Liberty University

School of Music

Technology-as-Instrument: A Case Study of Undergraduate Student Experience with DAW Technology

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by

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Abstract

Within the typical music appreciation class, diverse subsections of students exhibit varying levels of experience that can result in challenging inequities in engagement and comprehension. For those students with no background in playing an instrument or singing, musical ideas often need more context and perspective. Technology can present an opportunity for all students to explore the elements of music by utilizing music production software as a virtual instrument. In this study, the researcher utilized curriculum strategies specifically designed to foster deep musical connection through a technology-as-instrument approach. Through informal learning and the tools of music production, students visualized and interacted with musical concepts that could sometimes seem abstract and unrelatable. This illustrative case study aimed to investigate students' music skill development and observe their learning process while using a Digital Audio Workstation (DAW) to accomplish creative activities. The researcher used surveys and focus groups to collect rich qualitative data about the students' experience. Aural tests and listening activities gathered quantitative data to establish baseline aptitude and measure improving listening skill. Study results demonstrated diverse benefits to student learning in the categories of concept comprehension, listening skill, and creative processes. Additionally, a majority of students improved their scores in an aural discrimination activity after study treatment. This research demonstrates the learning benefits that a technology-as-instrument approach can achieve and clarifies the need for instructional strategies that assist undergraduate students in acquiring a personal context with the elements of music in an introductory music course.

Keywords: music technology, DAW, undergraduate, untrained student, the other 80%, musicianship, elements of music, technology-as-instrument, TPACK, SoundTrap

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Chapter 1: Introduction

Applying the best approach to assist students in their learning is of paramount concern to educators in any classroom environment. This purpose is no small prospect in the undergraduate environment, where a diverse student population with distinct backgrounds is the norm. Freshmen starting their collegiate career are shuffled into general survey art courses that provide a valuable segment of their liberal arts education with music appreciation being a popular selection for students due to its universal appeal. Professors accept the daunting task of condensing the complexity of the art form's fundamentals and a millennia of classical music history into one semester. There is more to this challenge than the time frame. Instructors must also choose how to relate specialized and sometimes elevated musical concepts to a diverse student population with varied musical background. Even the most fundamental and simple of musical ideas can pose a challenge to students who lack connection to singing or playing an instrument. Inexperienced students are often confused by concepts that they see as abstract an unrelatable. The incorporation of technology-as-instrument may serve as a solution for educators to increase student comprehension through kinesthetic experience. With the opportunity to explore and manipulate music through computer software, students may gain a physical experience that allows them to connect to musical concepts that otherwise seem intangible. This chapter will summarize the history of creative and technology research and outline the design and direction of this study.

Background

Electronic and computer technology have been mainstays of music classrooms for many decades. Historically used to reinforce traditional music learning (notation software, aural training, practice skills, etc.), computer technology has shifted into a more central role for music instruction. In recent decades, instructors and researchers have increasingly focused on software technology and its positioning and role in content and student learning.[1] In a supportive position, technology can assist music learning as a tool, but when used as the featured curricular component, technology assumes a role as an active instrument of learning. Instead of merely choosing to approach a task with the aid of technology as a tool, using technology as the primary instrument showcases its ability to accomplish unique results not possible without it.[2] Coupled with the modern student's ability to comprehend and adapt to many technologies and to manipulate diverse platforms, this use of technology is a natural addition to music pedagogy. This study seeks to capitalize on this complementary positioning between technology and music learning and to further illuminate its benefit to undergraduate student learners.

Besides this proclivity to modern technology, students also show a natural inclination toward creativity. This natural inclination for experimentation and exploration observed in childhood remains a strong characteristic of college students, driving their learning and motivation.[3] David Brinkman observes: "Creative people can recognize and understand problems and represent them in a way that stimulates action. They are curious, tolerant of ambiguity,

[1] P. Mishra and M. J. Koehler, "Not '"What"' but '"How"': Becoming Design-Wise about Educational Technology," in *What Teachers Should Know about Technology: Perspectives and Practices*, ed. Y Zhao (Greenich, CT: Information Age Publishing, 2003); Jay Dorfman, *Theory and Practice of Technology-Based Music Instruction* (New York: Oxford University Press, 2013), William I. Bauer and Richard J. Dammers, "Instrumental Music Learning and Technology," in *Engaging Musical Practices: A Sourcebook for Instrumental Music*, ed. Suzanne L. Burton and Alden H. Snell (Lanham, Maryland: Rowman and Littlefield, 2015), accessed April 24, 2022, http://ebookcentral.proquest.com/lib/liberty/detail.action?docID=4338345.

[2] Will Kuhn and Ethan Hein, *Electronic Music School: A Contemporary Approach to Teaching Musical Creativity* (New York, NY: Oxford University Press, 2021), 13.

[3] Scott Watson, *Using Technology to Unlock Musical Creativity* (New York, NY: Oxford University Press, 2011), 17.

willing to surmount obstacles, willing to grow, intrinsically motivated, and willing to take moderate risks, and they have a desire and the ability to work for recognition."[4]

How can instructors utilize students' natural creative instincts for music learning? The nexus may be computer software technology. A central place for technology in music education expands how students can experience and learn with music. The possibilities of music production software enable students to compose and arrange music with no notational literacy, allowing them to create music that follows their instincts instead of traditional structures. This possibility can enable students to experience music in non-traditional but deeply meaningful ways.[5]

Why are many teachers slow to adopt this higher level of technological commitment? First, teachers are often ill-prepared to implement such options and feel unqualified to manage the imposing minutia of tech interfaces.[6] According to Jay Dorfman, many teachers have observed few models of this teaching themselves and find training challenging to obtain.[7] Second, a lack of research-supported pedagogy may contribute to lagging educator development.[8] These reasons and others show it can be a challenging task for instructors to acquire the skills needed to use technology as both a tool and a platform. Even though this

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[4] David J. Brinkman, "Teaching Creatively and Teaching for Creativity," *Arts Education Policy Review* 111, no. 2 (2010): 50, https://doi.org/10.1080/10632910903455785.

[5] Rosemarie Piccioni, "Integrating Technology into Undergraduate Music Appreciation Courses" (DME dissertation, Columbia University, 2003).

[6] Jay Dorfman, "Learning Music with Technology: The Influence of Learning Style, Prior Experiences, and Two Learning Conditions on Success with a Music Technology Task" (PhD dissertation, Northwestern University, 2006), 17.

[7] Dorfman, *Theory*, 6.

[8] J. Savage, "A Survey of ICT Usage across English Secondary Schools," *Music Education Research* 12, no. 1 (2010): 89–104; Peter R. Webster, "Computer-Based Technology and Music Teaching and Learning: 2000–2005," *International Handbook of Research in Arts Education* 16 (2020): 1311, https://link.springer.com/chapter/10.1007/978-1-4020-3052-9_90.

elevated skill level is a challenge for some to acquire, Dorfman assures educators it is "necessary to advance to more sophisticated levels of technology integration and to a place in which teachers can base their teaching on technology as the major medium for music learning."[9] These challenges are certainly formidable, but recent trends in education and technology have evolved with refined integrations for classrooms, including core computer capabilities, a growing relevance of software to learning, new roles for teachers that pair well with creative technology, and a recognition of the relevance of technology to students.[10]

A key development in the relevance of computer technology to the classroom may be the availability of multi-track music production software, referred to in this study as the digital audio workstation (DAW). Software such as GarageBand and Audacity are historical examples of popular DAW solutions for recording and editing. Research studies, trade journals, and conferences have long presented these tools as the evolving frontier of learning and creativity.[11] Built on the capabilities of MIDI programming (Musical Instrument Digital Interface), an audio loop library, and user-friendly editing and effects, these programs allow users to explore and arrange music with little required skill. Students without traditional training can explore musical concepts by arranging pre-recorded loops or by composing unique rhythms and melodies. The DAW interface can also allow for a higher level of engagement for more advanced students through editing functions in the piano roll, sampler window, and staff view. As all students come

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[9] Dorfman, *Theory*, 6.

[10] Dorfman, *Theory,* 13.

[11] Jonathan Kladder, "Digital Audio Technology in Music Teaching and Learning: A Preliminary Investigation," *Journal of Music, Technology and Education* 13, no. 2 (December 1, 2021): 219–237; David Thompson, "Music Education Technology Curriculum and Development in the United States: Theory, Design, and Orientations" (2022), accessed August 26, 2023, https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/dissertations-theses/music-education-technology-curriculum-development/docview/2856727037/se-2.

with their own refined tastes and innate musical instincts, DAWs and other music production software can offer all students success and learning that is often personal and authentic.[12]

Within the past decade, a development that made this technology exponentially more applicable to the educational environment is–the DAW moved to the cloud. Consumer applications such as SoundTrap and BandLab came to the rescue of many teachers during the age of the "pandemic classroom." Along with the ability to record, edit, and arrange, students collaborated by sharing access to the same projects and communicating via video and chat functions. These cloud-based applications also provided a cross-platform solution for educators, whether their devices were Mac, Android, or Windows, etc.

The purpose of DAW software is to produce music through the functions of a multitrack editor, with users employing the tools of editing, arranging, and composing music. This intuitive connection with creativity is a natural intersection for instructors to utilize for substantive music learning. In view of this study, it is important to consider the philosophical underpinnings of such a powerful connection and not take them for granted. Burnard, a noted author on the creativity topic, underlines the distinction between creativity and technology by explaining, "Whether seeing creativity being in relationship with technology or creativity as emerging through technology, both vantage points are essential to genuinely fostering music learning."[13]

The nexus of the creative curriculum and technology is a topic approached in various research, including the intersection between technology and instructional design, the legitimacy of technology-based learning, music composition with technology, and technology use by

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[12] Jeanne Bamberger, "The Development of Intuitive Musical Understanding: A Natural Experiment," *Psychology of Music* 31, no. 1 (January 2003): 36.

[13] Pamela Burnard, "Reframing Creativity and Technology: Promoting Pedagogic Change in Music Education," *Journal of Music, Technology & Education* 1, no. 1 (November 16, 2007): 39.

undergraduate students.[14] Next steps for this field include suggestions by researchers to examine the composition experiences of non-music majors in an introductory music course, the role and importance of digital creation on computers for non-music majors, how technology benefits students' performing, listening, and analyzing skills, and how teachers may prepare for this eventuality.[15] The second chapter of this study delves deeper into both foundational studies and current research on this topic.

