on the above inferences. Inter-rater reliability information was analyzed and is available in Chapter IV.

Instructional Method and Teaching Strategies

An instructional method must connect teaching strategies to desired outcomes. Ensuring student achievement through purposeful teaching strategies should have direct bearing on an individual's music performance. Connecting teaching to learning remains crucial, but the two are not necessarily synonymous (Duke, 2005). Previous studies explored the relationship between instructional method and music performance ability (Delzell, 1989; Dalby, 1989; Lee, 1997; Ouren, 1997; Sheldon, Reese, & Grashel, 1999). Many studies identified successful teaching strategies (Codding, 1985; Lee, 2007). In addition to studies on SmartMusic® discussed in the literature review, other studies explored the effects of computer instruction on music performance (Eisele, 1985; Garnett, 2001).

Skill Exercises

A main tenet of music education requires linking desired music performance outcomes to teaching strategies and assessment tools (Asmus, 1999; Goolsby, 1999). Many studies explore related topics such as transfer of musical knowledge/skills or contextualized learning, inherent in the teaching, learning and assessment process (Glenn, 2000; Goolsby, 1999; Jorgensen, 2004; Olijnek Scheuzger, 2006). Integrating targeted skill or knowledge exercises with music excerpts follows as a logical extension of this concept. To that end, numerous research studies explored aspects of pedagogy, warm-up routines or musical development exercises connecting to music performance outcomes (Buck, 1994; Goff, 1996; Henry, 1991; Ronkin, 1996). Several published band method books – e.g. Standard of Excellence, KJOS; Essential Elements 2000, Hal Leonard; Ed Sueta Method, Macie Publishing; – utilize similar skill development strategies, as evidenced in their teacher's guides and scope and sequence curriculum outlines.

Design

The framework for the study employs pre- and post-test measures of student musical performance against musical instruction. Two participant groups – teacher-led and teacher-led using SmartMusic® assessment – received a series of five lessons over a three-week period. Both instructor and study participants utilized a rubric containing the same teaching and learning strategies (see Appendix A & B). Pre- and post-test recordings of student music performance for lyrical and technical etudes were evaluated by three independent judges. A flowchart of the study design appears in figure 5.

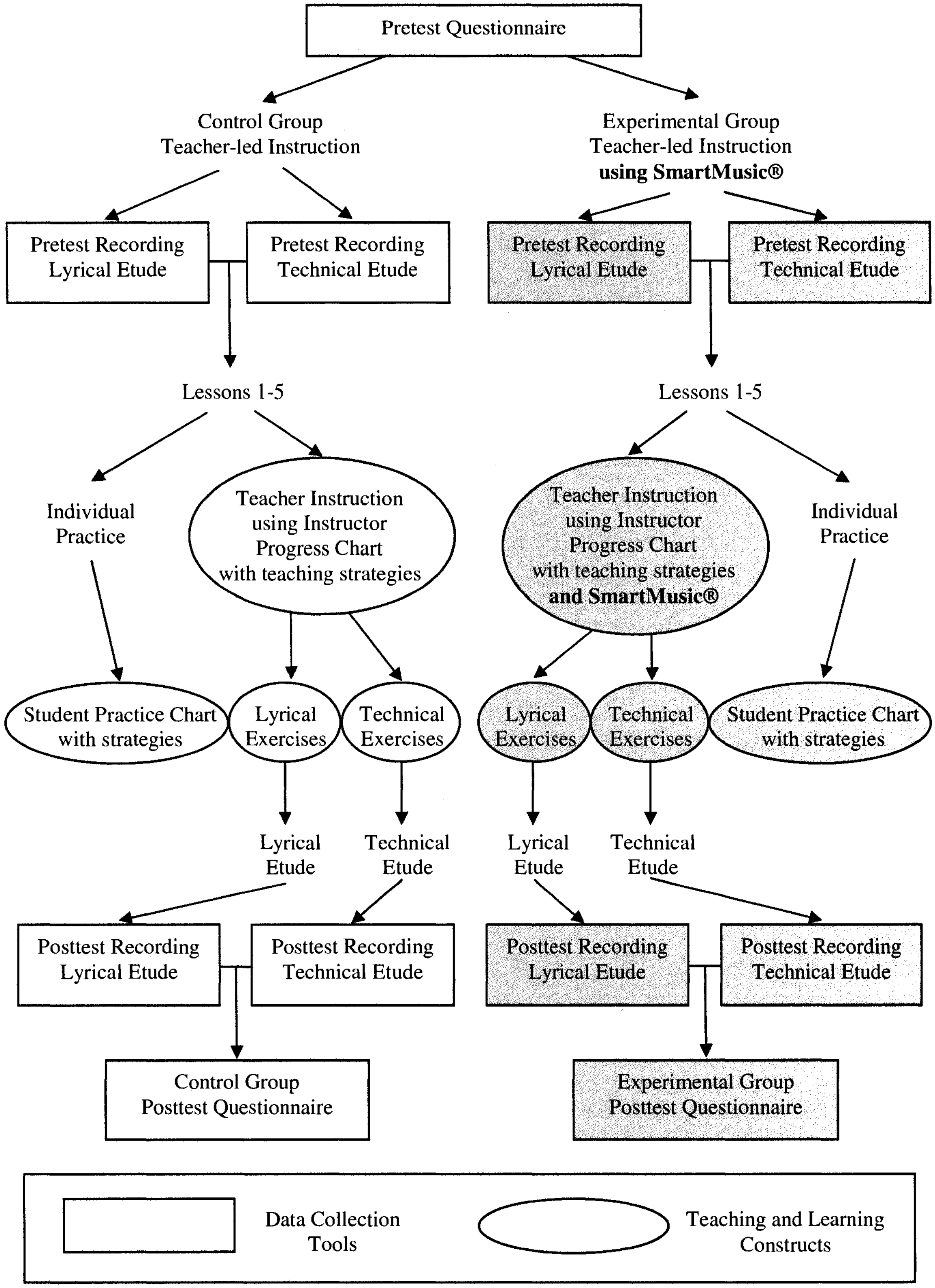


Figure 5. Study Design Framework.

Model

The conceptual design of this study focused on the effects of instruction on music performance. Though the SmartMusic® assessment program provides feedback using percentage scoring for some types of music examples, the researcher deemed this information inadequate for this study to properly explain and evaluate student music performance. A criterion-referenced evaluation form and rubric provided the assessment framework for this study. Multiple measures of music performance using three judges employing a research-based performance assessment tool comprise efforts to address reliability and validity. Of utmost importance to the researcher, connecting the skill development exercises to the assessment etudes connects educational theory to pedagogical practice. While developing the skill exercises, the researcher employed sequential cognitive and psychomotor activities (see the Marzano taxonomy in Chapter II) correlating with the etude. This practice is consistent with similar skill development strategies used by several music method book publishers, as discussed previously. Likewise, the teaching and learning strategies used by instructor and student in this study connect instruction to assessment. Purposeful integration of these factors attempt to maximize the potential educational value of SmartMusic® assessment to explore the efficacy of this teaching and learning tool.

Because SmartMusic® provides feedback on only two aspects of music performance – pitch and rhythm – questions regarding music performance must investigate which performance factors are influenced by the program. Allowances for differing musical styles, i.e. legato, staccato, etc., have not been made in previous studies, though results typically note particular effects on rhythm and pitch. Auditions for all-state, honor bands, festivals and summer camps frequently employ lyrical and technical music examples (several examples include: Georgia and Kentucky All-State Bands, Minnesota Band Directors Association Honor Bands, etc.). Both lyrical and technical etudes with corresponding exercises were purposefully used to explore the possible effects of SmartMusic® on differing styles of music. Likewise, two measures of music performance – music performance score (MPS) and technical performance score (TSS) – attempted to examine the same.

Limitations

The following factors limit this study:

1. The subjects were from a single outlying suburban Midwestern school system.
2. The researcher served as instructor for both the experimental and control groups, raising the possibility of unintentional bias.
3. The participants received instruction over a relatively short time frame – five sessions over a three-week period.
4. Though modeled after similar studies, using recognized research methodology, this study is one of the first to examine the assessment features of SmartMusic®.

Delimitations

This study utilized two measures of musical performance from contrasting music etudes – one lyrical, the other technical. The music performance score (MPS) and technical skills score (TSS), as determined by three independent judges, delineated performance ability. For practicality, performance exercises and etudes consisted of two short contrasting – lyrical and technical – musical passages lasting approximately thirty seconds each. Accommodating the current lesson schedule already in place at the program administration site, lesson instruction for each individual occurred in fifteen-minute time blocks. Access to the SmartMusic® program outside of the teacher-led lessons was not provided due to numerous potentially confounding variables, including access to the technology.

CHAPTER II

REVIEW OF SELECTED LITERATURE

"Most will agree that music technology today is not a passing fad but an established part of the educational scene" (Webster, 2002b, p. 416). However, an often referenced idea first proposed by Lehman (1985) in a prospective article on computer use warned, "there are hundreds of ways to misuse computers in education and only a few ways to use them properly" (p. 12). Justification for technology use should extend beyond availability or potential appeal. Review of these practices remains crucial to ensuring proper application of technology in education settings. Many successful and appropriate ventures are reviewed below. Assuming proper benevolence, present and historical applications of technology in education share a common goal – improving student learning and achievement. Aspects of learning and achievement, both theoretical and pedagogical, are highlighted below. Most aptly, cautious optimism should be exercised as identifying, evaluating and connecting educational theory and practice to technology implicitly legitimizes these endeavors.

Brief History of Technology in Music Education to 1990

The integration of technology and music education has historical roots in the United States dating back over one hundred thirty years. Webster (2002a) provides an overview of many technology developments involving music (see *Historical Perspectives on Technology and Music).* The focus of this summary follows technology developments affecting music education, including considerations where societal practice or music education movements affect the role of technology.

One of the first ethnomusicological expeditions aided by music technology was lead by Béla Bartók and Zoltán Kodály in the closing decades of the nineteenth century. They traveled about the Prussian countryside making recordings of folk songs using wax cylinders. Their collection of songs, later notated and published, gave particular attention to rhythmic accents and vocal inflections. The newly discovered wax cylinder recording technology made this project possible. In addition to the historical importance of this endeavor, dissemination of ethnic folk music fostered cross-cultural exposure, a prevalent music education theme in recent decades.

A significant technological development that revolutionized the music industry was the invention of the record. In 1870, Thomas Edison designed the first record player (Copland, 2006). Similar in style to the wax cylinder and the player piano, the records were cylindrical tubes, about the size of an empty toilet paper roll. Around 1900, the first flat disc format, the 78, was created. It was 10 inches in diameter and got its name from the fact that it was designed to play at 78 revolutions per minute. Though the flat design was a significant improvement over its predecessor, these discs presented some disadvantages such as short playing time and excess static (Music in the mail, 2006a). The discs were made of a shellac compound that was thick, heavy and easily breakable.

Just after the turn of the twentieth century, Frances Elliott Clark began work using the Victor Talking Machine for general music instruction. Shortly thereafter, she joined the VTM company and developed instructional materials that made general music instruction possible in schools where music was not presently available (Labuta & Smith, 1996). Educational use of recorded music became widely accepted as a result of Elliott's efforts.

In a 1926 article appearing in the Music Supervisors' Journal, William Fisher proclaims:

> We live in a period of rapid and surprising changes. From our age-long bondage to time and space we are fast being released, and no thinking man dares set the bounds for tomorrow's discoveries. (Webster, 2002a, p.38)

Fisher's comments were in response to thoughts about using the radio for music education purposes.

A major improvement of the record industry came with the invention of the 33 LP (Long Playing record) in 1948. An LP could hold up to a total of 60 minutes of music, but typically did not last more than 40 minutes. The vinyl plastic material was more flexible than shellac found in 78s and did not break as easily. Originally called "Microgrooves" (MG), the spiral grooves are 4 times smaller than those found on 78s. Though still coveted by some audiophiles, LPs gave way to compact discs (CDs) in recent decades. The first musical accompaniment system using recording industry technology was a series of LPs produced by Music Minus One beginning in 1950.

Another significant invention discovered during World War II, the magnetophone, led to development of more durable and eventually more portable music recording formats. The American-based Radio Frankfurt in occupied Germany used the magnetophone to record and distribute radio programming. Pre-recorded programming became significant to broadcast media in subsequent years. Many years later, technology along the same lines brought 8-track tapes, cassette tapes and other magnetic-based audio and video components. It likewise followed that educational materials and popular culture necessities developed to capture the advantages provided by this technology.

Bronson (1949) used an IBM device as a learning tool to sort and analyze data on British-American folksongs. A series of data points (phrase structure, meter, cadence type, etc.) about a particular song was entered on a 3.25 x 7.125 punch card. These cards were used to sort or compare similarities of songs based on the data entered. Bronson is careful to emphasize the use of the machine strictly as a time saving device to handle discrete data and not as a means to solve aesthetic problems.

In the 1950's and 1960's, Milton Babbitt, Lejaren Hiller, Leonard Isaacson, John Cage, and Pierre Schaeffer among others, experimented with various forms of electronic music (Riddell, 2001). Babbitt experimented with synthesizers and serial music. Hiller and Isaacson experimented with computer-composed instrumental music, producing the *Illiac Suite for String Quartet.* Cage fueled his curiosity by utilizing various forms of technology including tape recording, radios and computers. Schaeffer experimented almost exclusively with recorded sound. He also researched electronic sound typology and morphology, producing an incomplete though influential philosophical treatise. Advancements in digital technology have shed new perspective on his ideas (Riddell, 2001). With regard to the newly discovered applications of music technology in the mid-twentieth century, Riddell asserts:

> Music technology has simply evolved to accommodate almost any musical aspiration that an artist might have, simultaneously supporting traditional and non-traditional ways of thinking about music. (Ibid, p. 338)

However, due to the limitations of computer technology at that time, Riddell also observed that it was more than a decade after Babbitt's work that using computers for musical creation became "useful and desirable" (Ibid, p. 338).

Following World War II, the idea of combining technology and education remained a concurrent view, reflecting similar thoughts from earlier generations. With regard to educational technology, Jones (1957) observed that most applications of technology related to daily, parsimonious tasks. He advocated the combined use of qualitative research methods and technology to shed light on teaching and learning principles involving music and technology.

Beginning in January of 1958, Leonard Bernstein's Young People's Concerts with the New York Philharmonic exploited the rapidly developing television medium. Bernstein's television broadcast's showcased his teaching abilities, reaching millions of viewers over a fourteen year period (Bernstein, 2006). Bernstein not only utilized technology on an unprecedented scale, but he also characterized this series as "among my favorite, most highly prized activities of my life" (Bartram, 2004, p. 19).

In 1965 the Music Educators National Conference (MENC) held a symposium on educational media. Among the recommendations set forth from this conference were suggestions advocating the use of teaching machines, audio recordings, slides, filmstrips and motion pictures. Additional recommendations included cautious use of television and video as instructional media.