While this natural propensity toward creativity is an ideal place for instruction to be centered, educators also benefit from other specific pedagogical strategies that complement and support the use of computer technology in the classroom. The first is informal learning, a modern approach to the music classroom that has grown in legitimacy and acceptance. Perhaps the oldest and most natural style of music instruction, the use of informal learning now in the modern classroom has grown through the work of Lucy Green and others. An approach that resembles the authentic social mechanisms of music learning *outside* the classroom, the informal learning approach is a natural accompaniment to technology use and a creative curriculum.[16] In her book *Hear, Listen, Play,* Green outlines informal learning strategies based on how students learn on their own, with others, and with familiar music.

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[14] Dorfman, *Learning*, 145; Jonathan McElroy, "Music Composition as Pedagogy: A Qualitative Case Study of Students' Experience with Composition" (PhD dissertation, New York University, 2022); Piccioni, "Integrating Technology"; Leila Heil, "Synergy in the Composition Classroom: Powerful Learning Through Technology and Instructional Design," *Journal of Music, Technology & Education* 12, no. 2 (September 1, 2019): 165–78, https://doi.org/10.1386/jmte_00004_1.

[15] McElroy, "Music Composition," 305; Dorfman, *Learning,* 36.; Piccioni, "Integrating Technology," 156.

[16] Steve Giddings, Technology for Unleashing Creativity: Practical Tips and Tools for Music Educators (New York, NY: Oxford University Press, 2022), 3.

This approach requires two fundamental changes to the typical classroom setup. First, educators must adopt a more customized path of learning that they pursue from the student's perspective, rooted in exploration and peer learning. The fostering of self-motivation and independent learning will allow students to develop a sense of agency as they pursue their interests and learning.[17] Second, for this type of learning to empower the creativity and learning of students, educators must reorient the student/teacher relationship. Out of necessity, teachers will find it essential to adopt the role of a facilitator instead of the traditional instructor. In a student-centered approach, teachers often start with a designed activity and often replace lectures and presentations with extended exploration and experimentation. The instructor positions himself as an observer of students and their work, providing feedback in a facilitator role.[18] While these pedagogical changes may seem to be a daunting upgrade for some, a certain level of adoption is important for a creative technology classroom.

An additional pedagogical accompaniment for a technology-centered curriculum is one that is rooted in philosophy and learning–that of constructivism. The constructivist educator centers their approach around the idea that students learn best by “doing” through “direct interaction and manipulative experiences that allow students to build on what they already know and grow from experience that also prepares them for more sophisticated experiences in the future.”[19] The constructivist’s assumption is that students learn better through individual experiences, building knowledge through interactions. By structuring learning in an existing context, students can connect with the new concepts and incorporate them into their experience.

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[17] Giddings, *Technology*, 29.

[18] Dorfman, *Technology*, 90.

[19] Ibid., 40.

This constructivist approach is why modern popular music is paired with music technology activities, as it is a genre well-connected to students' presiding experiences. In their book *Electronic Music,* Kuhn and Hein remind educators that without topical relevance, students "have no frame of reference to draw on, then new information and experience may be meaningless."[20] In an overview of constructivist characteristics relevant to music educators, Peter Webster offers the following:

- Knowledge is formed as part of the learner's active interaction with the world.
- Knowledge exists less as abstract entities outside the learner and absorbed by the learner; rather, it is constructed anew through action.
- Meaning is constructed with this knowledge.
- Learning is, in large part, a social activity. [21]

These items represent the values that help construct student knowledge in experiential ways. Intrinsically related to the action theory approach of John Dewey, constructivist efforts can assist both students and teachers in fashioning enriching learning environments and can be an effective complement to the technology-centered curriculum.[22]

What may result from implementing this classroom strategy, instructional philosophy, and technology use? The first result may be to reach the student populations not currently served by traditional music programs and performance ensembles. Students in this majority, known as "the other 80%," are those who do not participate in music education during high school.[23] In his book, *Technology for Unleashing Creativity*, Steve Giddings offers that "technology and

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[20] Kuhn and Hein, *Electronic Music*, 9.

[21] Ibid., 36.

[22] Dorfman, *Technology*, 39.

[23] David Brian Williams, "The Non-Traditional Music Student in Secondary Schools of the United States: Engaging Non-Participant Students in Creative Music Activities through Technology," *Journal of Music, Technology & Education* 4, no. 2 (2012):133.

creativity are ways to engage those unengaged learners in music and...to instill relevant skills for active lifelong music making."[24] The second result may be the growth of quality instruction. For this subsection of students, using a creative curriculum to grow musicianship through computer technology tools can beneficially affect the comprehension of musical concepts.

Theoretical Framework

This illustrative case study operates within multiple theoretical structures and from a position of methodological eclecticism. This practical research approach requires the researcher to choose whatever tools may best address the research questions.[25] In her writing about the maturing field of qualitative research in music education, Kate Fitzpatrick explains such frameworks "posit that finding solutions to problems is of greater importance than the method used to solve those problems."[26] Case studies are uniquely situated to investigate questions and find solutions in music education. Because of its dynamic and complex nature, music education benefits from the deeper context that qualitative mechanisms can bring to complex phenomena.[27]

The author of this study also views the topic from a constructivist approach to music education. Technology-based music promotes individual, self-constructed learning through creative work, allowing "students' serendipitous discoveries of new knowledge and

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[24] Giddings, *Technology*, 3.

[25] C. Teddlie and A. Tashakkori, "Mixed Methods Research: Contemporary Issues in an Emerging Field," essay, in *The Sage Handbook of Qualitative Research*, ed. Norman K. Denzin and Yvonna S. Lincoln (Thousand Oaks, CA: Sage, 2011), 295.

[26] Kate R. Fitzpatrick, "Mixed Methods Research in Music Education," essay, in *Oxford Handbook of Qualitative Research in American Music Education*, ed. Colleen M. Conway (New York, NY: Oxford University Press, 2020), 213.

[27] Fitzpatrick, "Mixed Methods," 210.

connections."[28] In connecting constructivist learning to music education, Peter Webster, a noted advocate for a creative curriculum, explains that "constructivism holds that all knowledge and meaning are constructed by the individual either personally or through social-cultural interaction.[29] Vygotsky described how new concepts and experiences translate to students' existing understanding most effectively within the "zone of proximal development."[30] The use of creative music technology in the classroom may prove compatible with these approaches because of its focus on self-learning, creativity, and familiar content. Untrained students also bring deep personal knowledge and musical instinct to the classroom, "even if they lack the tools to articulate their understanding."[31] Allowing space for constructive, informal learning may assist researchers in further illuminating the benefits of creativity and technology in music learning.

Problem Statement

The music classroom has long involved creative technologies to assist with instruction, but research is still investigating how undergraduate students may benefit from using creative technology as an instrument. This study seeks to address this research gap by studying benefits to students' comprehension and learning processes when using technology to accomplish creative tasks. Within the typical music appreciation class, diverse subsections of undergraduate students present varying levels of training and experience that can create challenging inequities in

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[28] Dorfman, *Technology*, 36.

[29] Peter R. Webster, "Construction of Music Learning," essay, in *MENC Handbook of Research on Music Learning*, ed. Richard Colwell and Peter R. Webster (New York, NY: Oxford University Press, 2011), 38.

[30] L. S. Vygotsky, *Mind in Society: Development of Higher Psychological Processes* (Cambridge, MA: Harvard University Press, 1978), 86.

[31] Giddings, Electronic Music, 9.

engagement and can impact comprehension of musical concepts.[32] To the student with no background in playing an instrument or singing, musical ideas can often lack context and perspective. Therefore, the assumed requirements of musical literacy and experience in musicking could hinder student confidence and participation in class. DAW technology presents an opportunity for untrained students to explore the elements of music by using music production software to explore and create. This pedagogy remains a largely unaddressed topic in research, especially among undergraduate students.[33] By including creative activities and music production tools, untrained students may visualize and interact with musical concepts that would otherwise seem abstract and unrelatable.

Statement of the Purpose

The first purpose of this illustrative case study was to observe student skill development while using technology as an instrument to accomplish creative tasks. This included observing differences in the results of an assessment activity for untrained students. The second purpose of this study was to investigate the learning process from the student's point of view. This included examining the unique connections that technology may allow in students' personal and authentic learning.

Significance of the Study

This research addressed an important and evolving direction of modern music education and its use of technology-as-an-instrument. Limited knowledge of these benefits to student learning and comprehension represents a gap in the research literature. For anyone who has

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[32] Dorfman, *Technology,* 7.

[33] McElroy, "Music Composition," 23.

played an instrument or sung in a choir, musical comprehension is often directly linked to one's physical experience (tactile feedback, aural stimulation, etc.). Through repeated exposure, instrumentalists and singers build a deep knowledge of their musicianship by experiencing the elements of music through their instrument (vocal instrument included). Students without background or exposure may have a limited knowledge base established through personal experience. Their knowledge is often rooted in and limited to performance value, "fan" knowledge, connection to lyrics, and in decoding emotional expression.[34] When expected to analyze music in relation to its foundational elements, a musically untrained student may not reflect the same level of understanding as a student with prior experience. In the typical college music appreciation course, many levels of comprehension and skill will exist. This skill gap is a difficult challenge for traditionally untrained students to overcome, further demonstrating group inequities in engagement and understanding.

How can educators level the playing field and provide all students an interface that allows for meaningful learning about these fundamentals? Research and pedagogy have shown strong trends toward schools offering courses with creative curricula and non-traditional ensembles, with instructors seeking solutions to serve the untrained musician.[35] Additionally, with the increased accessibility of DAW applications, multiple interfaces exist that provide a physical and

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[34] Barbara Freedman, "Music Fluency: How Technology Refocuses Music Creation and Composition," essay, in *The Oxford Handbook of Technology and Music Education*, ed. S. Alex Ruthmann and Roger Mantie (New York, NY: Oxford University Press, 2020), 368.

[35] Josh Bula, "Technology-Based Music Courses and Non-Traditional Music Students in Secondary Schools" (2011), accessed October 13, 2023, https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/dissertations-theses/technology-based-music-courses-non-traditional/docview/998182818/se-2; William M. Hungate, "How Music Technology Can Increase Musicianship Skills in High School Students" (Dissertation, 2016), accessed December 29, 2023, https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/dissertations-theses/music-technology-high-school-education-how-can/docview/1831572777/se-2?accountid=12085.

personal instrumental connection as students manipulate melodies, analyze harmonies, and generate rhythm patterns. Research investigating this particular use of music technology is still evolving, and a gap in the literature exists regarding the use of technology by undergraduate music appreciation students to explore and understand unfamiliar musical concepts. Previous studies in technology and creativity have addressed closely related topics with music majors. For example, well-known advocates for creative curricula, Peter R. Webster and David Brian Williams, examined technology's role in undergraduate music curricula, providing an exhaustive explanation of the use and benefit of technology in collegiate music education.[36] In a study highlighting the role of technology in students' compositions, Johnathan McElroy examined the composition process and experience of student music majors. McElroy called future researchers to extend the topic of students' composition experiences to studying those of non-music majors in a music appreciation class.[37] Other studies have surveyed music appreciation instructors to learn what technologies are utilized and for what use.[38] Still, the ways students specifically interact with music technology is still largely unexplored.[39] This study sought to illuminate the benefits a technology-as-instrument approach may offer untrained college students as they discover their musicianship in a music appreciation classroom. A kinesthetic exposure to the elements of music combined with their natural sense of musicianship can establish a beneficial

[36] Peter R. Webster and David Brian Williams, "Technology's Role for Achieving Creativity, Diversity and Integration in the American Undergraduate Music Curriculum: Some Theoretical, Historical and Practical Perspectives," *Journal of Music, Technology & Education* 11, no. 1 (August 1, 2018): 5–36, https://doi.org/10.1386/jmte.11.1.5_1.

[37] McElroy, "Music Composition."

[38] Piccioni, "Integrating Technology."

[39] Dorfman, Theory and Practice, 7.

quasi-instrumental expertise that brings context to a student's musical understanding. For those without a "voice," due to a prior lack of opportunity or exposure, creative tasks may help them extend comprehension beyond a novice level.[40] Students may discover a newfound comprehension of musical concepts based on the context honed within a creative technology curriculum.

Research Questions

This study sought to examine how a technology-as-instrument approach may benefit students' skill acquisition, creative process, and overall comprehension of the elements of music.

RQ1: Does a technology-as-instrument approach result in measurable growth in students' comprehension and aural discrimination skills in an undergraduate music appreciation course?

RQ2: How do students perceive their learning, comprehension, and creative process when using a technology-as-instrument approach?

Definition of Terms

DAW*:* Digital Audio Workstation. A computer application meant for the recording and editing of multitrack audio projects. Examples include ProTools, Avid, SoundTrap, BandLab, GarageBand, Logic, Audacity, etc.

Garage Band: A multitrack music production software available on the Mac platform. GarageBand is often used for music technology classrooms in middle and high schools.

MIDI: Musical Instrument Digital Interface. A universal computer protocol that communicates musical performance features in computer code (pitch, volume, duration, etc.).

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[40] Kaschub and Smith, *Minds on Music*, 51.

Musical Elements: the concepts and components of music, including melody, harmony, timbre, rhythm, form, and texture.

Piano Roll: a graphic-notation view for editing the pithch and duration of note events, similar to a player piano roll.

Sampler Window: a view that allows users to edit and manipulate individual audio files outside of the main multitrack interface.

Staff View: a view allowing users to see MIDI recordings in staff notation.

SoundTrap: A multitrack, cloud-based interface that allows users to record, arrange and edit an audio project.

Summary

The modern field of music education has shown much interest and application in how music technology benefits secondary school students. Researchers still have yet to investigate how technology, when used as an instrument, may benefit the undergraduate student. A modern pedagogy rooted in informal learning, creativity, and exploration can contribute to an effective and relevant curriculum where educators may also expect to see unrealized benefits for students who are untrained and inexperienced.

Chapter Two: Literature Review

As with any topic in music education, the importance of collective knowledge and ongoing inquiry is invaluable. While research regarding classroom use of music software is still in its early stages, there is a well-established body of research on music technology generally. Chapter Two summarizes the use of music technology in music education in relation to foundational and current research, along with parallel and complementary subtopics.

The Music Appreciation Classroom

Research centered on technology in the music classroom now goes back decades and includes topics on electronic instruments, notational software, mobile apps, and multitrack software. Regarding the latter, Piccioni studied the use of technology in undergraduate music appreciation courses. In her study, Piccioni reminds the reader that the collegiate music appreciation classroom did not begin as a place of student-centered exploration but historically consisted of students listening to examples of classical repertoire and learning music terminology. Music educators who participated in her study recalled their own music appreciation experience and identified their own lack of interest as students as a motivating factor in their search for a more relevant curricular approach now as instructors.[1] Their goal was to bypass the exclusive use of traditional pedagogy for a music appreciation class and focus on listening skills so that students could comprehend and deconstruct the music they heard. Instead of listening alone, the educators used various creative activities aided by technology to enrich

[1] Rosemarie Piccioni, "Integrating Technology into Undergraduate Music Appreciation Courses" (2003), accessed August 26, 2023, https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/dissertations-theses/integrating-technology-into-undergraduate-music/docview/288363656/se-2?accountid=12085, 56.

student learning. Although this study deals with a different generation of technology, it offers a fundamental connection to the current author's research as it highlights music technology's benefit to untrained undergraduate students. Piccioni identified three phases that the educators used to structure instruction. Phase one focused on helping students realize their innate musical ability despite the lack of traditional experiences. Students learn there is value in studying music in part as they recognize their responses to it.[2] Instruction in phase two introduced the elements of music to students, giving the topics and tools to approach listening examples on a more elevated level.[3] Finally, phase three encompassed the ability to use this expanded knowledge in verbal response and explanation of any type of music.[4]

The instructors Piccioni interviewed spoke of the difficulty in implementing a creative technology curriculum in large classes and the need for continual self-education.[5] This research provides an essential connection between the topics of the non-traditional curriculum, creative use of technology and the untrained student. Piccioni states:

> New digital technologies are now being used to provide opportunities for students to develop deeper and richer understandings of music. Students can experience the performance and creation of music without learning to play a traditional instrument or work with traditional notation. These advances allow learners to undergo substantive musical experiences in nontraditional ways.[6]

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[2] Piccioni, *Integrating*, 72.

[3] Ibid., 73.

[4] Ibid., 74.

[5] Ibid., 142.

[6] Ibid., 19.

For future research, Piccioni identifies the category of students who are amateur musicians. This cohort can be musically perceptive but traditionally untrained and requires more study "because they have a physical understanding of music with limited theoretical abilities to read it."[7] These students represent a "musica practica" category of musician, with deep and perhaps self-taught physical experience through exploration and performance but little to no knowledge of music theory and notational skill.[8] This sub-group that the typical student population represents is of important relevance to the current study and to the topic of modern music education, as explained later in this chapter.

Kudlawiec studied the effect of including participatory activities on undergraduate students in a music appreciation classroom that provides for exploratory learning. Based on Elliott's praxial philosophy that information about music should naturally grow into interaction and physical performance, Kudlawiec investigated whether active musicking resulted in measurable benefits to their cognitive knowledge and attitude.[9] Alternatively, Silverman examined how democratic and student-centered teaching may affect learner confidence and advance their critical listening skill. Her research found that when instructors lessen the divide between intellectualism and students' personal experiences, useful collective listening can take place in a supportive and open environment.

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[7] Piccioni, "Integrating," 27.

[8] Ibid.

[9] Nancy Anne Kudlawiec, "The Effect of Active Music Making on Achievement and Attitude of College Music Appreciation Students" (2000), https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/dissertations-theses/effect-active-music-making-on-achievement/docview/304588233/se-2?accountid=12085.

The Informal Classroom

In 2002, Lucy Green published her influential book *Music, How Popular Musicians Learn*. This vital addition to the topic of the modern classroom outlined Green's research into a pedagogical strategy modeled on how popular musicians learn.[10] Green's ensuing publications formed a new direction for modern music education and its application in the classroom. Informal learning for the music classroom centers on social and familiar learning in the following ways:

1. Learning music that they choose and identify with
2. Learning by listening and copying recordings initially on a trial-and-error basis
3. Playing and learning alongside friends
4. Acquiring knowledge in holistic, haphazard ways, and learners navigate the learning themselves
5. Integrating listening, performing, composing, and improvising throughout the learning process. [11]

Although relatively new to the structured curriculum, informal music learning has existed since humanity's beginning and represents a culturally relevant teaching strategy. Giddings' book *Technology for Unleashing Creativity* connects informal learning with technology as a powerful pairing for authentic learning.[12] Authentic learning results when the materials and goals of the curriculum align with personally and culturally relevant material. Undoubtedly, choosing from modern genres for demonstration makes pedagogy more culturally relevant, but authenticity can also be gained with the tools of music technology. This fundamental connection

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[10] Lucy Green, How Popular Musicians Learn: A Way Ahead for Music Education (Aldershot: Ashgate, 2001).

[11] Lucy Green, Hear, Listen, Play!: How to Free Your Student's Aural, Improvisation, and Performance Skills (New York, NY: Oxford University Press, 2014), xvii.

[12] Giddings, *Technology*, 26.

is the case with music production software, which is already a popular tool for amateur student musicians outside the classroom for exploration and creativity.[13]

The Constructivist Classroom

Another way to look at the informal classroom and authentic learning is through a constructivist lens. The constructivist educator understands that the student constructs knowledge from previously learned and familiar material. Peter Webster connected the worlds of music education and constructivist learning, offering "constructivism holds that all knowledge and meaning are constructed by the individual either personally or through social-cultural interaction."[14] He includes four characteristics of constructivism-based learning in music education.