Computers and Electronic Devices

The first mention of computers in music education was at the end of the 1950s. The University of Illinois at Urbana-Champaign pioneered the Programmed Logic for Automatic Teaching Operations (PLATO) program, a mainframe system connecting a teacher's terminal to a series of student terminals. PLATO included many features such as private messages and real-time chat that continue to be used in programs such as

Blackboard and WEBCT (Woolley, 1994). The professional Association for Technology in Music Instruction (ATMI) was formed in 1975. Its mission is "to improve music teaching and learning through the integration of current and emerging technologies into the music learning environment" (ATMI, 2006, p. 1). A significant breakthrough in the late 1970s was the development of the microcomputer, which introduced new opportunities for home and personal computer use.

Other significant developments in the late 1970s and 1980s included synthesizers, Musical Instrument Digital Interface (MIDI) technology and interactive media such as hypertext, CD-ROM and Laserdisc (Higgins, 1991). These developments laid the groundwork for musical instruction programs, discussed in the next section.

Technology and Music Accompaniment

One of the first musical accompaniment programs using a computer was Vivace® by Coda Music released in June 1994. It was available on both Mac and PC platforms. This system used a combination of software and hardware to produce musical accompaniment for wind instrument soloists. The target user for this system was beginning to advanced wind instrument musicians. Available repertoire continuously expanded and included standard repertoire selections as well as typical selections found on many secondary school state solo and ensemble contest lists. Several limitations such as obtaining copyright permission for electronic distribution in this format and computer processor limitations presented formidable obstacles. Cost may have also been a limiting factor. The necessary hardware components, separate accompaniment cartridges required for each musical selection and optional accessories required a significant investment. A unique attribute of this system from its inception was the "intelligent accompaniment" feature – an attempt to produce accompaniment that would be able to respond to the soloist. With the continued improvement of computer processor speed and software upgrades eliminating the need for special hardware, this capability became feasible and much more practical. In 1998, Vivace® was greatly expanded, improved and renamed SmartMusic®.

Computers and Web-based Music Technology

Of the many music technologies available in the1990s, educational applications involve a system using various combinations of computer software, hardware or web-based applications. Even existing technologies gravitated toward integration or at least compatibility with computers as they continued to develop (Buck, 2001). The following discussion highlights three categories of computer technology: productivity, professional and instructional. Though some software, hardware and web-based application functions may overlap these categories, classification of these technologies are considered from a music education standpoint. The first two categories are briefly highlighted, as they are less significant to this study. Within the instructional category, several types are identified, focusing mostly on musical accompaniment and evaluation programs.

Computer-based productivity technologies include word processors, databases, spreadsheets, graphic design programs, presentation software, etc. In the music educator's world, these programs serve a multitude of functions. Some possibilities include: uniform, instrument and music library inventories; budget and purchase calculations; grading, curriculum and standards assessment record keeping; parent letters and newsletters; multimedia classroom presentations, etc. (Rudolph, 1996). Especially when communicating with parents and the public, web-based activities such as websites and listservs provide valuable, accessible and efficient communication (Buck, 2001).

Professional music technologies assist the educator with music-related tasks and include music performance, music notation, sequencing, etc. Recordings, available in numerous formats through devices such as iPods provide the music educator with a multitude of professional resources. Though these products can also be used in educational settings, their primary function relating to this study serves the professional needs of the music educator. Many teachers are involved in composing, arranging or editing music to enhance student learning or performance. To this end, music notation programs are one of the most frequently used music software programs (Hess, 1998). These programs have educational applications – even various products available for novice or student users – and they remain powerful tools for the music educator. In a discussion following a presentation at an education conference for overseas educators, Buck (2001) recalled that some technology-savvy music educators used sequencing and synthesizer capabilities to assist their music programs. Several music teachers expressed interest in this idea as they face instrumentation shortages or other limited resources.

In the teaching and learning paradigm, technology influences instructional delivery, content and the relationship of teacher and student. Bond (2002), in an internet-based music instruction project in Australia, cites others stating technology is a "transforming agent extending the range of resources available to students, as well as allowing new and dynamic relationships to form between teachers, students and the broader community." (Ibid, p.12). Like other traditional teaching models, feedback, motivation and interactive frameworks comprise an important instructional role. Even though delivery of content and types of feedback promote more student-initiated learning, the same interactive strategies must be present (Ibid).

Studies on Vivace® and SmartMusic® Accompaniment

Tseng (1996) conducted a case study of ten college flute students using the Vivace® accompaniment system. This study investigated how students incorporated the Vivace® system into their practice sessions, how it affected their practice, how students reacted to this teaching tool and how past experience using a computer accompaniment affected current use of this system. She also submitted a questionnaire to the manufacturer, Coda Music Technologies, Inc. Through case study analysis, Tseng found mixed and sometimes conflicting results, though all participants envisioned ways that the Vivace® system could be utilized for music students. Qualitative data analysis showed that all participants believed the accompaniment system helped them learn music quickly, citing additional confidence-building stage presence benefits derived from simulated performance. Some technical difficulties were encountered and noted as limitations. Tseng suggested that her study has "profound implications for instrumental music education, research in music education and computer-based learning" (p. 12).

In a study of middle school students using the Vivace® system, Ouren (1997) explored the skills, motivation and attitude of eight eighth and ninth grade students. Pre- and post-test performance results were evaluated, showing increased scores from an independent judge in seven of eight participants. Rhythm and interpretation/musicianship were the two most noticeable categories showing improvement. Ouren suggested that the Vivace® system had a positive effect on students' musicianship. To varying degrees, all students identified a sense of accomplishment and success using the Vivace® system.

In a nationwide survey of 172 United States band directors, Snapp (1997) sought to discover how Vivace® was being used in school music programs and to find evidence of musical growth after using the system. The respondents indicated that Vivace® was primarily used as a supplemental tool of instruction, most often for solo and ensemble preparation. Snapp claims that he found evidence suggesting a direct relationship between the Vivace® system use and student musical growth.

Quality musical performance is at the heart of the technology debate. In a study addressing this topic, Sheldon, Reese and Grashel (1999) studied college-age instrumentalists preparing for a solo recital performance. Participants were given six weeks to prepare an intermediate level solo work on a secondary instrument. While preparing for the performance, participants were assigned to one of three groups: no accompaniment, live accompaniment or intelligent digital accompaniment (SmartMusic®). At the end of six weeks, students performed the prepared pieces two times: first with no accompaniment, next with the prescribed mode of accompaniment. Both performances were recorded and scored by a panel of judges using a predetermined rubric. The results showed mixed outcomes. Most notable among these, the mean scores (indicating overall quality of performance) were noticeably higher for the first performance in the two groups using accompaniment in their practice sessions (live or digital). The second performance showed almost no difference between groups, with overall mean scores lower than the first performance for both accompaniment groups, but higher for the no-accompaniment group. The authors suggest that when the participants achieve a higher score under the same conditions, this fact may be attributable to the confounding tendency of repeat testing. For the accompaniment groups, the results suggest that the additional variable, accompaniment, may be affecting the results through added complex interaction. Lastly, students using the digital accompaniment reported increased motivation to practice. Addressing motivation using digital accompaniment was a suggestion for further study.

A recently completed study explored the effects of SmartMusic® instruction, previous musical experience and time on the performance ability of beginning band students (Lee, 2007). Three performance assessments using percentage scores generated by SmartMusic®, gathered at four, eight and twelve weeks, were analyzed. Assessment scores from SmartMusic® considered the musical elements of pitch and rhythm. The ANCOVA, with covariate determined using Gordon's *Intermediate Measures of Music Aptitude* (1986), showed no significant difference among instruction groups at any of the measurement intervals. A significant difference was reported, respective to time, for students with more than one year of formal music training compared to students with less than a year of instruction.

Education Theory and SmartMusic®

Glenn (2000) observed that students most often perform solos in a different context than they practice – with or without music accompaniment, respectively. She hypothesized that preparing and performing with the use of music accompaniment may affect final public performance due to decontextualization. In an effort to contextualize learning, Glenn used an experimental group that prepared using SmartMusic® accompaniment and a control group that used no accompaniment during individual preparation. Both groups performed the post-test using a live accompanist. Her results did not show a statistical significance between groups, but the experimental group did show overall improved post-test scores. In a follow-up questionnaire, participants who used the accompaniment technology also indicated a greater number of positive comments regarding their performance and felt the technology helped them improve their musicianship.

Interactive Pyware Assessment System® Overview and Comparison

Similar to SmartMusic® assessment, the Interactive Pyware Assessment System® (iPAS®) performs assessment functions with a less-complicated interface. Available tools include assessment, tuner, metronome and recording. Both programs facilitate assessment of pre-programmed or user-created exercises. Both include content from published method books, though SmartMusic® currently holds the larger selection. The user-created SmartMusic® assessments are proprietary, requiring Finale® notation to create the necessary files. iPAS® uses a MIDI file format which can be created using any notation program. Both programs provide access to assessments through a web-based server, allowing increasingly sophisticated options such as announcements, due dates, email contact and automatic assessment collection. Of notable interest, the iPAS® assessment feedback includes pitch, rhythm and intonation, whereas the SmartMusic® assessment provides pitch and rhythm information (note: severe intonation discrepancies appear as "wrong" notes in SmartMusic® assessment). Other differences exist, but are too numerous to cover here. Zanutto (2006) provides a basic, though already dated comparison of both programs. To date, no research studies were found by the researcher exploring the Interactive Pyware Assessment System.

Education Theory Involving Music Achievement

When considering musical achievement, many agree that there is no single factor denoting musicality. Shuter-Dyson (2002) references the work of several early twentieth century psychologists. Charles Spearman evaluated the *Seashore Measures of Musical Talents* (1938), finding no single unifying factor. Attempting to explore the role of musical development, James Mursell and others concluded that early childhood experiences are important to subsequent music achievement potential. Brain researchers in the early 21st century using the work of Edwin Gordon and psychologists Shaw, Gruhm, Rauscher, Hodges and Flohr viewed the effects of musical stimuli, experience and instruction on music achievement. Many other examples connecting theory and achievement exist, but are too numerous to explore here. However, Shuter-Dyson suggests that connecting learning theory to research is important because it implies pedagogical elements. Shuter-Dyson continues to point out that there has been limited research connecting teaching strategies to the works of noted educational psychologists such as Piaget, Bruner, Ansubel, Gagne and others, though the author highlights the importance of doing so.

Related Education Theory Conclusions

Considering these facts, it is not surprising that the recent SmartMusic® studies involving measures of musical achievement have shown mixed results, at best. Nonetheless, as Shuter-Dyson (2002) suggests, connecting theory and learning is an educationally necessary endeavor. In addition, Colwell justifies an outline of educational taxonomies to highlight the "importance of connecting educational objectives and procedures with assessment" (2002, p. 1129). Failure to show significant results (where

$p < .05$) in research studies on music achievement may be a function of the complexity of measuring multi-faceted indicators of musical achievement. Equally important are development of valid and reliable measurement tools. Also absent in most of these studies is the connection between assessment, theory and learning. Following this line of thought, the next section highlights the most relevant learning theories used in this study.

Education Theory and Practice Related to this Study

Assessment

Asmus (1999) proclaims that assessment is "an integral part of the instructional process" (p. 19). He continues to point out the value of assessment information for teacher and student, particularly citing motivation to continue learning. Among the instructional outcomes, "music performance is one of the most authentic [real-world] assessment opportunities available in schools" (Ibid, p. 20).

Colwell (2002) suggests that during the 1990's, "assessment [was] one of the more important issues in education" (p. 1128). According to him, the relationship between standards, assessment (evaluation) and accountability is well defined. Though questions surface about the appropriateness of high-stakes testing, these relationships delineate what students should know, be able to do and at what level. Within these, the role of assessment and evaluation is to "provide data on the extent of success and failure but only hint at the causes" (Ibid, p.1128). Three important objectives of assessment must be:

1. There must be a direct match between the curriculum and what the student is expected to know and do in the assessment…

2. On-demand assessments should address important outcomes, not trivial items selected for ease of measurement.
3. Allowing students to answer three of five questions is inappropriate on high-stakes tests. All questions should be important; all questions must be answered to determine minimal competency (Ibid, p. 1128).

Simply, the assessment must match the content taught, evaluate desired outcomes and contain only salient information.

Diagnostic & Performance-based Assessment

Of the many types of assessment available to the music educator – summative, diagnostic, authentic, formative, etc. – diagnostic assessment is most applicable to this study. The purpose of diagnostic assessment is to identify the problems of learning. A key subcomponent of diagnostic assessment in music performance is error detection (Goolsby, 1999). While a strategy often used in large group rehearsal, error detection skill applies equally to individual music performance through metacognition and self-actualization strategies – discussed below. A topic related to this task and concept shared by Colwell, Goolsby, et. al., effective learning requires connecting desired outcomes to assessment. Too often, the purpose of teaching activities remains unstated and unclear to the student – a fact verified by Goolsby's (1999) research on large group rehearsals. Objectives provide the framework for assessment – to determine if learning has taken place. After implementing a targeted assessment program, one Iowa high school band director reported that students recognized the relationship between progress (achievement) and assessment while obtaining more "profound musical understanding" (Burrack, 2002, p. 30).

Performance-based assessment components provide particular relevance when examining music performance. By nature, this process requires connecting learning to assessment. Performance-based assessments emphasize "the students' ability to apply what they know and are able to do in the performance of a task or in the production of their own work" (Scott, 2004, p. 17). More pointedly, Eisner (1999) states:

> performance assessment is aimed at moving away from testing practices that require students to select the single correct answer from an array of four or five distractors to a practice that requires students to create evidence through performance that will enable assessors to make valid judgments about "what they know and can do" in situations that matter. Performance assessment is the most important development in evaluation since the invention of the short-answer test and its extensive use during World War I (p.54).

(note – performance assessment in this context connotes performance of a task to demonstrate knowledge or skill – not exclusively music performance). Demonstrating knowledge requires several prerequisite steps. Especially relative to music performance, the presentation medium requires knowledge and skills (even if it is the performance task) in addition to new learning tasks. More information regarding the learning process required is explained through education taxonomies below.

Marzano Taxonomy of Education Objectives

Like Benjamin Bloom's taxonomy and two recent revisions (Hauenstein and Krathwohl), the Robert J. Marzano taxonomy explores aspects of the learning process. The importance of this taxonomy, which became pivotal for inclusion in this study, is that it "recognizes the role of new knowledge about how learning occurs" (Colwell, 2002, p.

1141). An informative summary of these taxonomies appears in *Assessment's Potential in Education* (Ibid, p. 1140-6) from which much of the information below is extracted. Unlike others, the Marzano taxonomy combines cognitive and psychomotor domains, an especially applicable consideration for instrumental music performance. Three systems – cognitive, metacognitive and self – comprise the framework for six levels of the taxonomy, with the first four representing the cognitive category.