1. Knowledge is formed as part of the learner's active interaction with the world.
2. Knowledge exists less as abstract entities outside the learner and absorbed by the learner; rather, it is constructed anew through action.
3. Meaning is constructed with this knowledge.
4. Learning is, in large part, a social activity.[15]

These characteristics align with many natural directions of technology-based music instruction, including individual work and small group collaboration, creative projects, and exploration. Music technology supports constructivist learning approaches as students search for

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[13] Giddings, *Technology*, 25.

[14] Richard Colwell and Peter Webster, *MENC Handbook of Research on Music Learning*, vol. 1 (New York: Oxford University Press, 2011), accessed February 2, 2024, https://ebookcentral.proquest.com/lib/liberty/detail.action?docID=829330, 38.

[15] Colwell and Webster, *MENC Handbook,* 36.

solutions to musical problems while building on their previous experiences.[16] Instructors can "leverage technology in support of active, social music *making* that emphasizes the *doing* of music, rather than solely focusing on learning *about* music."[17] In his book *Theory and Practice of Technology-Based Music Instruction,* Dorfman unpacks technology's constructivist benefits to students, stating that "when experienced, constructivist learning in music is quite powerful; it can lead to students' serendipitous discoveries of new knowledge and connections within and between disciplines."[18] This particular kind of learning necessitates that educators entertain a different set of considerations for curriculum planning and instructional tools.

The TPACK Classroom

The intersection of technology with the music classroom can result in meaningful student benefits. When designing a curriculum, instructors should consider pedagogical efforts from an instructional perspective. An often-cited paradigm for technology is the TPACK model, or Technological Pedagogical Content Knowledge. Shulman created the PCK framework (Pedagogical Content Knowledge) to explain the type of knowledge that exists at the intersection of disciplinary and pedagogical knowledge, which TPACK is based on.[19] According to Schulman, an instructor's knowledge about content and pedagogy combines to form a necessary

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[16] Jay Dorfman, "Learning Music with Technology: The Influence of Learning Style, Prior Experiences, and Two Learning Conditions on Success with a Music Technology Task" (2006), accessed October 12, 2023, https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/dissertations-theses/learning-music-with-technology-influence-style/docview/305305072/se-2?accountid=12085, 37.

[17] Alex Ruthman, *Engaging Musical Practices: A Sourcebook for Middle School General Music.*, ed. Suzanne L. Burton, 2nd ed. (Rowman & Littlefield, 2022), 178.

[18] Jay Dorfman, *Theory and Practice of Technology-Based Music Instruction* (New York: Oxford University Press, 2013).

[19] Lee Shulman, "Those Who Understand: Knowledge Growth in Teaching," *Educational Researcher* 15, no. 2 (February 1986): 8.

category of "pedagogical content knowledge" unique to each discipline.[20] The addition to this model came from Mishra and Kohler (2006), who added the third component – technology.[21] The TPACK model is shown here in graphic form.

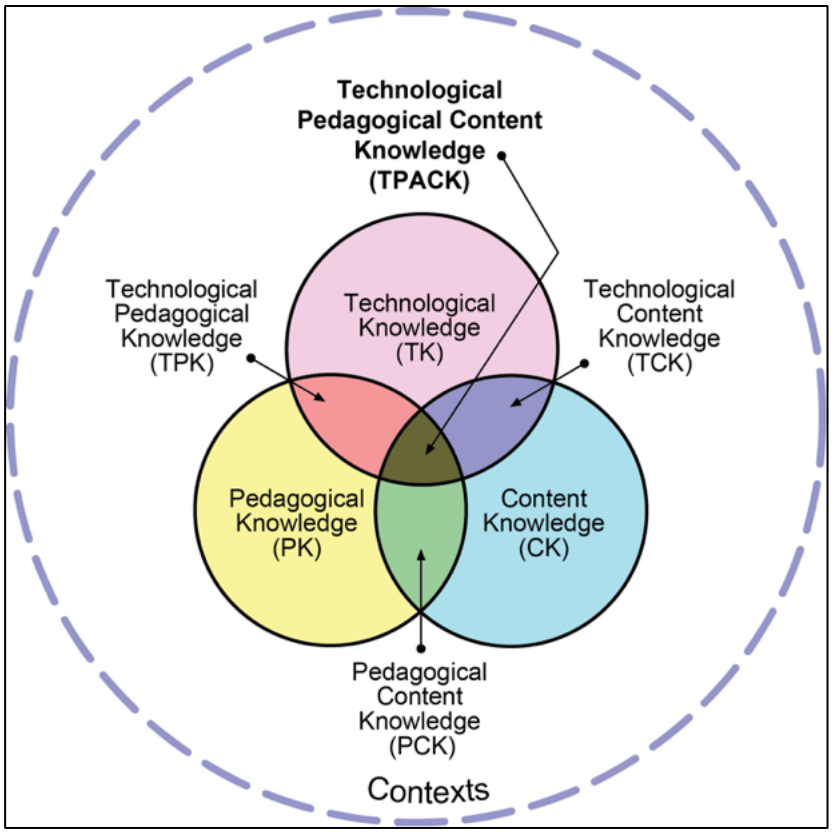

Figure 1. TPACK Instructional Model[22]
Used with permission.

In his book *Music Learning Today*, Bauer explains how TPACK can benefit music education through technology. Teachers who are not always "digital natives" must seek to

[20] Schulman, "Those Who Understand," 8.

[21] Mishra and Koehler, "Technological," 1023.

[22] tpack.org, *TPACK Image*, *Https://Matt-Koehler.com/Tpack2/Using-The-Tpack-Image/*, 2012, accessed February 9, 2024, http://tpack.org.

comprehend the intersectional knowledge that results from the thoughtful alignment of discipline expertise, pedagogical know-how, and technological proficiency in the music classroom.[23] The components of TPACK – content knowledge, pedagogical knowledge, and technological knowledge – "have a dynamic relationship, influencing each other in ways that may impact a learning curve in the context of any particular environment, possibly affecting a teacher, a choice of technology, pedagogical approach, or even the content studied."[24] The TPACK framework addresses an important deficiency for music educators who limit their inquiry to the "how" of education, instead of also preparing for the "what" and "why."

Because music teachers face an ever-increasing universe of technological possibilities for the classroom, incorporating an instructional model that is designed explicitly for technological consideration, is critical. The TPACK model can help educators "take focus off technology itself and place it on ways in which technology might assist students in achieving curricular goals."[25] This is important for selecting relevant technologies and considering tools for content and instruction. In his thorough examination of the application of the TPACK model on music education, Dorfman advises the music educator to attend to the content component. This category represents the educator's grasp of music theory, music history, and musicianship. Without a well-balanced approach to technology's overlap with the discipline's content knowledge, "music teachers run the risk of becoming technology teachers."[26]

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[23] William I Bauer, Music Learning Today: Digital Pedagogy for Creating, Performing, and Responding to Music (New York: Oxford University Press, 2020), 12.

[24] Bauer, Music Learning, 13.

[25] Dorfman, Theory and Practice, 48.

[26] Ibid., 46.

In their examination of technology on instrumental music learning, Bauer and Dammers came to similar conclusions, suggesting that the TPACK model assists educators in considering "the affordances (benefits) and constraints (limitations) of the particular technology regarding helping students achieve desired musical outcomes."[27] Such efforts keep technology from being used for imprecise outcomes. They provided a criterion for the use of technology in music technology, suggesting that music educators consider "(a) the musical content to be learned and processes to be experienced, (b) pedagogies that are appropriate to the acquisition of that content and facilitating those experiences, and (c) how technology might enable and enrich the content, musical processes, and/or pedagogical approach."[28] These suggestions make up z structure for thoughtful curriculum development – an exercise that has largely been skipped over as music technology efforts have focused on implementation. This imbalance may arise from the quickly evolving nature of technology, but educators must make time to answer and plan for these important considerations.

Investigating the deployment of TPACK to music classrooms, Testa gathered qualitative data from teachers about their experiences with technology in their own undergraduate education, and professional classroom teaching experience. This research found that the use of technology for music learning benefited a wide variety of students, but that teachers were not prepared to use this pedagogy while in their own undergraduate training.[29] Of special interest to

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[27] William I. Bauer and Richard J. Dammers, "Instrumental Music Learning and Technology," in *Engaging Musical Practices: A Sourcebook for Instrumental Music*, ed. Suzanne L. Burton and Alden H. Snell (Lanham, Maryland: Rowman and Littlefield, 2015), accessed April 24, 2022, http://ebookcentral.proquest.com/lib/liberty/detail.action?docID=4338345, 218.

[28] Dorfman, Theory and Practice, 28.

[29] Michael Testa, "Music Technology in the Classroom" (PhD Diss., University of Massachusetts Lowell, 2021), 105.

the author of this paper, Testa identified cross-platform technologies as a direction of needed research. The SoundTrap application used in the current study, being cloud-based, falls into this category and including it in research activities may help further illuminate the TPACK topic.[30] Angeli and Valanides have extended the TPACK framework by focusing on its application to music education and with a focus on a TPACK learning affect. Their efforts concentrate on how emotional experiences can serve as a learning catalyst for student motivation and learning, extending previous work of researchers.[31] Their research-tested learning design sought to demonstrate the interrelation of technology, musical elements, and affect by using student's emotional connection as a starting point for student learning and interest. The work of Macrides and Angeli may stand as the most relevant of writings about technology's application to music education. They provide guidelines for teachers in their efforts to implement TPACK curriculum and content, including the following:

1. Identify content for which technology integration can have an added value: i.e., topics that students have difficulties in grasping or teachers have difficulties in presenting/teaching.
2. Identify representations for transforming the content to be taught or learned into more understandable forms that are not possible to implement without technology.
3. Identify teaching methods that are impossible or difficult to implement with traditional means and without technology.
4. Select appropriate tools with the right set of affordances.
5. Design and develop learner-centered activities for integrating technology in the classroom.[32]

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[30] Testa, "Music Technology," 110.

[31] Elena Macrides and Charoula Angeli, "Domain-Specific Aspects of Technological Pedagogical Content Knowledge: Music Education and the Importance of Affect," *TechTrends* 62, no. 2 (January 19, 2018): 166–175, 173-174.

[32] Macrides and Angeli, "Domain Specific Aspects," 167.

In addition, Macrides and Angeli outlined extensive learning design principles that include many parallel directions to this author's study. Relevant connections include the use of student interest and emotion as motivation, using media as an instructional tool, and the use of DAW software for creative activities. They are listed here:

- Use affect (emotion elicited from a musical excerpt) to motivate students to engage in analysis and exploration of musical excerpts and related concepts.
- Use technology to help visualize and explore cognitive aspects of the music, such as the musical concepts of major/minor mode, melodic movement, melodic contour, dynamics, tempo, timbre/sounds, texture, pitch, melodic and rhythmic motives, ostinato, phrases, sections, etc.
- Use an animation or an interactive animated listening map of a short musical excerpt (a ready-made or a teacher-created one) to support identifying and understanding of musical structure and elements, according to curricular objectives.
- Alternatively, use a notation software to create and play simplified versions of short musical excerpts that will exemplify the use of specific musical elements and structures, and/or provide visualizations to support understanding of concepts using different representations, i.e., notation view, piano-roll editor, and other tools and affordances of the software.
- Use the affordances of technology to understand how the use of cognitive aspects (musical elements) influences the generation of certain emotions (affective elements)—relate cognitive and emotional aspects though the different transformations that become possible with the use of the affordances of the technology.
- Use a notation file that has been prepared before the lesson, and, instruct students to (a) experiment with contrasting dimensions of a musical element in order to understand how a change of feeling or mood can be induced, and/or (b) apply the new device or element in a short task using a semi-completed template file so that students can become more familiar with technical, cognitive and affective aspects of a particular concept or combination of two-three concepts (i.e., soft vs loud dynamics, thin vs thicker texture, staccato vs legato, ascending vs descending melody, etc.).[33]

While this list does not specifically address the use of DAW technology, it outlines the general value of technology to students' visual, aural, and kinesthetic experiences while learning.

[33] Macrides and Angeli, "Domain Specific Aspects," 173-174.

Learners can program their comprehension with a kinesthetic experience rooted in exploration and creativity.

The Creative Classroom

Educators often use the term "creativity" to legitimize their approach in the curriculum of any discipline. To be creative is a human trait made possible by unique cognitive abilities rooted in logic, problem-solving, and aesthetics. In the music classroom and in other arts disciplines, creativity is a natural accompaniment to any learning. It is often the central component of classroom activities, providing a natural method for learning and a beneficial source of motivation.[34]

Peter Webster, a leader in researching musical creativity, defines creative thinking in music as:

> …the engagement of the mind in the active, structured process of thinking in sound for the purpose of producing some product that is new for the creator. Creative thinking is a dynamic process of alternation between convergent and divergent, thinking and moving in stages over time, enabled by certain skills (both innate and learned) and by certain conditions all resulting in a final product.[35]

The process that Webster describes represents a choreography of the stages in an individual exploratory process, framed by divergent and convergent thinking, and resulting in both a creative process and product. He advanced this model of creative learning to find a place, the

[34] Scott Watson, *Using Technology to Unlock Musical Creativity* (New York, NY: Oxford University Press, 2011), 17.

[35] Peter Webster, Encouraging Imaginative Thought in Music with Students in Our Classes, http://www.peterrwebster.com, n.d., 1.

tools, and the time for creativity in modern music education.[36] To accomplish this, Webster considered many variables along with current research of the day in order to compile the following model of creative thinking:

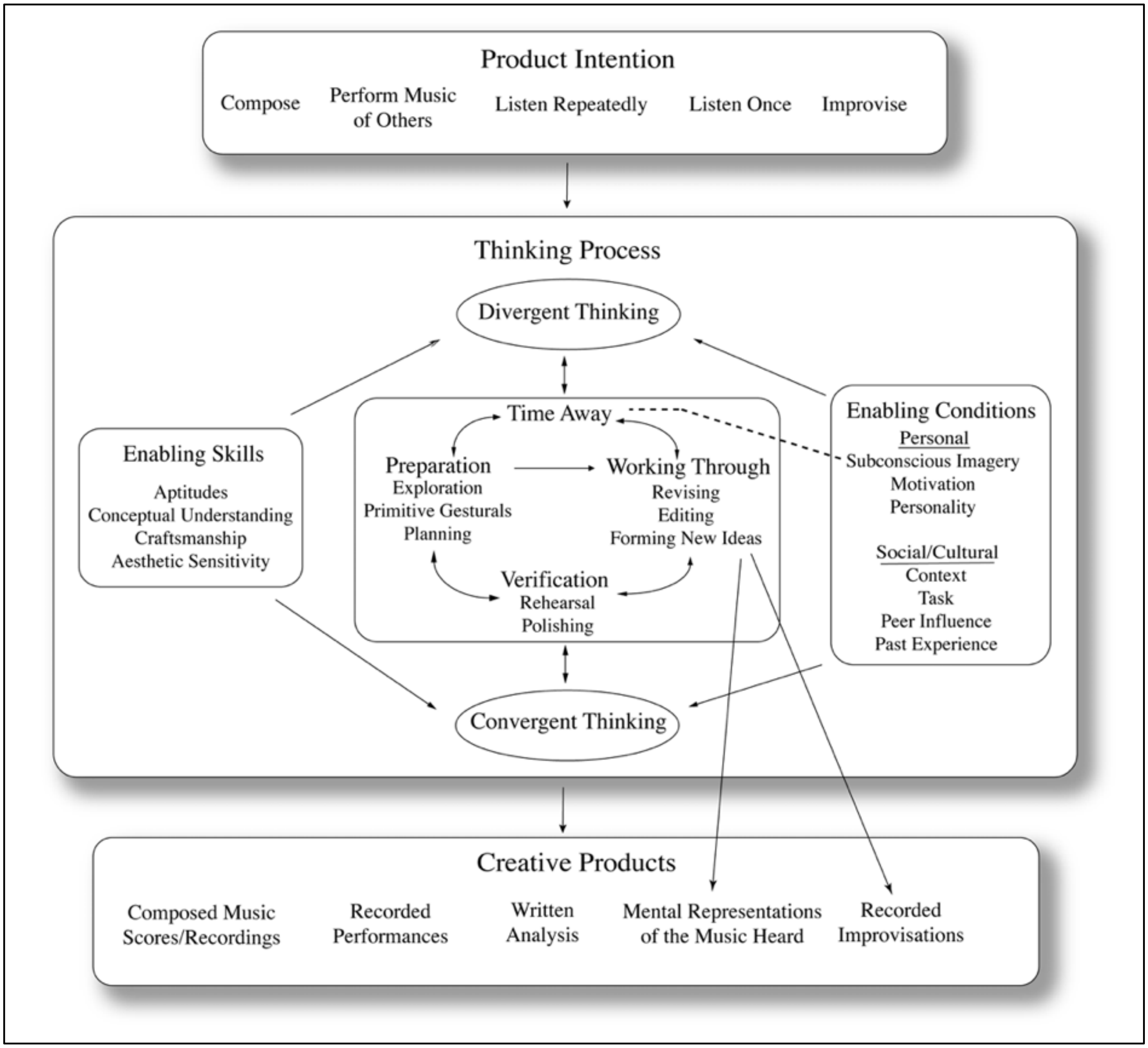

Figure 2. Model of Creative Thinking Process in Music[37]
Used with permission by the author.

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[36] Peter R. Webster, "Creativity and Music Education," in *Creativity and Music Education*, ed. Timothy Sullivan and Lee Willingham (Edmonton, Canada: Canadian Music Educators' Association, 2002), 28.

[37] Webster, *Creativity*, 12.

Highlights from this model include the role of problem solving, convergent and divergent thinking, stages of creative thinking, the importance of novelty, and the utility of the creative product.[38] These concepts show the unique aspect of musical creativity. In other disciplines, a problem-solution model is often the limit of creativity, but with music, "a 'force' in the creator inspires or drives the creative spirit," typically resulting in the creative products of composition, performance, and improvisation or listening and analyzing.[39]

Most observers would assume the typical music education classroom to be a creative environment, but often, the only creativity students experience in a traditional ensemble may be the "re-creating" of others' work through secondary performance. This typical music classroom may lack the time needed for a creative process to bloom. In the more flexible informal music classroom, students have the opportunity to cultivate authentic creativity with active listening, exploration, improvisation, and composition as key directions of a curriculum, with creativity at its core. These additions allow for a different dimension of student perception and learning, attaining an understanding of music that is enriching and that deepens their musical experience.[40] While a natural tendency for any student, undergraduates can show various levels of comfort and ability in creative environments. It is important to consider each student's skill, comfort with risk, aptitude with problem-solving, learning style, personality, etc.

To grow comfort and familiarity with creative activities that may require divergent thinking with open-ended tasks, educators should consider what pedagogy will encourage a

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[38] Webster, *Creativity*, 12.

[39] Webster, "Creative Thinking," 13..

[40] Bauer and Dammers, *Instrumental*, 226.

fluency in creative environments.[41] Hallam suggests a structure to facilitate creativity with supportive activities, including:

(a) Listening to music and developing aural skills, including the ability to audiate
(b) Imitating musicians and musical styles and genres
(c) Analyzing how music is structured
(d) Engaging musically with others more experienced than oneself.[42]

These steps represent constructive, informal, and authentic values. They also represent an approach compatible with TPACK instructional planning, which provides a thoughtful and thorough implementation for music technology activities.

Creativity and Technology

Music technology can take many forms and can assume diverse roles. As a central part of a creative curriculum, its application most often falls into the category of electronic technology or computer software. Teachers normally use many kinds of technological aids, including electronic instruments, digital recordings, notational software, and other utilities that support learning in the music classroom. Heil reminds educators that these tools facilitate and enrich learning through "authentic activity-based tasks…that extend options for creating music, individualized approaches to learning, dynamic student-teacher interactions and a flexible-supportive work environment."[43] In her study, she observed how high school students' creative efforts using compositional software. Using Garage Band software and a MIDI keyboard,

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[41] Erin E. Sovansky et al., "Not All Musicians Are Creative: Creativity Requires More than Simply Playing Music," *Psychology of Music* 44, no. 1 (October 15, 2014): 32, accessed December 3, 2023, https://doi.org/10.1177/0305735614551088.