Level 1: Knowledge Retrieval

Level 2: Comprehension

Level 3: Analysis

Level 4: Knowledge Utilization

Level 5: Metacognition

Level 6: Self

The taxonomy is not hierarchical between systems, though an implied order of the four cognitive levels exists – borrowing from Bloom's recognizable configuration. Within each level, information, mental procedures and psychomotor procedures comprise the framework for learning. Learning involves complex interactions of all three systems, though sequential and/or inclusive components exist with each.

Of particular interest to this study is the inclusion of "self" when examining the learning process. Examining importance, efficacy, emotional response and motivation becomes part of the learning process. Colwell continues to suggest "examining student motivation reveals a summary of the student's beliefs about importance, efficacy and emotion" (Ibid, p. 1143). The self-system determines the extent of which a student becomes engaged in the learning process. As noted by prominent educational psychologists – Bandure, Maslow and Buber to name a few – personal investment (motivation) is a key underpinning of learning.

Metacognition

Metacognition – thinking about one's own learning – involves self-reflection on the process of learning. McPherson (2005) points out that researchers have studied this topic for nearly two decades. Their findings show that school-age children become increasingly capable of monitoring their own cognition and planning cognitive learning strategies. Students utilizing metacognition acquire new knowledge and skills more quickly. Equally important, monitoring thinking as well as goal setting facilitates connection between purpose and activity (Ibid).

Common threads between metacognition, constructivism, active learning, learning by doing, inquiry-based learning, student-centered learning, etc. involve student participation and input during the learning process. To varying degrees, students assume control of their own learning. Through these models, the role of the teacher shifts from imparting knowledge to guiding learning.

Motivation

Many education pundits identify motivation as a key factor determining learning and achievement. According to Duke and Pierce (1991), student learning depends on many factors, including, among others, motivation, logical sequence of learning tasks, success and praise. Further, success fuels motivation to pursue greater skill levels (Ibid).

In 1997, National Assessment for Educational Progress (NAEP) – also known as the Nation's Report Card – conducted nationwide assessments exploring eighth-grade students' ability to perform, create and respond to music. Questions involving motivation, deemed important by test designers, appear among the categories of information gathered along with music background and music content questions (Schneider, 2005, p. 56).

The potential of technology to motivate students was highlighted in several SmartMusic® studies (Tseng, 1996; Sheldon, et. al. 1999; Ouren, 1997; Snapp, 1997; Glenn, 2000).

Validity and Reliability

Validity – the extent to which a measurement tool actually measures what it is believed to – remains important to the credibility of any research study. Reliability – the consistency of a measurement tool – follows validity for the same reasons. A measure can be reliable, but not valid. However, the reverse is not possible. Several types of validity related to music research include content, criterion-related and construct (Asmus, 2006). Of most relevance to this study are content and construct validity. Content validity explores the effectiveness of the measurement tool as a substantive measure (Ibid) – in this study, music performance. Construct validity refers to the effectiveness of a measurement tool to measure "specific traits underlying the test" (Ibid, p. 101). Music assessment constructs become valid through specific operational definitions and constructs including observable (assessable) and measurable criteria. In this regard, assessment rubrics and well-defined assessment criteria promote validity within the research design.

Music Practice Strategies

Effective music instruction and individual practice share many attributes. Jorgensen (2004) outlines three phases of individual practice and advocates use of strategies by teacher and student. These three phases – planning, execution and evaluation – echo similar considerations outlined earlier in the learning strategies literature review. In addition to the above, Jorgensen underscores the importance of "metastrategies," consistent with self and metacognition theories, also relating to the Marzano taxonomy. A greatly summarized rendition of Jorgensen's practice strategies outlined in *Strategies for Individual Practice* follows:

- Planning Phase
  - Practice with defined learning objectives/goals
  - Balance "playing" and "non-playing" practice
  - Warm-up, with purpose and goals
  - Establish routines – but include variations
  - Include familiar and unfamiliar music
  - Manage time – consider duration, frequency, relevance & quality
- Execution Phase
  - Mental rehearsal – cognitive information and mental imagery
  - Perform combinations of whole piece and isolated sections
  - Isolate difficult passages and "transfer" learning through skill development exercises
  - Practice correctly – use repetition of difficult passages
  - Vary tempo
  - Distribute practice sessions over time
- Evaluation Phase
  - Feedback – knowledge of results is essential to learning process
  - Evaluate to improve
  - Use aural and visual feedback – including audio and video recording
  - Detecting errors – include many areas such as pitch, rhythm, dynamics, intonation, steadiness of pulse and tonality.
  - Study the music (cognitively) to analyze and employ all music markings
  - Practice whole sections followed by error correction within section
  - Use constructive messages
  - Employ metastrategies – specific, relational and general
  - Control strategies – use knowledge to:
    - check
    - evaluate
    - predict
  - Regulate strategies by considering:
    - effort required
    - task selection
    - speed (efficiency of learning)
    - intensity (p. 98)

Jorgensen continues to point out that success of the practice strategy remains relative to the individual needs and ability of the performer. Jorgensen's own research in a separate study showed 40% of the students entering a music conservatory reported that their previous teachers placed "no" or "very little" importance on practice. In a survey of music educators, 84% surveyed considered practice "important." Similar to Goolsby's (1999) assertions, the connection between teaching objectives and student learning too often remains unclear, with students and teachers displaying differing views. Providing a glimmer of hope, another study shows that successful practice strategies can be taught, but Jorgensen reminds educators "practice must be practiced" (Jorgensen, 2004, p. 99).

CHAPTER III

METHODOLOGY

This study provides data on how the assessment components of SmartMusic® affect student music performance. Because SmartMusic® fits well in a region-typical, active high school instrumental music program with periodic individual lessons, evaluating its effectiveness became part of the impetus for conducting this research. This researcher explored the assessment capability of SmartMusic® (beginning with Finale Performance Assessment®) for several years. Informal pilot studies, numerous targeted technology implementation projects, literature review, software improvements and general technology interest helped shape the study design.

Study Population

Study participants included 46 (N=46) secondary school instrumental music students from an upper-Midwestern mixed rural/suburban school system. The school district, centered in a town of about 18,000 residents, encompasses several other smaller communities and vast rural areas. Though economically diverse, the community remains ethnically homogeneous. The 2000 United States census information reported 97% of the residents were white. From the same report, household annual income demographics showed 18% earning less than $25,000, 28% between $25,000 and $49,999, 26% between $50,000 and $74,999 and 27% reporting more than $75,000.

The school district houses a kindergarten center, three elementary school buildings (grades 1-5), one middle school (grades 6-8) and one high school (grades 9-12). Of the 1725 high school students, approximately 700 students participate in curricular music courses including band, choir and/or orchestra. Nearly one third of the music students participate in an instrumental ensemble (231 students during the 2007-08 school year), with many electing more than one music course.

Descriptive Statistics

During the 2007-08 academic year, all currently enrolled high school band students were invited to participate in the study. During this study, the researcher served as a classroom instructor for these students – through lessons, as the large ensemble director or both – as well as the research instructor. For scheduling purposes and other practical reasons, primarily underclassmen from two lower-level, ability-based bands comprised the participants in the study. Fifty-four students began the study, with 47 completing all five instructor-led sessions along with the pre- and post-test recordings. One student performance was eliminated due to a technical recording problem, leaving data for 46 study participants (N=46). Participants included 24 ninth grade students, 18 tenth grade students, 3 eleventh grade students and 1 twelfth grade student. A summary of participants by grade level appears in table 1:

Table 1

Study Participants by Grade Level

Grade Level	*Number of Participants*
Grade 9	24
Grade 10	18
Grade 11	3
Grade 12	1
Total	N=46

Identification of Variables

Two levels of music instruction, with (pink group) or without (yellow group) the SmartMusic® assessment module, served as the independent variable in this study. The music performance scores (MPS), obtained from three independent judges, provided quantitative data evaluating music performance, the dependent variable. The MPS includes all six categories found in the performance evaluation form (Appendix C). The technical skills scores (TSS), a subset of the MPS, explored the effect of the music instruction upon four categories from the performance evaluation form – pitch, rhythm, facility and articulation. Composite scores refer to the three-judge average for any respective measure. Statistical analysis utilizes composite scores for MPS and TSS measures for technical and lyrical etudes. Utilized in the analysis of covariance (ANCOVA), covariate pre-test measures were compared to respective post-test measures, relative to the music instruction. Existing grouping variables include school geographic location, music instrument already chosen by the student and gender. The student and teacher rubrics and teacher-led instruction remained constant for all study participants.

Method

The study employed a pre- and post-test control group design, examining the effects of SmartMusic® assessment upon student music performance. Study participants received five 15-minute individual music lessons over a three-week period totaling 75 minutes of instruction during the end of the fall semester in 2007. Music designed for this study included short, contrasting lyrical and technical etudes coupled with related skill development exercises (see Appendixes E, F, G & H). To increase reliability, three independent judges analyzed pre- and post-test recordings of the etudes. Treatment of the experimental and control groups remained identical, excepting the addition of the SmartMusic® assessment program module for the experimental group. Teacher-led instruction for both groups, aided by the Instructor Progress Chart and Rubric (Appendix B), included the use of a metronome, tuner and recording equipment.

The researcher randomly assigned study participants, splitting matched pairs, to the experimental or control group. Matched pairs, respective of woodwind, brass or percussion families, were determined using current progress in the student's music lesson book, i.e. students on approximately the same page of the same book were assumed to be of comparable performance ability. Using the random number function in a Microsoft Excel® spreadsheet, the researcher examined the matched pairs, assigning the participant with the higher number from the random sequence to the control (yellow) group. The participant with the lower number was assigned to the experimental (pink) group. Distribution of completed study participants included 13 woodwind, 8 brass and 2 mallet percussion students in the control group. The experimental group contained 16 woodwind, 5 brass and 2 mallet percussion musicians. Table 2 shows the distribution.

Table 2

Study Participants by Instrument

Instrument Family	*Control Group*	*Experimental Group*	*Family Total*
Woodwind	13	16	29
Brass	8	5	13
Percussion	2	2	4
Total	n=23	n=23	N=46

All study participants received a Student Practice Rubric and Chart (Appendix A) – a practice record and rubric incorporating research-based teaching and learning theories. The rubric listed strategies directly applicable to lessons or individual practice sessions – with or without the instructor and with or without the computer. The strategies include, tempo adjustments, isolation of difficult passages, practice loops at incrementally increasing speeds, error detection, etc. Both groups received instruction on how to use the practice rubric.

Study participants performed two contrasting music etudes – one lyrical and the other technical (see Appendix F & H, respectively). The former etude utilizes a public domain tune by Georg Friedrich Händel, with the melody spanning a total range of nearly two octaves. The 20-measure asymmetrical phrase culminates in a fragmented extended cadential progression. The researcher added articulations, dynamics and a metronome tempo range to compliment the lyrical nature of the tune. The melody from the researcher-created technical etude covers one octave, emphasizing a linear chromatic tritone, syncopation, dynamic contrasts and plentiful articulations. Contrasting etudes emphasizing primarily either lyrical or technical skills were chosen to highlight possible differences in the effect of the program on student performance.

A set of respective skill-development exercises preceded each etude (see Appendix E – lyrical etude; see Appendix G – technical etude). Designed to capture the respective etude's most salient musical components, the skill exercises utilized the appropriate key signature, range, finger patterns, etc. of the each etude. To increase technical facility, the step-wise skill exercises incorporated an incrementally increasing rhythmic progression when performed at a steady tempo, i.e., progressing from quarter, to paired eighth, to single eighth notes, etc. Multiple articulation patterns (see figure 6 & 7) further enhanced skill development through sequential, contextualized steps.

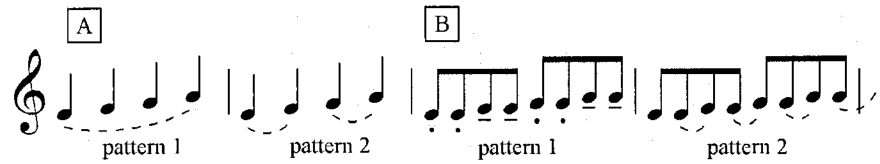


Figure 6. Articulation Pattern Samples for Lyrical Etude Skill-development Exercises.

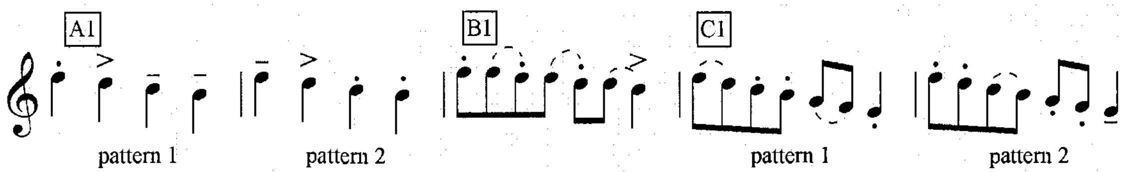


Figure 7. Articulation Pattern Samples for Technical Etude Skill-development Exercises.

Considering performance limitations imposed by some music instruments (especially with regard to range), the researcher chose to modify a few of the etudes to better fit the needs of an intermediate level musician. As a result, the etudes, appropriate transposition withstanding, are instrument specific. For efficiency purposes of this study, only pre- and post-test recordings of the lyrical and technical etudes – not the skill exercises – were collected and analyzed. During the study, each participant generated four recordings, typically lasting less than a minute each.

Instruction

Lesson instruction occurred mostly during the regularly scheduled school day, with a few students choosing "zero" hour (before school) or after school time slots. The current school policy allows "pull-out" music lessons, with the cooperation of the affected classroom teacher. Lesson schedules were organized in twenty-minute increments, accounting for transition time, ensuring at least fifteen minutes of instruction. Students self-selected lesson times at least two days apart.

The student and instructor accomplished several tasks during the first guided practice session. These include music dissemination, pre-test recording, practice rubric explanation and, for the experimental group, a SmartMusic® demonstration. To ensure consistency of recording quality, the researcher blindly recorded all participant pre- and post-test performances using SmartMusic®. After receiving the appropriate music, the student viewed the lyrical etude while the instructor sounded the metronome, selecting a tempo marking at or near the lower end of the indicated tempo range. The student took approximately thirty seconds to visually review the music and ask any questions. Following SmartMusic® software adjustments by the researcher and a brief explanation of the metronome countoff, pre-test recording commenced. Pre-test recordings of the technical etude followed the same procedure. For both the lyrical and technical etudes, the instructor logged performance tempo markings and made notes on the Instructor Progress Chart and Rubric (Appendix B). For the student, the instructor introduced the practice strategies and practice log found in the Student Practice Rubric and Chart (Appendix A). The researcher asked students to keep a log of their practice time outside of the instructor-led sessions. Both instructor and student charts contain the same teaching and learning strategies. In the remaining lesson time, students performed the respective skill development exercises, reviewed the music etudes and, for the experimental group, received a demonstration of SmartMusic®.

Subsequent sessions utilized the same instructional materials and expanded upon the teaching and learning strategies. The instructor led students through the exercises and etudes, using a variety of interactive techniques. Lessons progressed from exercise to etude at appropriately increasing incremental speeds. Practice loops helped isolate and improve problem areas. The instructor encouraged student self-assessment by asking students to identify his or her own difficult areas and suggest strategies for improvement, especially referring to the practice rubric. Other instructional strategies included using the metronome, making tempo adjustments (immediate and incremental) and using a tuner. Following each lesson, the instructor documented student progress on the Instructor Progress Chart. The instructor collected post-test recordings of the lyrical and technical exercises using SmartMusic® at the end of the fifth session.

Participants in the experimental group using SmartMusic® received additional instructional feedback. The instructor utilized the SmartMusic® assessment module for the music exercises and etudes. Audio and visual components of the software facilitated several types of assessment for the student and instructor. These components include error detection (red and green notes), recording, metronome (with auditory clicks, visual cursor or both), fingering charts, tuner, metronome, tempo adjustments (immediate and incremental) and practice loops (separated by one measure countoffs). To utilize fully and administer consistently these software assessment capabilities, the instructor executed the SmartMusic® tools during the lessons. The SmartMusic® program provided instructional feedback, comparable to teacher-only instruction in content, though different in delivery and perhaps efficiency. Qualitative data regarding the SmartMusic® program operation is discussed in the discussion section of Chapter V.

Data Collection and Measurement Tools

The researcher collected several types of data. After receiving research study information (Appendix I) and indicating consent (Appendix J), participants completed a pre-test questionnaire (Appendix K). The form gathered demographic, musical experience, technology and self-rated interest and aptitude information. The post-test questionnaire (Appendix L & M) contained follow-up interest and aptitude questions with evaluation components. The researcher collected blind pre- and post-test recordings of all study participants using the SmartMusic® program.

Three independent judges analyzed audio recordings of pre- and post-test performances. Members of this panel shared three criteria: 1) each possessed 15 years or more of public school instrumental music teaching experience; 2) each taught individual lessons to students in a similar setting, yielding realistic expectations and insight regarding student performance; 3) none were familiar with the students involved in the study. To analyze student music performance, each judge utilized a typical music contest solo performance evaluation form (Appendix C) and researcher-assigned performance evaluation rubric (Appendix D). The evaluation form contains six categories requiring the adjudicator to assign a point value of 1 (low) to 5 (high) within each category. The categories include tone, intonation/pitch accuracy, rhythm, technique, interpretation/musicianship and articulation (winds)/execution (percussion). The sum of all scores in each category produced a value (music performance score – MPS) ranging from 6 to 30 points. Typical contest solo adjudication forms usually include other performance evaluation categories such as balance/blend or presentation, etc. but, the researcher chose to eliminate these factors due to lack of relevance to this study.

The researcher analyzed data from pre- and post-test recordings in several ways. Acquisition of technical skills was determined using the technical skill score (TSS). It focuses on technical music performance skills – pitch, rhythm, technique/facility and articulation (winds)/execution (percussion). The sum of the scores from these four categories produced a value (technical skills score – TSS) ranging from 4 to 30 points. However, artistic music performance encompasses more than technical execution. In this regard, the music performance scores (MPS) of lyrical and technical etudes shed light on the overall music performance ability of study participants. To ensure consistent treatment of adjudicator data, the researcher calculated composite mean scores of all three judges for each measure before proceeding with statistical analysis. ANCOVAS considering pre- and post-test measures were evaluated for significance at $\alpha = .05$ level.

Equipment

Software and hardware configurations for this study included the following equipment: a Hewlett-Packard Pavilion laptop computer with 512 MB of RAM, 3.0 GHz Pentium 4 processor, Windows XP professional operating system with service pack 2, SmartMusic® v. 10.1, a SmartMusic® microphone and Klipsch ProMedia 2.1 computer speakers. The SmartMusic® accompaniment files were created using Finale® 2007, while notation files of the performance etudes and exercises were created using PDF 995. The school district network server provided ample storage for student audio recordings and included a T3 broadband internet connection.

Threats to Validity

Considering the potential threats to validity for this study, the researcher employed the following controls. Especially inherent in experimental-design research studies in education, barriers exist with regard to accessing and recruiting secondary school-age students. Though the necessary institutional review board process ensures proper ethical considerations, gathering a statistically powerful sample that meets all requirements proves difficult. Educating students, parents and school board members was necessary to ensure understanding of the research study and enlist the support of interested participants. Though familiarity with the community creates potential researcher bias, recruitment of 54 participants (with N=46 completed participants) may not have been otherwise possible. To ensure consistent utilization of the technology tools, the researcher chose to operate the SmartMusic® program during lesson instruction. Using a detailed scoring rubric to evaluate student performances promoted consistent measurement (reliability) among multiple independent judges. Inter-rater reliability was statistically assessed and mean-score averages were used throughout. For the judges, presenting pre- and post-test recordings in random order promoted internal consistency reliability. Due to the statistically small sample size, matched random assignment of study participants within subject variable groupings (woodwind, brass or mallet percussion) promoted greater likelihood of equal distribution, though still randomized, between subject groups. Where appropriate, the researcher took multiple steps to ensure participant anonymity and reduce subsequent bias. These measures include randomization, color-coding data sheets and frequent use of ID numbers or other limited identification means. Though not a replacement for research experience, several years of preparation, extensive familiarity with the SmartMusic® program and numerous targeted research and technology projects provided the researcher with valuable insight through statistical and qualitative means.

CHAPTER IV

RESULTS

This study investigated the effects of SmartMusic® assessment upon student music performance and the efficacy of this teaching and learning tool. The research provides quantitative data on student music performance of lyrical and technical musical examples. The performance evaluation results from three independent judges as well as other qualitative survey data address the following research questions:

Restatement of the Research Questions

1) Do students who use SmartMusic® assessment achieve greater technical skills and increase music performance ability?

2) Is SmartMusic® assessment an appropriate tool for examining student music performance, facilitating integration of applicable teaching and learning components?

3) Does SmartMusic® assessment provide an educationally justifiable medium, linked to motivation, for teaching knowledge and skills to music students?

Inter-rater Reliability

A correlation coefficient determined the inter-rater reliability among three independent judges for pre- and post-test measures of the lyrical and technical etudes. The results, shown in table 3, show a positive, large-strength, significant relationship in all cases ($.807 < r > .894$, $p < .001$).

Table 3

Inter-rater Reliability

	Composite Pretest r	*Composite Post-test r*
Lyrical Etude	.883	.821
Technical Etude	.807	.894

Presentation of Data

Question 1: Do students who use SmartMusic® assessment achieve greater technical skills and increase music performance ability?

Respectively, data gathered from the technical skills scores (TSS) and the music performance scores (MPS) address this question. The TSS data utilizes a subset of the information found in the MPS. It focuses on technical music performance skills – pitch, rhythm, facility/technique and articulation/execution. However, artistic music performance encompasses more than technical execution. In this regard, the MPS of lyrical and technical etudes shed light on the overall music performance ability of study participants. Composite pre- and post-test scores for both TSS and MPS measures from the lyrical and technical etudes comprise the data used in the analyses of covariance (ANCOVAs).

Separate analyses of covariance (ANCOVAs) using three-judge composite technical skills scores (TSS) for the lyrical etude (TSS_l) and the technical etude (TSS_t) measured the difference in technical skills among students receiving instruction with or without SmartMusic® assessment. The TSS minimum and maximum possible scores range from 4 (low) to 20 (high). The TSS lyrical etude mean scores for the SmartMusic®

group improved from 9.61 to 13.30, pre- to post-test while the teacher-led group improved from 9.97 to 12.42. The TSS technical etude mean scores showed similar results. The SmartMusic® group moved from 7.42 to 12.80 pre- to post-test as the teacher-led group changed from 9.10 to 12.59. Table 4 reports the composite pre- and post-test group statistics for both etudes.

Table 4

Group Statistics for Lyrical and Technical Etude Composite Technical Skills Scores (TSS)

TSS Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error of Mean
Composite - Pretest, Lyrical Etude TSS	Smart Music & Teacher	23	9.6087	3.66205	.76359
	Teacher	23	9.9710	3.99863	.83377
Composite - Pretest, Technical Etude TSS	Smart Music & Teacher	23	7.4203	2.72330	.56785
	Teacher	23	9.1014	3.59213	.74901
Composite - Posttest, Lyrical Etude TSS	Smart Music & Teacher	23	13.3043	3.39327	.70755
	Teacher	23	12.4203	3.88238	.80953
Composite - Posttest, Technical Etude TSS	Smart Music & Teacher	23	12.7971	3.76284	.78461
	Teacher	23	12.5942	3.90022	.81325

For the lyrical etude TSS_l, the ANCOVA pre-test covariate made a significant adjustment ($p < .001$), but the grouping variable did not demonstrate a statistically significant difference $F(1, 43) = 2.89$, $p = .097$. The covariate-adjusted mean for the SmartMusic® assessment group ($mean_{adj} = 13.44$) exceeded the respective mean of the control group ($mean_{adj} = 12.29$) indicating a larger, though not statistically significant, effect for the experimental group.

For the technical etude TSS_t, the ANCOVA pre-test covariate made a significant adjustment ($p < .001$) while the grouping variable showed a statistically significant difference $F(1, 43) = 4.29$, $p =.044$. The covariate-adjusted mean for the SmartMusic®

assessment group ($mean_{adj}$ = 13.53) exceeded the respective mean of the control group ($mean_{adj}$ = 11.86) indicating a larger effect for the experimental group. The strength of the relationship between music performance and instruction using SmartMusic® assessment, as determined by η^2 was moderate, with SmartMusic® accounting for 9% of the variance in post-test technical etude performance scores.

Separate ANCOVAs using three-judge composite music performance scores (MPS) for the lyrical etude (MPS_l) and the technical etude (MPS_t) were conducted to determine the difference in music performance among students receiving instruction with or without SmartMusic® assessment. The MPS minimum and maximum possible scores range from 6 (low) to 30 (high). The MPS lyrical etude mean scores for the SmartMusic® group improved from 13.41 to 18.35, pre- to post-test while the teacher-led group improved from 13.72 to 17.16. The MPS technical etude mean scores showed similar results. The SmartMusic® group moved from 10.54 to 17.54 pre- to post-test as the teacher-led group changed from 12.65 to 16.90. Table 5 reports the composite pre- and post-test group statistics for both etudes.

Table 5

Group Statistics for Lyrical and Technical Etude Composite Music Performance Scores (MPS)

MPS Group Statistics

	Group	N	Mean	Std. Deviation	Std. Error of Mean
Composite Lyrical Etude Pretest MPS	Smart Music & Teacher	23	13.4058	4.94102	1.03027
	Teacher	23	13.7246	5.12831	1.06933
Composite Technical Etude Pretest MPS	Smart Music & Teacher	23	10.5362	3.39896	.70873
	Teacher	23	12.6522	4.68231	.97633
Composite Lyrical Etude Posttest MPS	Smart Music & Teacher	23	18.3478	4.69201	.97835
	Teacher	23	17.1594	5.38973	1.12384
Composite Technical Etude Posttest MPS	Smart Music & Teacher	23	17.5362	5.36707	1.11911
	Teacher	23	16.8986	5.23338	1.09123

For the lyrical etude MPS_l, the ANCOVA pre-test covariate made a significant adjustment ($p < .001$) but the grouping variable did not demonstrate a statistically significant difference $F(1, 43) = 2.44$, $p = .126$. The covariate-adjusted mean for the SmartMusic® assessment group ($mean_{adj} = 18.47$) exceeded the respective mean of the control group ($mean_{adj} = 17.03$) indicating a larger, though not statistically significant, effect for the experimental group.

For the technical etude MPS_t, the ANCOVA pre-test covariate made a significant adjustment ($p < .001$) while the grouping variable showed a statistically significant difference $F(1, 43) = 6.03$, $p =.018$. The covariate-adjusted mean for the SmartMusic® assessment group ($mean_{adj} = 18.56$) exceeded the respective mean of the control group ($mean_{adj} = 15.88$) indicating a larger effect for the experimental group. The strength of the relationship between music performance and instruction using SmartMusic®

assessment, as determined by η^2 was moderate, with the computer program accounting for 12% of the variance in post-test technical etude performance scores.

For the lyrical and technical music etudes, both groups showed improvement from pre- to post-test. However, the pre- to post-test mean scores for the SmartMusic® assessment group showed a larger gain for both etudes on both MPS and TSS measures. Even though the gain was not statistically significant at the α=.05 level in all cases, the effect of the SmartMusic® assessment program is evident (figure 8 & 9).

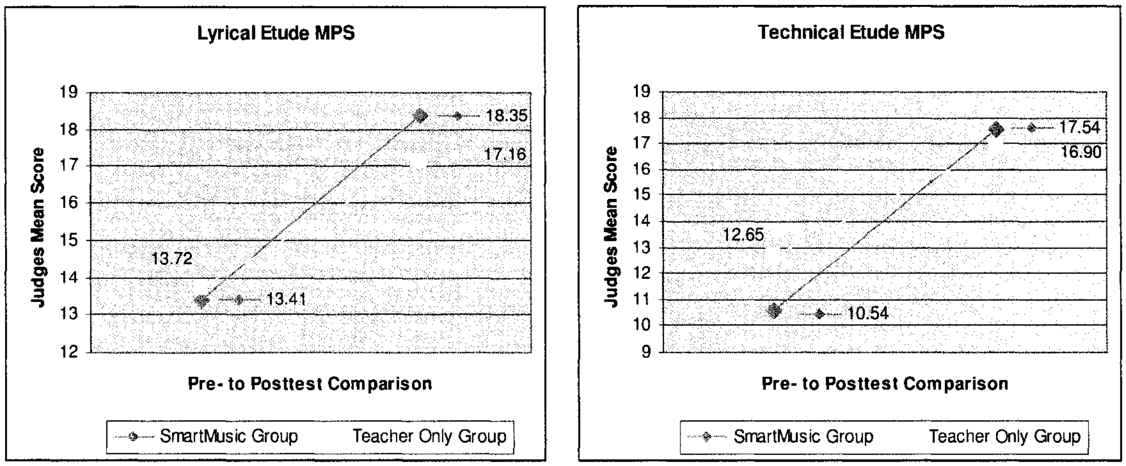


Figure 8. Pre- to Post-test Mean Music Performance Scores (MPS) for Both Etudes by Group.