[42] Susan Hallam, *Music Psychology in Education* (London: Institute of Education, 2008).

[43] Leila Heil, "Synergy in the Composition Classroom: Powerful Learning through Technology and Instructional Design," *Journal of Music, Technology & Education* 12, no. 2 (January 2019): pp. 165-178, https://doi.org/10.1386/jmte_00004_1, 167.

students with various skill levels composed music. The informal process of editing and arranging their ideas through exploration and experimentation "contributed to a low-pressure learning environment and fostered student reflection."[44] This use of technology is an attractive prospect for educators seeking tools that level the instructional playing field and provide a new depth to students' musical experience.

When considering new creative tools for student learning Kaschub and Smith provide criteria for instructors to consider:

- Does the available tool enhance the student's ability to meaningfully connect with a world of sound?
- Are the sound options offered by the tool, sounds with which the composer has a personal connection?
- Are the sound options authentic to the task the composer has adopted?
- Can the composer make meaning with the tool?[45]

With the right creative technology, both trained and untrained students construct new musical knowledge onto familiar knowledge through authentic experience, helping them develop a sense of agency as they guide their own musical journey.

Even beyond the classroom, Giddings reminds teachers that "technology and creativity are ways to engage those unengaged learners in music and your opportunity as a music educator to instill relevant skills for active lifelong music making."[46] Of course, this desirable result is a noble goal in all styles of musical pedagogy, but does the creative curriculum empowered by technology result in a unique path to student success? As mentioned already, this combination is constructivist, informal, and authentic in its nature of learning. Educators need to understand

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[44] Heil, *Synergy*, 170.

[45] Kaschub and Smith, *Minds on Music*, 51.

[46] Giddings, *Technology,* 3.

these intersections and the possible implications for their classrooms by committing to "enact pedagogies that develop communities of creative musical practice, that extend musical capacities, and that nurture and support creative thinking as a disposition."[47] By appreciating the multidimensional aspects of the creative process and choosing to implement creative activities, instructors can confidently choose this curricular direction to benefit the comprehensive music learning of all students. Educators may find this type of classroom to be a solution that broadens the population that music programs serve.

"The Other 80%"

The use of DAW software for exploration and creativity offers unique benefits for the music appreciation classroom. As mentioned in previous sections, the informal and constructivist classroom allows for instruction that is relevant and effectual for each student, and regardless of prior experience and notation literacy, all students can realize this benefit.

Researcher David Williams has termed this subsection of student populations as "the other 80%."[48] In his research, the vast majority of educators polled agreed that reaching these students is an important priority and that technology-based music instruction (TBMI) plays a unique role in this cohort's development.[49] According to Williams, the attributes of the non-traditional student are as follows:

1. Are in the sixth through twelfth grades
2. Do not participate in traditional performing ensembles
3. Have a music life independent of school music
4. May sing or play an instrument (if so, likely drums, guitar or keyboard)

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[47] Michele Kaschub and Janice Smith, *Composing Our Future: Preparing Music Educators to Teach Composition* (New York: Oxford University Press, 2013), 100.

[48] Williams, "The Non-Traditional Music Student," 133.

[49] Ibid., 144.

5. May not read music notation
6. May be unmotivated academically or have a history of discipline problems
7. May be a special needs student
8. May aspire to a career in music recording or music industry.[50]

While Williams polled high school teachers, and most current research also deals with this age group, the typical undergraduate freshman is situated closely enough in age and development to expect the same results. Undergraduate students who have experience playing an instrument or singing strongly link their musical comprehension to their kinesthetic experience (tactile feedback, aural discrimination, etc.). These experiences allow them to code the knowledge of musicianship to their personal experience and to understand concepts like melody, harmony and rhythm, kinesthetically. Those students with no prior experience are at a distinct disadvantage when contemplating these concepts in a traditional music appreciation class, and these same elements of music can seem highly abstract. Instead, untrained students often focus their knowledge about music on performance value, artist biography, lyrical content, and emotional expression.[51]

In a survey of high school teachers, Dammers identified the typical music technology class as serving this cohort of non-traditional students.[52] Both authors identify TBMI as broadening the "horizon" of music education with non-traditional students and also for continuing research to illuminate the intricacies of educating them. Addressing the needs of this student population is a logical approach for music educators, as it not only extends the reach of music programs but also transforms the way students and their potential are perceived. The non-

[50] Williams, "The Non-Traditional Music Student," 137.

[51] Barbara Freedman, "Music Fluency," 368.

[52] Richard J. Dammers, "Technology-Based Music Classes in High Schools in the United States," *Bulletin of the Council for Research in Music Education*, no. 194 (2012): 73–90.

traditional student, while not fluent in the typical language of traditional ensembles and notation, has a personal expertise rooted in their own musical meaning and often exhibits advanced instincts of musicianship. Music educators often overlook the musical achievement of "the other 80%," leaving it without a place to develop.

Bula studied the makeup of music technology classes and how they served the non-traditional student. Of the respondents to this survey, roughly 20% stated that their music programs offered some category of modern music course (music technology, popular music, commercial music, among others). These courses were open to all students and mainly included those not in a traditional music course. Multiple teachers responded that music technology classes served as a gateway to traditional ensembles as students grew their musicianship and fluency, suggesting that the dynamic between traditional and non-traditional music courses is not necessarily incompatible. Bula suggests that a successful experience in a music technology class can build self-confidence in students, possibly changing their perceptions of traditional music ensembles.[53]

While not all students in the other 80% are untrained, educators must recognize the significance of this cross-section and commit to customizing learning beyond their typical pedagogy. Whatever their fluency, experience, or comfort level, computers help students to "think in sound" whatever their skill level and can "serve as a springboard to creativity by helping to generate musical ideas."[54]

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[53] Gordon, *Learning*, 54.

[54] Bauer, *Music Learning*, 65.

Audiation and Aptitude

Educators must keep in mind that achievement, while sometimes more noticeable, is different from aptitude. Musical aptitude, or potential, is a concept championed by Edwin Gordon and can bring to light essential variables between the achievement and ability of all students. In his extensive work developing tests to measure students' musical aptitude, Gordon found that half of students with high music aptitude never matriculate into music training beyond elementary school. Educators can then assume that nearly the same number of students with high overall music aptitude exist *outside* music programs as participating in them.[55] This represents a thought-provoking possibility for educators to consider. Many instructors may rightly assume that their programs are missing certain students, such as those with a full schedule or amateur musicians who are independently trained. Nonetheless, they may correctly assume that a considerable proportion of the broader population also possesses a high degree of musical potential. Gordon explains,

> There are students with high music aptitude who never achieve at the level of their potential because they have not had appropriate guidance or instruction in music. Thus, they do not have readiness or motivation to begin or continue to achieve in music. Given appropriate guidance and instruction, in time those students may be as successful as students who have high levels of music achievement and high music aptitude.[56]

This interplay between aptitude, opportunity, and achievement is a powerful relationship to consider for modern music education and a need that music technology opportunities can fulfill.

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[55] Edwin Gordon, *Learning Sequences in Music: A Contemporary Music Learning Theory* (Chicago: GIA Publications, 2012), https://ebookcentral.proquest.com/lib/liberty/detail.action?docID=5306413, 43.

[56] Ibid., 45.

Technology as Instrument

As the use of music technology and computer software shifts from utility or support to a central component, teachers can increasingly include it as a featured curricular element. Beyond the historical use of computer software for notation, aural training, or practice skills, educators may enlist music production software to accomplish unique results not possible without it.[57] This type of software is sometimes called multi-track music production software (MMPS) or, for this study, a digital audio workstation (DAW). Countless products fall into this category, including Garage Band, Audacity, ProTools, Logic, and Ableton. These products share many of the same traits, including capabilities to record separate tracks of digital audio, edit audio and apply effects, to edit MIDI recordings (Musical Instrument Digital Interface), use digital instruments and audio samples, and generally serve as the "hub" for digital music creation. The experience that these programs offer students complements their natural fluency with diverse platforms, serving as a natural interface for students' creative learning.

In his study "Music Composition as Pedagogy: A Qualitative Case Study of Undergraduate Music Students," McElroy approached music composition as its own pedagogy, asserting that studying the undergraduate experience can help address a gap in current literature. He asserts that the same questions about school age students' creativity and composition should also be asked about their college experiences. His case study illuminated how students' unique praxes affected their compositional experiences. "Music composition provided students an opportunity to explore, create, and learn through authentic musicing…Students gained understanding and involvement in a music praxis that was informed by research, listening,

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[57] Kuhn and Hein, Electronic Music School, 13.

composing, and sharing during the composition process."[58] McElroy found that using compositional instruction as pedagogy benefited the learning experience and "the unique and individual nature of each student was fostered, supported, and celebrated through music."[59] These findings reinforce the tenants of authentic learning, the informal classroom, and as a benefit to researchers in observing composition through a social learning lens. McElroy also suggests that future studies could explore the benefits of compositional pedagogy with non-music majors in a music appreciation course to enhance its advantages.[60]

Similarly, Dorfman investigated the effect of experience and learning style on student comprehension when using technology. He found that students with various backgrounds and learning preferences can all perform equally well with music software tasks, no matter their experience. His research demonstrated that music educators can consider computer-based instruction a legitimate instructional strategy for learning musical concepts.[61] In more recent work, Kladder investigated what kind of DAW technology teachers used and how they used this technology in their pedagogy. In the *Journal of Music, Technology and Education,* he shares findings that GarageBand was the most used software among surveyed teachers but that they found a need for cross-platform, web-based solutions.[62] From the results of this survey, Kladder suggests five cyclical steps required for the successful implementation of digital audio technology: instructional support, professional development, networking with professional

[58] McElroy, "Music Composition," 230.

[59] Ibid., 233.

[60] McElroy, "Music Composition," 305.

[61] Dorfman, "Learning Music," 145.