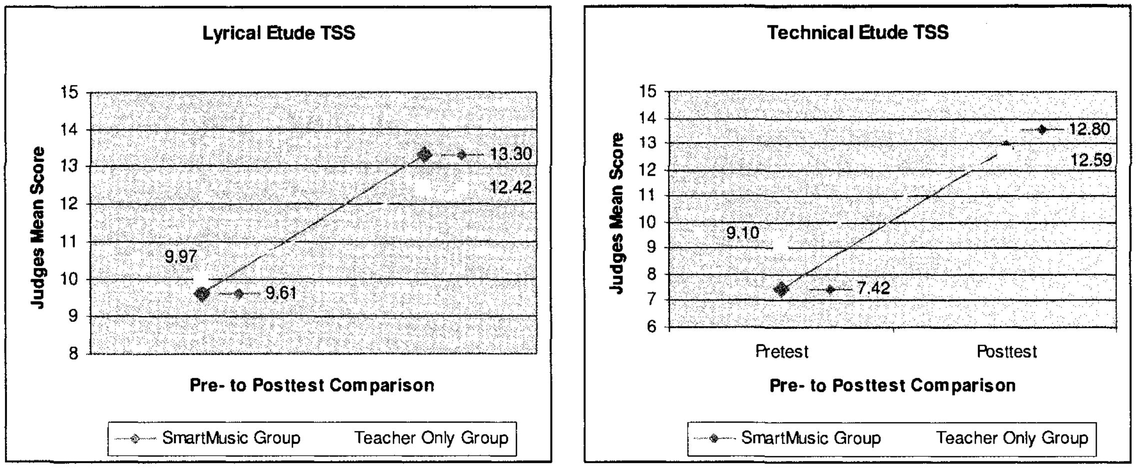


Figure 9. Pre- to Post-test Mean Technical Skills Scores (TSS) for Both Etudes by Group.

Question 2: Is SmartMusic® assessment an appropriate tool for examining student music performance, facilitating integration of applicable teaching and learning components?

Information gathered from participant pre- and post-test questionnaires portrays student perceptions regarding appropriate and applicable SmartMusic® assessment components. Comparing participant music performance with questionnaire data also provides insight regarding the same. Further qualitative evidence gathered from student surveys follows in the discussion section of Chapter V. All students completed the pre-test questionnaire, but four students failed to complete the post-test questionnaire, two from each group. Data below is based on 42 completed post-test questionnaires.

Several post-test questionnaire items addressed the appropriateness – usefulness – of SmartMusic® assessment as a tool for assessing student music performance. Assuming that assessment feedback affects music performance, improvement perceptions among study participants relate usefulness information. Considering improvement of music knowledge or skills, all respondents believed that they improved at least a little bit over the course of study. However, 48% of the SmartMusic® assessment group indicated that they improved "a fair amount" or "a lot," compared to 38% of the teacher-only group. Respective mean scores were 3.43 and 3.29, on a scale of 1 to 5. Ninety-five percent of the experimental group, when asked if they felt the computer program helped them improve their music knowledge or skills, indicated at least "a little bit," with 62% saying "somewhat," "a fair amount" or "a lot." When asked to rate SmartMusic® assessment, all experimental group students selected "average" or higher, with 52% choosing "above average" or "excellent."

No statistically significant relationships between student perception and music performance were found, despite the differences between groups noted above. However, research study constructs facilitated integrating SmartMusic® assessment with applicable – relevant – educational learning theories and instructional strategies. Study participants and instructor utilized the teaching and learning rubrics with applicable strategies (Appendix A & B) – applicable study design constructs. The instructor utilized the rubric and instructional strategies in every session for groups with or without the computer program. More than two thirds (73%) of the participants indicated that they used the practice rubric and found it helpful. After completing the study, students in both groups reported, on average, approximately 3 (relevant) strategies that were helpful to them (SmartMusic® group mean= 3.24 and teacher-only group mean 2.86), supporting the construct validity of the rubric and instructional strategies. As indicated above, students from the SmartMusic® group selected a greater number of helpful strategies. Of most relevance to the research question, 86% of the SmartMusic® group found the computer assessment feature helpful while 52% of the control group selected the comparable teacher assessment strategy. In addition to the earlier-discussed music performance data, these results suggest that SmartMusic® assessment is an appropriate – useful – tool for student assessment, facilitating integration of applicable teaching and learning components.

Question 3: Does SmartMusic® assessment provide an educationally justifiable medium, linked to motivation, for teaching knowledge and skills to music students?

Pre- and post-test questionnaires gathered student perceptions about the SmartMusic® assessment program. Justifiable links to educational theory and instructional strategy have already been established. Questionnaire data used in this section explored the relationship between motivation to use SmartMusic® assessment and learning. Further qualitative evidence through student comments follows in the discussion section of Chapter V. All students completed the pre-test questionnaire, but four students failed to complete the post-test questionnaire, two from each group. Data below is based on 42 completed post-test questionnaires.

All participants reported post-test perceptions about learning using the SmartMusic® assessment program. From the SmartMusic® group, 95% felt that the computer helped them at least "a little bit." Similarly, 100% of the control group felt that using a computer would help them improve their music knowledge or skills at least "a little bit," with 80% stating "somewhat," "a fair amount" or "a lot." Students from both groups –with or without the computer - felt that the music instruction helped them improve. However, speaking to the relationship between motivation and learning, student perceptions about learning using the SmartMusic® assessment program – real and hypothetical – suggest a similar optimism regarding technology use.

Practice time outside teacher-led lessons indicates willingness to improve, thus indirectly, motivation to learn. Ninety-four percent of the SmartMusic® assessment group reported individual practice "a little bit," "sometimes" or "a fair amount." Eighty-seven percent of the teacher-only group indicated comparable individual practice time. The combined responses from both groups, when asked if they would practice more if they could use SmartMusic® assessment to practice on their own, showed 62% answering "a little more," "probably" or "definitely." Student perceptions about individual practice using the SmartMusic® assessment program – real and hypothetical – suggest continued motivational appeal regarding technology use.

CHAPTER V

SUMMARY

Integration of technology in education has extensive historical roots. Recent attention to technology phenomena is more reflective of significant inventions than a passing educational fad. Just as the transistor made portable radios possible – an idea virtually unfathomable at that time – micro-processors charted the course for computers to become a societal necessity. Realizing the potential of new inventions is part of the development process. The marriage of education and technology is still in the honeymoon phase. However, efforts to integrate education and technology have resulted in numerous successful ventures. These manifestations include incorporation of educational learning theories and time-honored instructional strategies with emerging technologies. Therefore, it is appropriate and logical to assume that music technology, if implemented properly, will serve a similar and integral purpose.

Literature and Related Research Summary

Music technology is usually designed to teach or reinforce music knowledge and/or skills. Of the research studies completed to date on instructional music technology, most have focused on knowledge and skills. Several researchers have suggested the need for studies addressing the implementation of technology into teaching and learning environments. Of the relatively few studies available on SmartMusic® (and its predecessor Vivace®), many list the need for further research regarding its use and effectiveness. Additionally, most studies involving SmartMusic® used college students in various settings to simulate the experience of secondary school students. This study is one of the first to explore the SmartMusic® assessment features and one of the few to use the actual targeted audience for this educational software program – secondary school students. The assessment capabilities of SmartMusic® usher in a new era for music education technology – music performance assessment as a means of integrating teaching and learning strategies.

Results Summary

In both composite measures of music performance, the technical skills score (TSS) and music performance scores (MPS) showed parallel results. The lyrical etude TSS_l and MPS_l were not statistically different between groups receiving instruction with or without SmartMusic® assessment. However, there were significant differences in the technical etude TSS_t and MPS_t between instruction groups. The experimental group, utilizing SmartMusic® assessment, showed observable gains through higher mean scores in all measures of music performance for technical and lyrical etudes, though not all of the differences proved statistically significant. The data suggests that the SmartMusic® assessment program reinforces music performance skills, especially in technically oriented music passages. More study is necessary to determine if the program will affect musical performance for more lyrically oriented passages.

Based on student pre- and post-test surveys as well as study design constructs, SmartMusic® assessment is an appropriate and useful tool for student assessment with applicable teaching and learning components. Study design facilitated integrating the software with educational theories and strategies. While the educational components built into this study are not part of the SmartMusic® assessment software, the application of these ideas alongside the technology remains an important and educationally sound step to enhance learning. Students' initial impressions of SmartMusic® assessment indicated motivation to use the program. More study is needed to explore the continued appeal and long-term effects on student learning.

Results Discussion

During the lesson instruction, the researcher recorded observations regarding SmartMusic® assessment and study participant behavior. The software program presented potential benefits and obstacles. Many of these issues involve software design and function. Students also reacted to the SmartMusic® assessment program in different ways, necessitating additional considerations.

Researcher Observations

Error detection through visual (red and green notes, cursor, etc.) and auditory (recordings, metronome clicks, etc.) feedback provided extensive information facilitating teaching and learning strategies. Recording and listening to student performances encouraged student self-assessment. Visual feedback, i.e., red and green notes appearing after excerpt completion, reinforced student self-assessment. The metronome and cursor functions prompted "real time" corrections of rhythm errors, especially on longer note values. Fingering charts provided immediate information by pointing-and-clicking on any note. The tuner proved useful, especially when wrong (red) notes more aptly indicated severe intonation discrepancies. Tempo adjustments, immediate and incremental – using the cursor, clicks or both – provided secure pulse while building technical facility at increasing speeds. Practice loops allowed isolation of difficult passages to correct and improve technical errors.

Most significantly, the SmartMusic® assessment program fostered an interactive, learner-centered paradigm, empowering the student to direct his or her own learning from immediate, succinct and unequivocal feedback. As discussed in the literature review, e.g. Bond (2002), the role of the teacher also changes in a student-centered learning paradigm to guiding instruction rather than controlling it. The additional instructional resource provided by SmartMusic® program provides profound implications for individual practice. Because "practice makes permanent" (original source unknown), proper acquisition of music performance skills during individual practice sessions becomes paramount.

Benefits

Several SmartMusic® assessment program functions increased learning efficiency. When using the cursor function during performance, rhythm inconsistencies became immediately evident. Some adept students made real-time corrections; others noted the errors and commented at the conclusion of the performance. A few others found the cursor distracting – the program has a visual to auditory synchronization issue. Using metronome clicks without the cursor proved effective for these students. In all cases, this feedback instantly communicated the problem and facilitated student self-correction – a purposive application of contextualized learning.

Relating to Jorgensen's (2004) execution phase of individual practice, SmartMusic® assessment assists with one unproductive, but commonly observed student music performance behavior – continuously interrupting performance. Without frequent reminders, many students stop and start often, perpetuating the same cycle and hindering acquisition of necessary skills. Progress beyond the first problem section is often limited and lacks efficiency. Using the SmartMusic® assessment cursor (or accompaniment, if available) encourages the musician to continue performing until the end of the section.

Consistent with Jorgensen's (2004) views on individual practice, analyzing a larger section before selecting specific strategies for improvement is necessary for several reasons: 1) it simulates real music performance (contextual); 2) it provides the opportunity to gather information on numerous (and often repeated) musical issues; 3) it promotes greater understanding of the larger musical phrase (big picture); 4) it helps the learner (and teacher) prioritize and formulate comprehensive inter-related (as opposed to isolated) strategies for improvement. Colwell (2002) and Goolsby (1999) point out that students and teachers will see more efficient and lasting results after pursuing inter-connected strategies.

In addition to numerous benefits highlighted earlier, the researcher noted some miscellaneous anecdotal benefits of SmartMusic® assessment. The mouse tool provided an effective pointer to indicate specific points of interest on the music page. Finger charts, though lacking chromatic fingerings, aided student performance. The note name identification in combination with the fingering chart reinforced identification of accidentals lasting for the entire measure. Some students found listening to the recording of their own performance helpful, even motivational. With regard to pitch accuracy, especially for struggling brass players, the red & green assessment feedback helped pinpoint errors. This observation proved especially true for melodic lines containing large skips.

Obstacles

Setting aside the amount of time and cumbersome process to create SmartMusic® assessment files through Finale®, set-up/start-up time is a pivotal obstacle. The multi-menu start-up process has some potential shortcuts – though this researcher found that they would be more useful for an individual user who uses the same files on a regular basis. An example of the multi-menu process appears in figure 10.

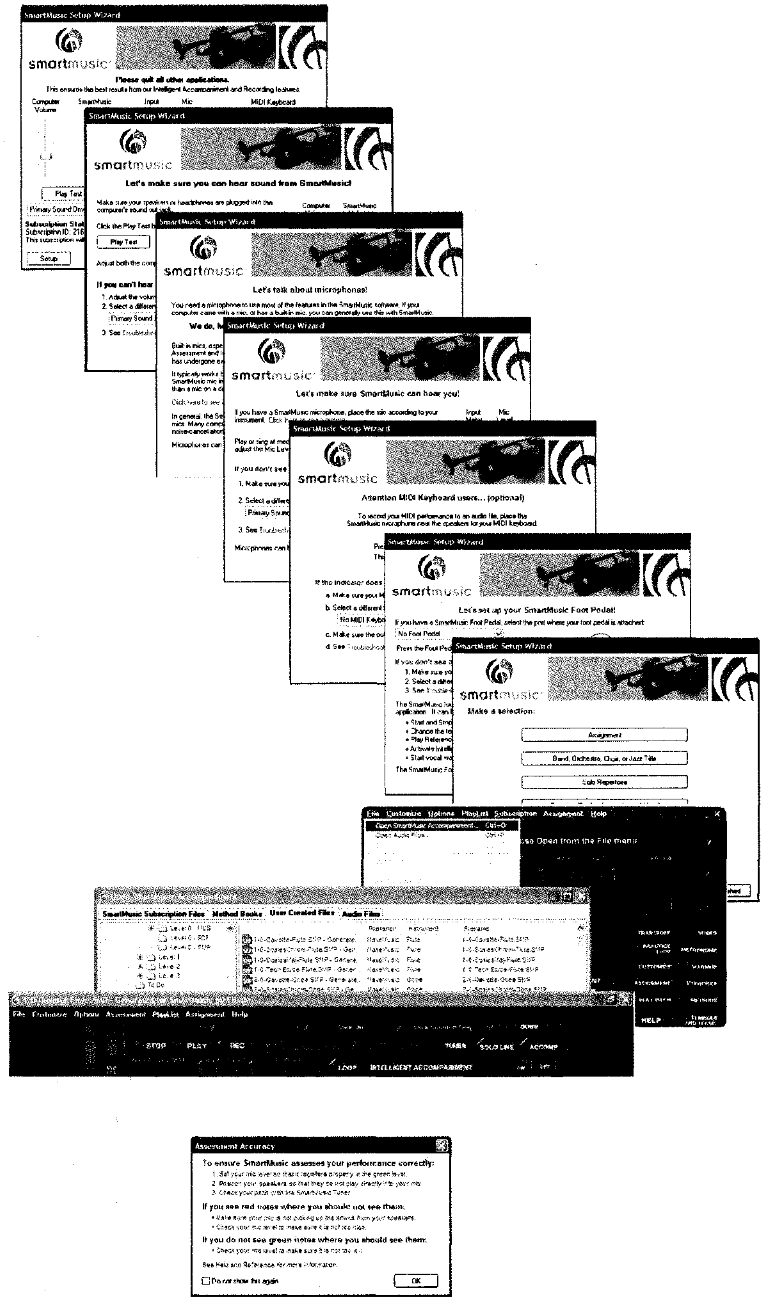


Figure 10. The SmartMusic® Multi-menu Start-up Process.

One of the study design components included the researcher operating the software to ensure efficient and consistent use of the program. Despite that precautionary measure, the typical set-up time was over one minute – an eternity when lessons are only fifteen minutes each. Each student set-up required proper microphone placement, microphone level adjustment (to ensure accurate software operation and appropriate recording) and computer volume adjustment. After set-up, in addition to an abnormally lengthy software start-up initialization, opening the program requires a multi-step process, wading through several dialogue boxes and menus to access the correct files. Since the program routinely checks for updates upon start-up, this process required additional time. Though SmartMusic® allows the user to terminate the update process, eventual updates are necessary and occasionally required as much as an hour – despite a T3 broadband internet connection. All of these details preceded music-making. Of related concern, saving performance recordings of only 30 to 45 seconds required a seemingly disproportionate amount of time – ranging from 15 seconds to nearly one minute.

Properly adjusting the microphone level ensures accurate assessment and quality performance recordings. Yet, finding the correct mic level often proves tricky. The adjustment controls, though easy to use, do not provide enough dynamic range to accommodate effectively all band instruments. Student performance using an appropriate dynamic range for musical expression can easily exceed the upper and lower microphone level thresholds. This fact results in distorted playback or missing assessment (absence of red or green on assessment page). Experimenting with microphone placement and real-time mic level adjustments (though impractical for individual practice) proved successful to minimize these effects.

Other miscellaneous obstacles follow below. In addition to microphone level adjustment, intonation plays a significant role in accurate assessment. For developing musicians, this fact provides instructional opportunities, but requires additional time and explanation. Students using on-screen notation do not benefit from pencil markings listed on their own music. Yet viewing the screen is necessary to take advantage of most of the SmartMusic® assessment components. In the same manner, students using the onscreen notation cannot highlight or create markings on paper to help improve their performance.

Software Limitations

The researcher noted several software limitations during this study. Some visual aspects of the program when displaying music notation are distracting. The software attempts to equally justify and display the same number of measures on each line, presenting two problems: 1) notation usually appears different on-screen than on paper; 2) a pick-up measure or a rhythmically busy measure occupies the same amount of space as a normal measure. This results in some measures elongating and some appearing crunched. The cursor appears at times to move in asynchronous movements to maintain proportionate beats. Students were distracted at times by the incongruity. The potential effects on rhythmic execution were noted by the researcher but not quantitatively analyzed in this study.

Some visual aspects of the assessment feedback relating to rhythmic performance require additional attention. Currently, if a student begins the correct note at the correct time, the assessment feedback shows a green (correct) note. Holding the note for the proper duration is not part of the assessment feedback. When viewing the feedback, students typically notice the red (wrong) notes first, though duration errors are not indicated, potentially leading the performer to incorrect conclusions.

Though students were eventually able to adjust to another visual element, splitting the screen to accommodate continuous display provided confusion. The green line used to indicate the split proved inadequate to delineate the change. The momentary flash as the top half of the page disappeared and reappeared with new notation often distracted the performer. Upon completion of the visible page, students learned to look to the top of the page to continue performing.

Synchronization of student performance to computer is necessary for accurate assessment. A correct performance displaced by one count will appear entirely incorrect (red notes) upon completion of the excerpt. While understandable, this problem becomes more difficult to accommodate when using metronome countoffs and practice loops. The computer adjusts the first measure countoffs for anacrusis (partial measure beginnings or pick-up notes), but no such feature exists for practice loops. The result requires the performer to employ amusical methods (full measure repeats or rhythmic displacement) for phrases involving anacrusic beginnings. Additionally, the assessment feature is not available for practice loops.

Following completion of the musical excerpt, the computer screen is filled with assessment feedback – especially if errors were made. In order to view the original notation, the performer must clear the screen (by starting the assessment again or reloading the file). A simple clear-screen function would solve this problem. Another software improvement already in the works, a more sophisticated microphone interface respective of instrument with additional controls indicating "recording in progress" would prove useful.

Student Rhythm Performance Observations

Without intervention, students with rhythm problems (especially cutting-off longer note values) often do not catch their mistakes and continue to make the same mistake upon subsequent performance of the passage. Likewise for some students, tempi are erratic, unless assisted by a metronome (or musical accompaniment). Other rhythm problems include the fact that the SmartMusic® assessment tool does not allow for performance of note values exceeding a sixteenth note. For mallet percussion students this fact presented a specific issue – rolls; this researcher observed frequent rhythm mistakes of long note values (typically two beats or longer). Adding rolls back to the music performance usually corrected the mistake.

An unforeseen side-effect of SmartMusic®, some struggling students using the cursor (without clicks) continuously skipped ahead, producing a jerky, hiccup performance, asymptomatic of musical artistry. In this scenario, keeping up with the cursor actually hindered the students' ability to improve music knowledge or skills. Depending on the student, using metronome clicks only, or clicks in combination with the cursor and/or allowing students to self-select a tempo, greatly improved the results. However, one student produced such an erratic performance, that none of the above approaches proved helpful. Ceasing foot tapping provided the best results in this case. These observations suggest the need for further study of successful rhythmic performance strategies in combination with SmartMusic® assessment.

Recommendations for Further Research

Opportunities for further investigation of this emerging technology abound. Though fraught with many potential pitfalls, experimental research studies using larger, diverse and multiple samples of secondary students remains a pressing issue, especially relevant to the future of the technology. Mixed results from several studies, including this one, showed observable mean score differences – though not statistically significant ones – between experimental and control groups (Ouren, 1997; Lee, 2007; Sheldon, Reese & Grashel, 1999). These results highlight the need for more study using larger sample sizes and to develop valid and reliable music performance measurement tools.

Longitudinal studies are necessary to establish a record of the long-term effects of SmartMusic® assessment and the Interactive Pyware Assessment System®. Comparisons between the competing programs may highlight efficacy issues while technical differences as well as practical ones should be considered. Differences in performance for students using these assessment programs at various experience levels will suggest appropriate use of the technology. In light of this study's findings, more investigation of the assessment programs' effects on lyrical music passages is needed to determine the relevance and/or statistical significance of these applications.

During the course of this project, dramatic improvements of the SmartMusic® software affected the direction of this study. In the exploratory phase of the research, Finale Performance ® assessment was the original target for study, as SmartMusic® assessment did not exist. It is therefore logical to assume that continued development brings increased applications of the technology and fosters additional research questions. One development, the online, integrated grade book, SmartMusic® Impact, yields additional consideration as to the potential benefits of the technology – particularly regarding authentic assessment. For a brief overview of SmartMusic® Impact, see Criswell (2007), *Student Assessment for the Digital Age.* The relationship of technology assessment to learning, the effects of tracking student achievement and the feasibility of implementing online assignments provide a potential starting point, as well as implications for manageable longitudinal study.

Of most interest to this researcher, discovering the effects of integrating technology and learning theory provide substantial room for exploration. Connecting learning theory to technology should remain as evident as utensils are to cooking. Extrapolating from this study, more investigation is needed on the interactive effects of multiple combinations of variables including learning exercises, teacher instruction, SmartMusic® assessment, SmartMusic® percentage scoring assessment, student operation of SmartMusic® and the SmartMusic® Impact grade book.

Implications for Teachers

Several obstacles to integrating technology in the educational environment exist. The cost of hardware, software and infrastructure is often restrictive. The recent rapid advances in technology also create a major limitation to its widespread use – keeping up with new developments. A Bartlett, Nebraska high school teacher states, "Today's gadget can be tomorrow's Atari 500 [an early 1980's computer system]... with all the demands put on teachers, it can be hard to stay current" (Kopkowski, 2006). Both from a cost and a practical viewpoint, keeping up with developments is a continuous task.

Extensive training to set-up, troubleshoot and fully utilize the software capabilities becomes a potential problem. In a survey of Florida music educators, Tredway (1994) found that the non-instructional use of technology for surpassed the educational applications. However, with the advancements in technology since 1994, that may no longer be the case. Kopkowski (2006) cites the experience of a Creswell, Oregon elementary school teacher who vividly remembers her initial overwhelming reaction to the thought of integrating technology in her classroom. Two years later and after sufficient training, the teacher and students regularly use handheld computers in their second grade classroom. In another recent case, a Minneapolis suburban middle school band director explained that his music department purchased iPods and that the music teachers use them regularly in their classrooms (S. Prescott, personal communication, April 12, 2006). He continued to express the practical advantage of accessing multiple recordings without the bulkiness of carrying numerous CDs.

Many software programs have a finite capacity for instructional purposes because they focus on basic level teaching strategies, such as drill and rote methods. Though SmartMusic® will exceed these limitations imposed by other software programs, an investment of time, energy and money is necessary.

Conclusion

Like any educational tool, SmartMusic® assessment is not a panacea. However, purposefully integrating this technology with other effective teaching methods and materials promotes the desired outcome – student learning. The results of this study highlight the need for further investigation, but also show that SmartMusic® assessment has a definite place in a diverse pedagogical music education arsenal. Teachers must be aware of the limits, but they also should not ignore the potential benefits. Especially in the current era of accountability, SmartMusic® assessment can become an efficient means to document student progress. Further exploration is needed to determine whether this music technology will have long-term effects on music education or music educators.

APPENDIX A

Student ID# ____________

Student Practice Rubric & Record

Date of Practice Session	-	-	-	-	-
Length (in minutes)	-	-	-	-	-
Scale _______________					
Tempo (mm) *	-	-	-	-	-
** Keep same mm for all 3 scale patterns*					
Scale Technical Exercise _______________					
Tempo (mm)	-	-	-	-	-
Melodic Musical Excerpt _______________					
Tempo (mm)	-	-	-	-	-
# Problem measures	-	-	-	-	-
Technical Musical Excerpt _______________					
Tempo (mm)	-	-	-	-	-
# Problem measures	-	-	-	-	-

Practice Strategies

1. Practice exercises in the order given.
2. Use a metronome.
3. Practice slowly – Only increase tempo if exercise is played correctly (that's 100%).
4. Find and circle your problem measures.
5. What caused the problem? (notes, fingerings, rhythm, range, articulation, tempo, etc..)
6. At a slower tempo, after making appropriate corrections, practice problem spot only-don't always start at the beginning! (Create a practice loop using only problem spot).
7. When problem spot is fixed, make a larger practice loop – using measure(s) or phrase(s) before and/or after.
8. What went well? What could be better? Identify areas to practice next time.

APPENDIX B

Student ID# ____________

Instructor Progress Chart & Rubric

	Session #	1	2	3	4	5
Scale ____________						
	Tempo (mm) *	-	-	-	-	-
	** Keep same mm for all 3 scale patterns*					
Scale Technical Exercise ____________						
	Tempo (mm)	-	-	-	-	-
Melodic Musical Excerpt ____________						
	Tempo (mm)	-	-	-	-	-
	# Problem measures	-	-	-	-	-
Technical Musical Excerpt ____________						
	Tempo (mm)	-	-	-	-	-
	# Problem measures	-	-	-	-	-

Practice Strategies

1. Practice exercises in the order given.
2. Use a metronome.
3. Practice slowly - Only increase tempo if exercise is played correctly (that's 100%).
4. Find and circle your problem measures.
5. What caused the problem? (notes, fingerings, rhythm, range, articulation, tempo, etc..)
6. At a slower tempo, after making appropriate corrections, practice problem spot only-don't always start at the beginning! (Create a practice loop using only problem spot).
7. When problem spot is fixed, make a larger practice loop - using measure(s) or phrase(s) before and/or after.
8. What went well? What could be better? Identify areas to practice next time.

APPENDIX C

CD#: «CD_» **Example #: «Example_»**
Track #: «Track_»

Performance Adjudication Form

INSTRUMENT: «Instrument»______________________________

SELECTION TITLE: «Selection»______________________________

See Scoring Rubric – 5 (high) to 1 (low)

SCORE	CATEGORY/criteria	COMMENTS
	TONE clarity, consistency, control, focus, warmth	
	INTONATION/PITCH ACCURACY accuracy to printed pitches, consistency of pitch	
	RHYTHM accuracy of note and rest values, correctness of meters, duration, pulse, steadiness	
	TECHNIQUE attacks, releases, control of ranges, mechanical skill	
	INTERPRETATION/MUSICIANSHIP dynamics, emotional involvement, artistry, phrasing, style, tempo	
	BOWING – Strings **ARTICULATION – Winds** **EXECUTION – Percussion**	

_______ **TOTAL**

_______ **Did the student maintain the given tempo? Y/N**

_______ **Did the student maintain a mostly steady tempo? Y/N**

Judge's Signature ______________________________ **Date** _______

APPENDIX D

Music Performance Evaluation Rubric

CATEGORY	5	4	3	2	1
Tone Quality	Tone is consistently focused, clear, and centered throughout the range of the instrument. Tone has professional quality.	Tone is focused, clear and centered through the normal playing range of the instrument. Extremes in range sometimes cause tone to be less controlled. Tone quality does not detract from the performance.	Tone is usually focused, clear and centered with minor inconsistencies in the normal playing range. Extremes in range present noticeable problems. Occasionally the tone quality detracts from the performance.	Tone is sometimes focused, clear and centered but often it is uncontrolled in the normal playing range. Extremes in range are usually uncontrolled. Often the tone quality detracts from the performance.	The tone is often not focused, clear or centered regardless of the range being played, significantly detracting from the performance.
Intonation/ Pitch Accuracy	Virtually no errors. Pitch and note accuracy is very precise.	An occasional isolated error, but most of the time pitch and note accuracy is correct and secure.	Noticeable intonation errors or wrong notes begin to detract from the performance.	Some accurate pitches and intonation, but there are frequent and/or repeated errors.	Very few accurate or secure pitches and many wrong notes.
Rhythm	The beat is secure and the rhythms are accurate for the style of music being played.	The beat is secure and the rhythms are mostly accurate. There are a few duration errors, but these do not detract from the performance.	The beat is usually secure and the rhythms are mostly accurate. A few duration errors begin to detract from the performance.	The beat is somewhat erratic. Some rhythms are accurate. Frequent or repeated duration errors. Rhythm problems detract from the performance.	The beat is usually erratic and rhythms are seldom accurate detracting significantly from the overall performance.