[62] Kladder, "Digital Audio Technoloy," 230.

music producers, free web-based DAW technology, and music teachers who enculturate into the world of digital audio technology.[63] Other research has also included investigations into technology used as medium, instrument, and interface in the music classroom and with varying age groups. Others have examined how technology intersects with curriculum, an identified gap in teacher education and classroom instruction. Extending the work of earlier research regarding technology's application, Thompson surveyed teachers using technology-based music instruction (TBMI) and examined their curricular applications, finding "computers as the central technological hub, an emphasis on composition as the primary class activity, and a reduced emphasis on music performance skills and notational literacy objectives" within this instruction.[64] Additionally, this research highlighted the need for a more accepted theoretical model to be utilized in structuring and filtering technology curricular use.[65]

Summary

A comprehensive examination of the literature revealed that researchers approach the music technology topic from various angles. Researchers dedicate a considerable amount of research to studying music technology classes designed for students in secondary education. This analysis identified a research gap when examining music technology's benefits to undergraduate music appreciation students. The survey examines complementary philosophical and pedagogical themes that serve as an appropriate foundation for further research.

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[63] Kladder, "Digital Audio Technoloy," 220.

[64] Thompson, "Music Education Technology," 111.

[65] Ibid., 131.

Chapter Three: Methods

Introduction

This research sought to understand the learning processes and benefits of a technology-as-instrument approach for undergraduate students. An illustrative case study was employed in a bounded system of the researcher's music appreciation class to investigate comprehension benefits. As creative learning represents a complex and dynamic topic, the researcher examined qualitative and quantitative data to observe a diverse and personal learning experience.

Design

The researcher employed an illustrative case study to investigate the experiences of students' creative learning with music technology. Yin explains that a case study can investigate a phenomenon in its real-world context while assuming many variables of interest.[1] Creswell and Poth defined a case study as:

> An approach in which the investigator explores a real-life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information (e.g., observations, interviews, audiovisual material, and documents and reports), and reports a case description and case themes.[2]

Researchers consider the variety of data they can gather, including quantitative evidence, as a valuable characteristic of the case study.[3] Since this study investigates the complex process and

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[1] Robert K. Yin, *Case Study Research and Applications: Design and Methods*, 6th ed. (Thousand Oaks, California: Sage Publications, 2018), accessed April 19, 2024, https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=3361990&site=ehost-live&scope=site&custid=liberty&authtype=ip,shib&ebv=EB&ppid=pp_C, 15.

[2] John W Creswell and Cheryl N Poth, *Qualitative Inquiry & Research Design: Choosing among Five Approaches*, 4th ed. (Los Angeles: Sage, 2018), 96-97.

[3] Yin, Case Study Research, 17.

result of music and will collect quantitative and qualitative data with multiple sub-units, the researcher utilized an embedded design.

In music education, researchers frequently employ the case study as a mechanism for research. Barrett credits this to its “flexibility of focus defining the phenomenon of interest.”[4] Moreover, Barrett highlights additional and specific attributes, including integrating diverse data collection methodologies, adopting multiple scholarly orientations, and acknowledging their contextual relevance.[5] In his study investigating compositional pedagogy, McElroy examined the learning processes of undergraduate students and utilized the case study to describe the complex phenomena of students’ authentic and independent learning.[6] Horton employed the intrinsic case study as one of multiple methods to investigate the intersection and connections of technology and musical creativity, highlighting the importance for music educators to consider their changing role when supporting their students’ creative agency.[7] Bell used the case study to describe the creative processes of young creators in the studio environment. His book *Dawn of the DAW* delves into the particular craftsmanship used by his participants' authentic and informal processes, demonstrating the intersection between musical actions and technical actions.[8]

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[4] Janet R. Barrett, “Case Study in Music Education,” in *The Oxford Handbook of Qualitative Research in American Music Education*, ed. Collen M. Conway (New York: Oxford University Press, 2014), 113–132.

[5] Barrett, Case Study Research, 114.

[6] McElroy, “Music Composition,” 306.

[7] Patrick William Horton, “Creativity and Technology in Music Teaching and Learning,” (PhD Dissertation, Northwestern University, 2022), 101.

[8] Adam Patrick Bell, *Dawn of the DAW: The Studio as Musical Instrument* (New York: Oxford University Press, 2018), 207.

Dammers employed a case study to examine factors surrounding the implementation of a music technology program.[9]

While researchers widely use case studies in the social sciences and education, they have claimed certain limitations to this design. Flyvbjerg outlines common misunderstandings about the limitations of case studies, including improper elevation of theoretical knowledge, difficulty generalizing results, challenges to progression beyond the hypothesis, biases toward the researcher's preconceptions, and difficulty summarizing results and developing theory.[10] In summarizing Flyvbjerg's work that dispels these misconceptions, Barrett posits that music education rightly "looks to case studies for multiple accounts of concrete, context-based knowledge, crucial in forming collective expertise and professional knowledge to inform teaching and learning."[11] Researchers may find that the key to validity and improving the quality of case study research may lie in efforts to gain methodological rigor, a commitment to a holistic result, and a "reintegration of the study's findings into the fabric of what is already known about the topic under study."[12]

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[9] Richard Dammers, "Bulletin of the Council for Research in Music Education," *Bulletin of the Council for Research in Music Education* 2010, no. 186 (2010): 55–65.

[10] Bent Flyvbjerg, "Case Study," in *The Sage Handbook of Qualitative Research*, ed. Norman K. Denzin and Yvonna S. Lincoln (Thousand Oaks, CA: Sage Publications, 2011), 301–316, 302.

[11] Barrett, "Case Study," 120.

[12] Ibid., 123.

Research Questions

This research study seeks to address the following questions:

RQ1: Does a technology-as-instrument approach result in measurable growth in students' comprehension and aural discrimination skills in an undergraduate music appreciation course?

RQ2: How do students perceive their learning, comprehension, and creative process when using a technology-as-instrument approach?

Participants

This research constitutes a bounded case study design undertaken in a music appreciation class, and employed purposeful sampling techniques to select participants stratifying them into embedded subsections. The basis of this case study lies in the existing literature and research on creative curriculum, informal learning, and technology in the field of music education. As with many topics in music education, contact with students is essential to learn about their experiences. The researcher recruited participants to conduct an illustrative case study from the undergraduate student population at Kennesaw State University (KSU). Creswell explains that recruiting students from a bounded class can provide a rich source of relevant case study data, including detailed information about the participants, as well as themes and issues that arise.[13] The researcher employed a purposeful sampling strategy, as this study occurred in his own class sections. To ascertain students' background in traditional music training, the researcher administered a survey to assess proficiency with notation, instrumental experience, participation in a traditional ensemble, DAW experience and music lessons. This survey allowed the

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[13] John W. Creswell, *30 Essential Skills for the Qualitative Researcher* (Thousand Oaks, CA: Sage, 2016), 269.

researcher to segment student groups and establish a baseline for later data analysis. The sampling and stratification for this research followed strategies of other studies, similar to categories used by Dorfman, that included music experience, general technology experience, and music technology experience.[14]

Since many students (no matter their major) already held traditional music training, understanding their background helped further segment the study sample and to translate results on multiple levels. Students described as “non-traditional” also made up a notable section, gaining their experience through self-guided instruction in singing, playing, or music production. Finally, a cohort existed representing students with little to no experience with reading, singing, or playing music. The researcher categorized students based on their responses to the experience survey. The researcher invited all students to take part in the research study, which he communicated through a class presentation, follow-up emails, and a meeting with interested students.

Setting

The researcher sought approval from the KSU Office of Research and the Bailey School of Music to proceed with the study within sections of the *Music in Society* course (MUSI 1107). *Music in Society* is a music appreciation class that includes up to ninety students in each section. As one of the required general education art electives (along with dance, theater, and art), it is representative of the general KSU student population and includes mostly non-music majors. This broad population was central to the purpose of this study as the researcher sought the cooperation of participants with all levels of music experience.

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[14] Dorfman, “Learning Music,” 3.

Data Collection Method

During a typical semester, the researcher/instructor spends a significant portion teaching the elements of music (melody, harmony, rhythm, expression, form, texture, instruments). During this segment, all students took part in traditional textbook learning and lectures on the elements of music. Students also completed creative activities in a cloud-based music production software called SoundTrap. Using pre-designed activities, they explored tasks that allowed for a hands-on approach for music creation in a multi-track editor, also referred to as a Digital Audio Workstation (DAW). Students completed activities that included analyzing the interplay of melody and harmony and composing melodies with SoundTrap's creative tools.

Students completed an initial participant survey (Appendix C) to outline their experience with music instruction, membership in performing groups, and fluency in musical concepts. Their responses allowed the researcher to segment students by these variables obtaining a stratified sample of participants. In addition to the musical background and experience survey, this study measured the musical aptitude of each student by using a peer-reviewed instrument. The researcher employed the Advanced Measures of Music Audiation (AMMA), a peer-reviewed instrument specifically designed for high school and college freshmen, to assess the music aptitude levels of each student. This testing instrument established a baseline to understand students' learning considering their musical aptitude, providing an important variable within the study group for the researcher to analyze.

After completing treatment tasks, students completed a score report (Appendix E) and learning experience survey (Appendix F) that recorded activity scores and a rating of their understanding, confidence level, and a description of their personal learning processes. The analysis of these data sources aimed to qualify and quantify the improvement that students may show and to gain a deeper understanding of this pedagogical tool through the student experience. Open-ended questions prompted participants to generate rich descriptions of their learning and interaction with technology.

Students completed an online activity to generate numerical data before and after the study treatment. Using activities designed by researchers at The Music Lab (Yale University and the University of Auckland), students tested their listening skills with major/minor modes, melody memory, and aural discrimination.[15] Students self-reported their scores through an online survey. The researcher gathered the data and user information and compiled them in password-protected spreadsheets in an online database.

This illustrative case study employed a two-tier design in gathering qualitative data by engaging students in surveys and focus groups. Yin suggests that this "dual pattern, involving two different levels of information about two different-sized groups, can strike the desired balance between the need to cover both the breadth and depth of an issue."[16] The learning experience survey allowed the researcher to identify experiences that could be investigated further within the focus group, forming a "thick description" of multifaceted learning. The focus group and discussion questions (Appendix G) allowed the study to collect rich data regarding complex, real-world events and to diminish the researcher's "selectivity and reflexive influences."[17] Focus group discussion transcripts were transcribed by software and edited by the researcher for readability.