APPENDIX D (continued)

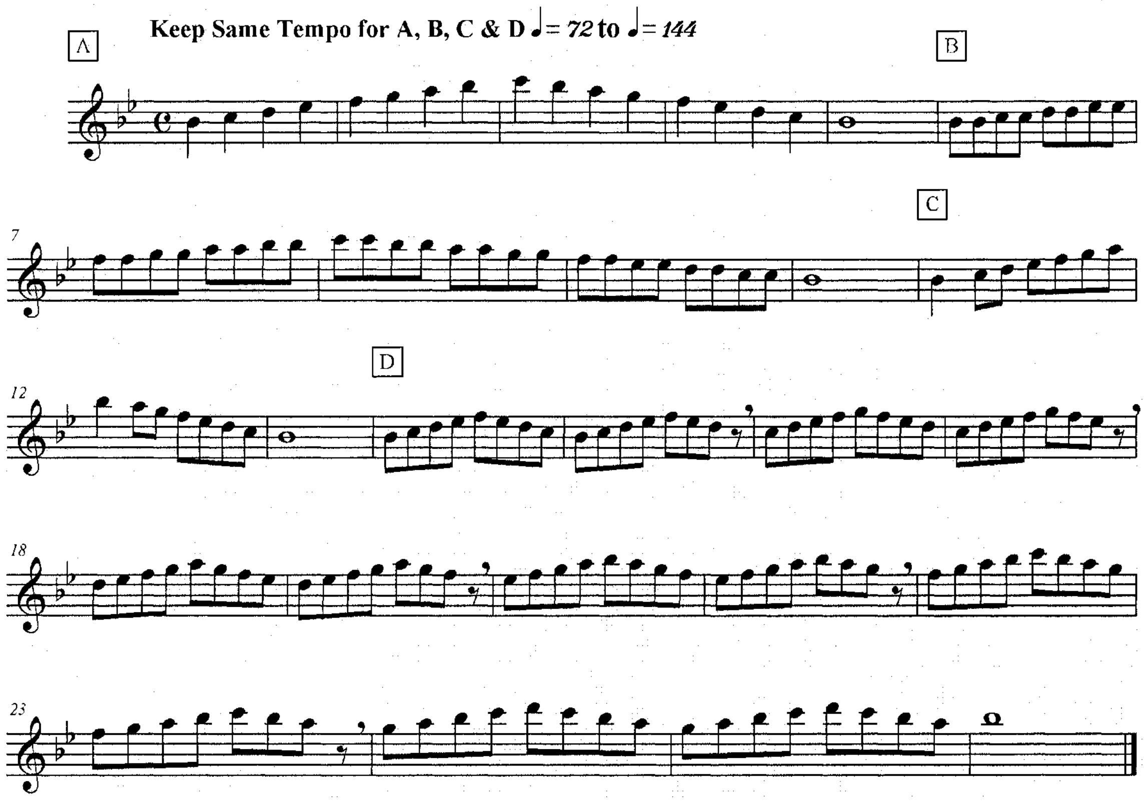
Technique	Proper attacks, releases and control are consistent. Facility is plainly evident.	Attacks, releases and control are usually consistent. Facility is usually adequate and does not detract from the performance.	A few attacks, releases and control issues are evident, detracting somewhat from the overall performance.	Many attacks, releases and control issues are evident, detracting from the performance.	Attacks, releases and control issues consistently detract from the performance.
Interpretation/ Musicianship	Performs with creative nuance, artistry, phrasing and expressive musical style in response to the score.	Typically performs with nuance, artistry, phrasing and expressive musical style.	Often performs with proper phrasing and style, but artistry is often lacking nuance or sufficient musical expression.	Sometimes attempts to perform with proper musical expression, phrasing and style, but artistry is lacking.	Rarely demonstrates expression and style - just plays the notes.
Bowing-Strings Articulation-Winds Execution-Perc.	Markings (staccato, legato, slur, accents, etc.) are executed accurately as directed by the score.	Markings are usually executed accurately as directed by the score.	Some markings are not executed accurately as directed by the score and begin to detract from the performance.	Many markings are not executed accurately as directed by the score and noticeably detract from the performance.	Markings are typically not executed accurately.

APPENDIX E

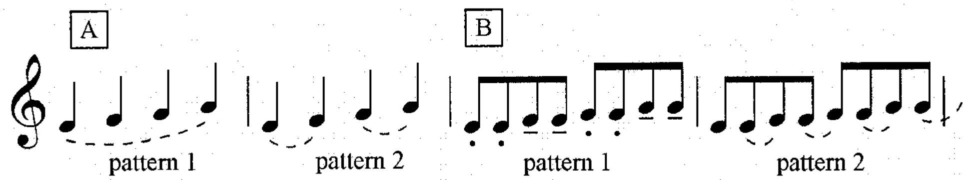
Flute

Skill Development Exercise - Lyrical Etude

M. Buck



Further Study – Use these articulation patterns in the above exercises. Also, create your own patterns.



APPENDIX F

Lyrical Etude

Flute

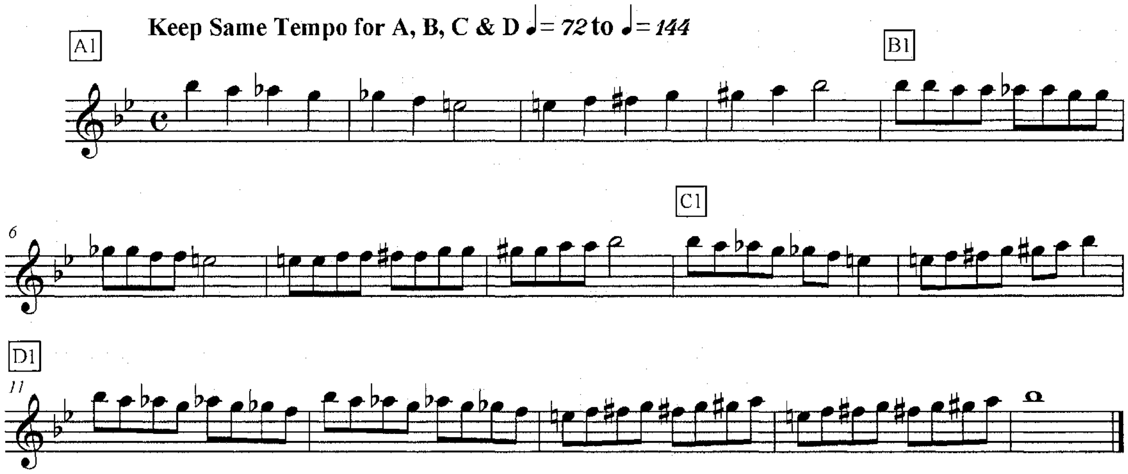
Gavotte

G.F. Handel
adapted by M. Buck

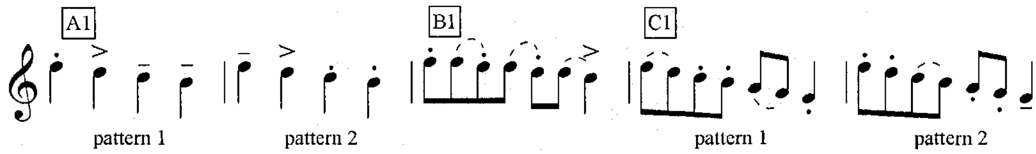
APPENDIX G

Flute **Skill Development Exercise - Technical Etude**

M. Buck



Further Study – Use these articulation patterns in the above exercises. Also, create your own patterns.



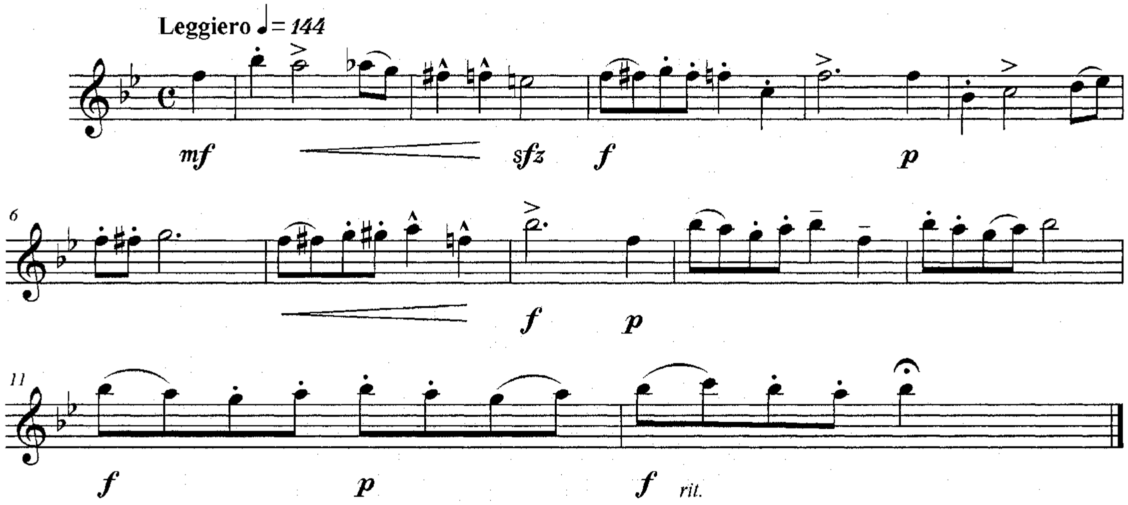
APPENDIX H

Technical Etude

Flute

Technical Etude

M. Buck



APPENDIX I

Music Lessons and SmartMusic® Research Study

What

HHS Band and orchestra students have the opportunity to receive free music lessons, learn some individual practice techniques and participate in a research study involving SmartMusic®.

Things to Know

Participation is strictly voluntary!

Yes, the lessons are free!

Mr. Buck is conducting a research project but, you do not need to participate in the project to get the free lessons.

Why

Research is needed to determine if a computer-based performance assessment program called SmartMusic® can help music students learn. You can volunteer to participate in this project. Please note that you can end your participation in the study at any time, for any reason - and you can still receive the remaining free lessons.

How it works

Student participants in the study will be asked to:

- attend a 30 minute training/information session
- attend five music lessons of 15-20 minutes each
- complete a short questionnaire (before and after)
- be willing to record your music performance
- Bring your instrument - all other equipment will be provided.
- Some students will work with just a music teacher; some students will study with a teacher using the SmartMusic® software.
- All data collected will remain confidential. Only HHS Student ID numbers will identify participants during the research.

For more information, contact Michael Buck.

This project has been reviewed by the Human Subjects Protection Review Committee, which ensures that research projects involving human subjects follow federal regulations. Any questions or concerns about rights as a research subject should be directed to the chair of the Institutional Review Board, The University of Southern Mississippi, 118 College Drive #5147, Hattiesburg, MS 39406-0001, (601) 266-6820.

APPENDIX J

THE UNIVERSITY OF SOUTHERN MISSISSIPPI

Institutional Review Board

118 College Drive #5147
Hattiesburg, MS 39406-0001
Tel: 601.266.6820
Fax: 601.266.5509
www.usm.edu/irb

HUMAN SUBJECTS PROTECTION REVIEW COMMITTEE
NOTICE OF COMMITTEE ACTION

The project has been reviewed by The University of Southern Mississippi Human Subjects Protection Review Committee in accordance with Federal Drug Administration regulations (21 CFR 26, 111), Department of Health and Human Services (45 CFR Part 46), and university guidelines to ensure adherence to the following criteria:

- The risks to subjects are minimized.
- The risks to subjects are reasonable in relation to the anticipated benefits.
- The selection of subjects is equitable.
- Informed consent is adequate and appropriately documented.
- Where appropriate, the research plan makes adequate provisions for monitoring the data collected to ensure the safety of the subjects.
- Where appropriate, there are adequate provisions to protect the privacy of subjects and to maintain the confidentiality of all data.
- Appropriate additional safeguards have been included to protect vulnerable subjects.
- Any unanticipated, serious, or continuing problems encountered regarding risks to subjects must be reported immediately, but not later than 10 days following the event. This should be reported to the IRB Office via the "Adverse Effect Report Form".
- If approved, the maximum period of approval is limited to twelve months.
  Projects that exceed this period must submit an application for renewal or continuation.

PROTOCOL NUMBER: **27101801**
PROJECT TITLE: **The Efficacy of SmartMusic Assessment as a Teaching and Learning Tool**
PROPOSED PROJECT DATES: **08/01/07 to 06/01/08**
PROJECT TYPE: **Dissertation or Thesis**
PRINCIPAL INVESTIGATORS: **Michael Buck**
COLLEGE/DIVISION: **College of Arts & Letters**
DEPARTMENT: **Music**
FUNDING AGENCY: **N/A**
HSPRC COMMITTEE ACTION: **Expedited Review Approval**
PERIOD OF APPROVAL: **10/25/07 to 10/24/08**

Lawrence A. Hosman (signature) — 10-29-07

Lawrence A. Hosman, Ph.D. — Date
HSPRC Chair

APPENDIX K

Pre-test Questionnaire

SmartMusic® Assessment as a Teaching and Learning Tool

Name: **Age:** **Birthdate: (mm/dd/yyyy):**

HHS Student ID#: **Instrument:** **Gender:** Male Female

Current grade level: **How many years have you played your current instrument? (include this year)**

Do you play any other instruments (not closely related to your current instrument)?
If so, list here:

Which kind of music groups do/have you participated in? (Circle all that apply)
Band Orchestra Choir Marching Band Pep Band Jazz Band
Solo or Chamber Ensemble Private lessons (any music instrument) Community Music Group (GTCYS, MacPhail, MYS, etc.) Church Music group Other:

How would you rate your *musical* ability/aptitude?
Extremely Poor Below Average Average Above Average Excellent

How would you rate your *computer* ability/aptitude?
Extremely Poor Below Average Average Above Average Excellent

How would you rate your s*chool or academic* ability/aptitude?
Extremely Poor Below Average Average Above Average Excellent

How often do you practice your instrument?
Rarely A little bit Sometimes A fair amount A lot

Which category best describes the reason you practice your instrument? (choose <u>all that apply</u>)
I don't practice
My parents make me practice
I only practice when I have an assignment, chair audition, lesson, etc.
I practice to relieve stress or concentrate on something other than homework, parents, etc.
I practice because I enjoy playing my instrument
I practice because I want to get better
Other:

If you could use a computer when you practice your instrument, how much would you practice?
Rarely A little bit Sometimes A fair amount A lot

Which computer platform do you use most often? PC Mac

Have you ever used *SmartMusic*® or any *other music software*? **Yes or No**
If so, *SmartMusic®?*
Finale (or other music notation software)?
Other – list here:

APPENDIX L

Post-test Questionnaire - Yellow Group

SmartMusic® Assessment as a Teaching and Learning Tool

HHS Student ID#: **Initials:**

Was your assignment: **too easy** **about right** **too hard**

Did you use the Student Practice Rubric (Blue Sheet)? **Y/N**

Did you find the rubric suggestions helpful?

Not at all A little bit Somewhat A fair amount A lot

Did you practice your instrument outside of the teacher-led lessons? Y/N If so, how much

Rarely A little bit Sometimes A fair amount A lot

As a result of these lessons, do you feel that you improved your musical knowledge or skills?

Not at all A little bit Somewhat A fair amount A lot

Do you feel that using a computer would help you improve your musical knowledge or skills?

Not at all A little bit Somewhat A fair amount A lot

If you could use a computer when you practice on your own, would you practice more?

Most likely not A slight chance A little more Probably Definitely

Which teacher-led strategies did you find *helpful?* (circle all that apply)

Metronome
Tuner
Tempo adjustment
Practice Loop
Teacher Verbal Assessment
Teacher asking for Self-Assessment
Recording
None of the above
Other:

Which teacher-led strategies did you find *troublesome?* (circle all that apply)

Metronome
Tuner
Tempo adjustment
Practice Loop
Teacher Verbal Assessment
Teacher asking for Self-Assessment
Recording
None of the above
Other:

Comments:

Thank you for your participation!

APPENDIX M

Post-test Questionnaire - Pink Group

SmartMusic® Assessment as a Teaching and Learning Tool

HHS Student ID#: **Initials:**

Was your assignment: **too easy** **about right** **too hard**

Did you use the Student Practice Rubric (Blue Sheet)? **Y/N**

Did you find the rubric suggestions helpful?

Not at all A little bit Somewhat A fair amount A lot

Did you practice your instrument outside of the teacher-led lessons? Y/N If so, how much

Rarely A little bit Sometimes A fair amount A lot

As a result of these lessons, do you feel that you improved your musical knowledge or skills?

Not at all A little bit Somewhat A fair amount A lot

Do you feel that the computer helped you improve your musical knowledge or skills?

Not at all A little bit Somewhat A fair amount A lot

If you could use a computer when you practice on your own, would you practice more?

Most likely not A slight chance A little more Probably Definitely

Overall, how would you rate *SmartMusic®?*

Extremely Poor Below Average Average Above Average Excellent

Which aspects of the computer program did you find *helpful*? (circle all that apply)

Metronome
Tuner
Tempo adjustment
Practice Loop
Assessment (Red/Green notes)
Recording
None of the above
Other:

Which aspects of the computer program did you find *troublesome*? (circle all that apply)

Metronome
Tuner
Tempo adjustment
Practice Loop
Assessment (Red/Green notes)
Recording
None of the above
Other:

Could you identify your problem areas without the help of the computer?

Not at all A few Some Many Most

Comments:

Thank you for your participation!

REFERENCES

Abeles, H. F. (1973). Development and validation of a clarinet performance adjudication scale. *Journal of Research in Music Education, 21,* 246-255.

Asmus, E. (1989). Computer-based modeling of music concepts for testing, evaluating, and refining theory. *PSYCHOMUSICOLOGY, A Journal of Research in Music Cognition*, *8*(2), 171-182. Retrieved August 24, 2008, from The Music Index Online database.

Asmus, E. (1999). Music assessment concepts. *Music Educators Journal*, *86*(2), 19.

Asmus, E. (2006). Quantitative analysis. In R. Colwell (Ed.), *MENC handbook of research methodologies* (pp. 95-175). New York: Oxford University Press.

Association for Technology in Music Instruction. ATMI Mission Statement. accessed March 30, 2006. http://atmionline.org/mission.htm.

Babbitt, M. (1983). Words about music. Stephen Dembski and Joseph N. Straus, eds. (Madison, WI: Univ. of Wisconsin Press.

Bartram, K. (2004). Lessons from a master: using the "Bernstein Formula" in music classrooms. *Music Educators Journal, 91,* 19-24.

Bennett, S. (1994) Can simple vocalization help improve the intonation of wind players? D.M.A. dissertation, Arizona State University, United States -- Arizona. Retrieved July 14, 2003 from Dissertations & Theses: Full Text database. (Publication No. AAT 9514867).

Bergee, M. J. (1988). Use of an objectively-constructed rating scale for the evaluation of brass juries: A criterion-related study. *Missouri Journal of Research in Music Education, 5*(5), 6-15.

Bernstein, L. Young People's Concerts, overview. Accessed March 25, 2006. http://www.leonardbernstein.com/youth.html.

Berz, W., & Bowman, J. (1994). Applications of research in music technology. Reston, VA: Music Educators National Conference.

Berz, W., & Bowman, J. (1995). An historical perspective on research cycles in music computer-based technology. Bulletin of the Council for Research in Music Education, 126. 15-28.

Bond, Austin (2002). Learning music online: An accessible learning program for isolated students. Retrieved July 9, 2008, from National Centre for Vocational Education Research. Web Edition ISBN 1 74096 096 3. Website: http://www.ncver.edu.au/research/proj/nr1013.pdf.

Bronson, B.H. (1949). Mechanical help in the study of folksong. *Journal of American Folklore, 62,* 81-86.

Buck, M. (1994). Developing musicianship through a systematic warm-up routine. Unpublished master's comprehensive project, VanderCook College, Chicago, IL.

Buck, M. (2001) CD ROM-a-lom-a ding dong meets MIDI the moocher: Integrating technology into the band, choir and general music classroom. Teacher workshop presented at the Near East South Asia conference, Istanbul, Turkey.

Burrack, F. (2002). Enhanced assessment in instrumental programs. *Music Educators Journal*, *88*(6), 27-32.

Codding, P. (1985) The effect of differential feedback on beginning guitar students' intonational performance in tuning strings (Computer-Assisted Instruction (CAI)). Ph.D. dissertation, The Florida State University, United States -- Florida. Retrieved July 15, 2003, from Dissertations & Theses: Full Text database. (Publication No. AAT 8524601).

Colwell, R. (1991). Basic concepts in music education, II. Niwot, CO: University Press of Colorado.

Colwell, R. (2002). Assessment's potential in music education. In R. Colwell & C. Richardson (Vol. Eds.) & J. J. Heller & N. DeCarbo (Part X Eds.), *The New Handbook of Research on Music Teaching and Learning* (pp. 1128-58). New York: Oxford University Press.

Copland, P. (2006). *Why 78, 45 and 33 1/3 record formats?* Retrieved March 25, 2006 from http://www.history-of-rock.com/record_formats.htm.

Criswell, C. (2007). Student assessment for the digital age. *Teaching Music, 15*(3), 46.

Dalby, B. (1989) A computer-based training program for the development of harmonic intonation discrimination skill. Ed.D. dissertation, University of Illinois at Urbana-Champaign, United States -- Illinois. Retrieved July 15, 2003, from Dissertations & Theses: Full Text database. (Publication No. AAT 8924801).

Delzell, J. (1989). The effects of musical discrimination training in beginning instrumental music classes. *Journal of Research in Music Education, 37*(1), 21-31.

Dixon, S. (2000). *Assessing the Performer*, Palatine Learning and Teaching Support Network. Retrieved June 6, 2008 from Palatine website: http://www.palatine.ac.uk/events/viewdoc/207/.

Duke, R., & Pierce, M. (1991). Effects of tempo and context on transfer of performance skills. *Journal of Research in Music Education*, 39 (2), 93-100.

Duke, R. (2005). *Intelligent music teaching: Essays on the core principles of effective instruction.* Austin, TX: Learning and Behavior Resources.

Eisele, M. (1985) Development and validation of a computer-assisted instructional lesson for teaching intonation discrimination skills to violin and viola students. D.Mus.Ed. dissertation, Indiana University, United States -- Indiana. Retrieved July 15, 2003, from Dissertations & Theses: Full Text database. (Publication No. AAT 8603297).

Eisner, E. (1999). Performance Assessment and Competition. *Education Digest*, *65*(1), 54.

Garnett, G. (2001). The aesthetics of interactive computer music. *Computer Music Journal*, *25*(1), 21-33. Retrieved February 27, 2006, doi:10.1162/014892601300126089

Goff, B. (1996). Technology in the college trumpet studio: Vivace. *ITG Journal 21*(1), 24-26.

Goolsby, T. (1999). Assessment in instrumental music. *Music Educators Journal*, *86*(2), 31. Retrieved August 19, 2008, from Professional Development Collection database.

Gordon, E. (1986). *Intermediate measures of music audiation.* Chicago: G.I.A. Publications, Inc.

Heller, J., & O'Connor, J.P. (2006). Maintaining Quality in Research and Reporting. In R. Colwell (Ed.), *MENC handbook of research methodologies* (pp. 38-72). New York: Oxford University Press.

Henry, J. (1991) The effect of a systematic choral warm-up strategy on student pitch-matching skills, knowledge of intonation concepts, and self-reported attitudes toward singing. D.M.A. dissertation, University of Missouri - Kansas City, United States -- Missouri. Retrieved July 15, 2003, from Dissertations & Theses: Full Text database. (Publication No. AAT 9208063).

Hess, G. J. Jr. (1998). The computer literacy of prospective music students: A survey. Retrieved March 30, 2006 from http://music.utsa.edu/tdml/conf-VI/VI-Hess.html.

Higgins, W.R. (1991). Technology. In R. Colwell (ed.), *Handbook of research on music teaching and learning.* New York: Schirmer Books.

Jones, R. (1957). Current trends and new directions in educational research. *Journal of Research in Music Edducation, 5,* 16-22.

Jorgensen, H. (2004). Strategies for Individual Practice. In Williamon, A. (Ed.) *Musical Excellence: Strategies and techniques to enhance performance,* (p.85-104). Oxford University Press, New York.

Kopkowski, C. (2006). Ready to Upgrade? *NEA Today, 24*(6), 24-31. publication of the National Education Association, March 2006

Labuta, J., & Smith, D. (1996). *Music education: Historical contexts and perspectives.* Upper Saddle River, New Jersey: Prentice Hall.

Lee, E. (2007). A study of the effect of computer assisted instruction, previous music experience, and time on the performance ability of beginning instrumental music students. Ph.D. dissertation, The University of Nebraska - Lincoln, United States -- Nebraska. Retrieved August 9, 2008, from Dissertations & Theses: Full Text database. (Publication No. AAT 3284028).

Lehman, P. (1985). The class of 2001: Coping with the computer bandwagon. Reston, VA: Music Educators National Conference.

McPherson, G. and Schubert, E. (2004). Measuring performance enhancement in music. In Williamon, A. (Ed), *Musical Excellence: Strategies and Techniques to Enhance Performance.* (pp. 61-84). New York: Oxford University Press.

McPherson, G. (2005). From child to musician: Skill development during the beginning stages of learning an instrument. *Psychology of Music, 33*(1), 5-35.

Music in the mail. (2006a) *Audio history – How the LP was invented.* Retrieved March 25, 2006 from http://home.sprynet.com/~musicin/audiotape.html

Music in the mail. (2006b) *Audio history – The tape recorder.* Retrieved March 25, 2006 from http://home.sprynet.com/~musicin/audiotape.html

National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. Washington, D.C.: U.S. Government Printing Office.

Olijnek Scheuzger, A. (2006). The effects of specific transfer activities on fifth grade orchestra and band students' rhythmic performance (Doctoral Dissertation, The Ohio State University, 2006). *ProQuest,* AAT 3226314.

Ouren, R. (1997). The influence of the VIVACE accompaniment technology on selected middle school instrumental students. Ph.D. dissertation, University of Minnesota, United States -- Minnesota. Retrieved August 22, 2008, from Dissertations & Theses: Full Text database. (Publication No. AAT 9738468).

Pocket songs online (2004). *The history of karaoke: Karaoke music, a tale of two countries.* Retrieved March 25, 2006 from http://www.pocketsongs.com/MainPages/karaokehistory.asp.

Riddell, A. (2001). Data culture generation: After content, process as aesthetic. Leonardo, 34(4), 337-343. Accessed March 30, 2006 http://muse.jhu.edu/journals/leonardo/v034/34.4riddell.html.

Ronkin, B. (1996). Music & technology: The vivace personal accompanist. *Saxophone Journal 20*(4), 16-17.

Rudolph, T. (1996). *Teaching Music with Technology.* Chicago: GIA Publications, Inc.

Saunders, T., & Holahan, J. (1997). Criteria-specific rating scales in the evaluation of high school instrumental performance. *Journal of Research in Music Education, 45,* 259-272.

Schneider, C. (2005). Measuring Student Achievement in the Future Based on Lessons from the Past: the NAEP Arts Assessment. *Music Educators Journal*, *92*(2), 56-61.

Scott, S. (2004). Evaluating Tasks for Performance-Based Assessments: Advice for Music Teachers. *General Music Today*, *17*(2), 17-27.

Seashore, C. (1938). *Psychology of Music.* New York: McGraw-Hill

Sheldon, D., Reese, S., & Grashel, J. (1999). The effects of live accompaniment, intelligent digital accompaniment, and no accompaniment on musicians' performance quality. *Journal of Research in Music Education, 47,* 251-288.

Shuter-Dyson, R. (2002). Introduction: Looking multiple ways in research. In R. Colwell & C. Richardson (Vol. Eds.) & H. Froehlich (Part III Ed.), *The New Handbook of*

Research on Music Teaching and Learning (pp. 277-8). New York: Oxford University Press.

Snapp, D. (1997). The uses and effectiveness of the Vivace Intelligent Accompanist(c) system in K--12 instrumental music programs. D.A. dissertation, University of Northern Colorado, United States -- Colorado. Retrieved March 25, 2006, from Dissertations & Theses: Full Text database. (Publication No. AAT 9827971).

Stanley, M., Brooker, R., & Gilbert, R. (2002). Examiner perceptions of using criteria in music performance assessment. *Research Studies in Music Education, 18,* 43-52.

Tamte-Horan, M. (1989). The development of instructional materials for training beginning choral conducting students to evaluate tone quality in high school choral music performance. Ed.D. dissertation, University of Illinois at Urbana-Champaign, United States -- Illinois. Retrieved July 15, 2003, from Dissertations & Theses: Full Text database. (Publication No. AAT 9011046).

Tredway, C. (1994). A curriculum for the study of audio, video, computer and electronic music technology for undergraduate music education majors based on a survey among members of the Florida Music Educators Association. (Doctoral dissertation, University of Southern Mississippi, 1994). *Dissertation Abstracts International, 55,* 3483.

Tseng, S. (1996). Solo accompaniments in instrumental music education: The impact of the computer-controlled vivace on flute student practice. Ph.D. dissertation, University of Illinois at Urbana-Champaign, United States -- Illinois. Retrieved March 25, 2006, from Dissertations & Theses: Full Text database. (Publication No. AAT 9625203).

United States Census Bureau, (2000). *American FactFinder.* Retrieved September 12, 2008 from http://factfinder.census.gov/home/saff/main.html?_lang=en

Webster, P. (2002a). Historical Perspectives on Technology and Music. *Music Educators Journal, 89*(1), 38.

Webster, P. (2002b). Computer-based technology and music teaching and learning. In R. Colwell & C. Richardson (Vol. Eds.) & H. Froehlich (Part III Ed.), *The New Handbook of Research on Music Teaching and Learning* (pp. 416-39). New York: Oxford University Press.

Woolley, David R. (1994). PLATO: The Emergence of Online Community. accessed April 14, 2006. http://www.thinkofit.com/plato/dwplato.htm.

Zanutto, D. (2006). Comparison of Online Music Assessment Software. Retrieved August 9, 2008 from http://www.atmionline.org/Conferences/Conf2006/Presentations/ZanuttoATMI2006.doc.

Zdzinski, S., & Barnes, G. (2002). Development and validation of a string performance rating scale. *Journal of Research in Music Education, 50*(3), 245-255.

Zukerman, P. (2008). Biography: National Arts Orchestra Music Director. Ottawa, Ontario. Retrieved July 10, 2008 from http://www.nac-cna.ca/en/naco/allabouttheorchestra/pinchaszukermanbiography/.