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[15] "The Music Lab," The Music Lab, accessed September 21, 2023, https://www.themusiclab.org/.

[16] Yin, Qualitative Research, 254.

[17] Ibid., 340.

Procedures

The researcher sought approval from relevant Institutional Review Boards (IRB), first from Liberty University and then from the researcher's home institution, Kennesaw State University. Upon approval from Liberty University, the researcher received IRB approval and permission to recruit from KSU (Appendix B). At the beginning of the semester, students listened to an in-class explanation of the study and received an overview document and consent form that detailed the study scope and timeline, participant rights, risks, and benefits (Appendix A).

Pre-treatment Measures

To gather data about the music background and experience of students, the researcher used the initial student survey as one of two pre-treatment measures. The student background and experience survey (Appendix C) investigated participant involvement in music lessons, instrumental ensembles and choirs, independent learning, and music production. The goal of this Qualtrics survey was to stratify the study participants into various levels of trained and untrained groupings. Participants completed the survey on their own time during the first week of class. The survey posed the following questions:

1. Did you participate in a traditional ensemble during middle or high school? Which ensemble, and for how long?
2. Did you take private music lessons as a child or teenager? If so, what instrument?
3. Have you ever taught yourself how to play an instrument? If so, how?
4. How do you typically enjoy music? (performer, composer, producer, appreciator, listener, concert goer, as entertainment, as an intellectual exercise)
5. At what level can you read music?
6. Have you used music production software to record, compose, or arrange music? (SoundTrap, GarageBand, FLStudio)

The data collected by this survey allowed the researcher to separate participants into sub-units based on their background and perceived ability, identifying untrained students as the major subunit of this case study. Using these sub-units, the researcher also categorized and developed qualitative and quantitative data.

An additional pre-treatment measure used in this study to measure student aptitude was the Advanced Measures of Music Audiation (AMMA). The AMMA was designed to measure the aptitude of undergraduate freshmen, non-music majors and music majors alike.[18] The AMMA test does not test achievement but music aptitude or potential. This study also sought to investigate the music learning of untrained students, a substantial portion of "the other 80%." Those students outside the normal world of training and performance can exhibit high potential on aptitude tests. Along with learning about the benefit of technology to these students, the researcher sought to correlate their learning and success to the variable of their music aptitude. As a pre-test measure, the researcher administered the AMMA test to all participants in the study. This test focused on aural discrimination, requiring students to detect sameness or difference in 30 short musical phrases. Each example included a pair of melodic phrases that were the same or were tonally or rhythmically different. The results from the aptitude test are included in Appendix D, with a discussion in later chapters. The scores from this 22-minute test were normalized by category with data provided by the publisher.

Treatment Measures

Within the treatment period, students participated in class activities and lectures for the week's topic. The activities in class instruction included presentation slides, video and audio media, and demonstration by the researcher/instructor. Treatment included the self-administered

[18] "The Purposes and Description of the Advanced Measures of Music Audiation," *Https://Giamusicassessment.com* (GIA, n.d.), accessed May 19, 2024, https://giamusicassessment.com/pdfs/AMMA%20-%20Purpose%20and%20Description.pdf, 5.

Super-Listener activity – an aural discrimination test taken before and after the SoundTrap activities. Students self-reported their test scores on a pre- and post-treatment survey. Completed between the two Music Lab test, the SoundTrap activity was a shared project between the instructor and each student. The graphic below represents the treatment sequence.

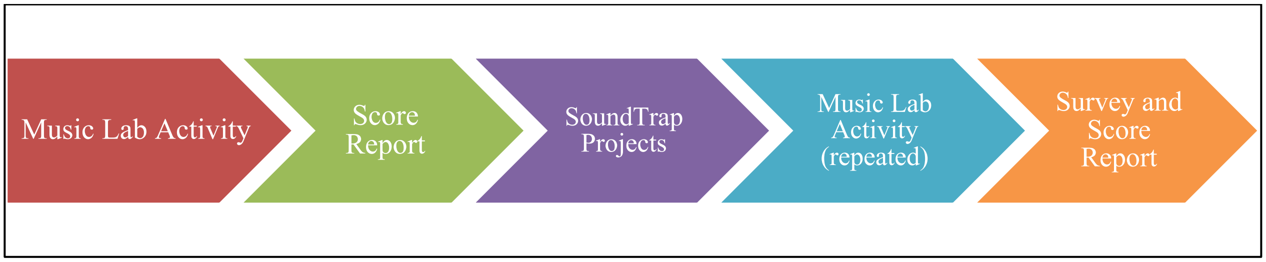

Figure 3. Treatment Sequence

The testing instruments used in the treatment period are activities developed by the Music Lab, a research venture of Yale University and University of Auckland. The Music Lab studies how humans hear and understand music including mostly ethnographic research projects.[19] The web-based activity chosen for this study is the Super-Listener activity – a test of aural discrimination, with students judging the sameness or difference between short melodic phrases, or tone scrambles. Students indicate an answer on their computer keyboard by pressing one of two alpha-numeric keys. They completed the same activity before and after the SoundTrap project assignment and reported their score on a score report survey.

Next, students completed a SoundTrap activity, utilizing technology as an instrument to accomplish a creative project. SoundTrap is a cloud-based DAW that allows students to produce music in a collaborative, multi-track environment. A custom assignment designed by the researcher/instructor was distributed to each student in SoundTrap. The project incorporated

[19] The Music Lab, "The Music Lab," *The Music Lab*, https://www.themusiclab.org/about.

skills applicable to the topic of the week and relevant to building aural discrimination skill. The result of this creative activity was not graded for content, and instead served as an instructional tool for students to construct their own musical understanding. The SoundTrap project also served to provide a common experience that students could describe their learning on the ending survey, and in resulting focus group discussions.

The researcher used self-administered surveys to gauge student perception of their learning after participating in the creative SoundTrap projects. The first survey, served only to report their score from the first Music Lab activity attempt. After the SoundTrap Project and second Music Lab activity attempt students completed a post-treatment survey. Questions allowed for participants to rate their understanding of the topic, report their Music Lab activity score, and recount the effect that DAW technology had on their music learning and comprehension.

Researcher Positionality

My interest and motivation for this topic emanate from my experiences as a teacher in music education. With the use of technology and music software as a central tool for instruction and musicking, educators can, in my opinion, provide unique experiences for students' authentic learning. This opportunity is an attractive topic for inquiry as undergraduate students' creative experience with technology remains largely unexamined in the research literature. I also find technology and its influence on student learning a motivating topic for my own practice and for all of music education.

As students create and learn within their personal and active context of musicking, I approach this topic as a constructivist educator, as summarized by Webster.[20] I also view my research through a hybrid lens of both praxial and aesthetic philosophy. Because students approach their learning personally and actively, a praxial music education is relevant.[21] Regelski terms a praxial classroom as a "musician laboratory" where students can actively participate in the musical experience.[22] The application of technology-as-instrument plays a distinctive role in the praxial approach to this research study. In addition, I view the student experience as an aesthetic one, examining their experience, confidence, and connection to their personal music making.[23] The emotional and cognitive connection to music is already intrinsic in students' personal preferences and worthy of being examined regarding their creative learning. Last, based on the complex and dynamic experience of music learning, I approach the challenge of this research through methodological eclecticism by seeking data through multiple methods and techniques.[24]

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[20] Peter Webster, "Construction of Music Learning," in *MENC Handbook of Research on Music Learning*, ed. Richard Colwell and Peter Webster, vol. 1 (New York: Oxford University Press, 2006), 36, accessed February 2, 2024, https://ebookcentral.proquest.com/lib/liberty/detail.action?docID=829330.

[21] David James Elliott, *Praxial Music Education: Reflections and Dialogues* (New York; Oxford: Oxford University Press, 2005), accessed April 25, 2024, https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=138147&site=ehost-live&scope=site&custid=liberty&authtype=ip,shib, 16.

[22] Thomas A Regelski, *Teaching General Music in Grades 4-8: A Musicianship Approach* (New York: Oxford University Press, 2004), 4.

[23] Bennett Reimer, *Seeking the Significance of Music Education: Essays and Reflections* (Lanham, Md.: Rowman & Littlefield Education, 2009), accessed April 25, 2024, https://ebookcentral.proquest.com/lib/liberty/detail.action?docID=467328, 100.

[24] Kate R. Fitzpatrick, "Mixed Methods Research in Music Education," in *Approaches to Qualitative Research*, ed. Colleen Conway (Oxford University Press, 2020), 175; Abbas Tashakkori and Charles Teddlie, "Mixed Methods Research: Contemporary Issues in an Emerging Field," in *SAGE Handbook of Mixed Methods in Social & Behavioral Research*, ed. N. K. Denzin and Y.S. Lincoln (SAGE Publications, 2021), 285–300.

My position in this study is that of a primary researcher, gathering and analyzing data. My exposure to this topic and its pedagogy is extensive through my professional background as an educator, composer, and performer and as the instructor of the participants' class. This combination of performance and practice is not unaddressed in arts-based research. McElroy addressed this in a similar research study by connecting to the explanation of Gouzouasis and the role of the artist/researcher/teacher. This triad of experience assists researchers in representing a holistic view of the topic at hand.[25] This consideration assisted me in viewing my interactions and research through a appropriate lens and confronting my own assumptions and biases.

As the instructor for the *Music in Society* course, my role also created an additional opportunity and challenge. Based on my involvement as both researcher and instructor of record, I was in a unique position to observe participants as their teacher. While this configuration required a planned and constant adjustment to minimize issues of power dynamics, the positioning resulted in a higher level of familiarity and relational trust.

Data Analysis

This study collected qualitative data through questionnaire responses and discussion questions, as well as quantitative data from aptitude testing and activity scores. The researcher analyzed qualitative data thematically with manual coding techniques and utilized Computer Assisted Qualitative Analysis Software (CAQDAS). Text-based sources (survey responses and focus group transcripts) were manually coded using open labels and category labels.[26] Following

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[25] Peter Gouzouasis, "Music in an A/R/Tographic Tonality," *Journal of the Canadian Association for Curriculum Studies* 5, no. 2 (December 1, 2007): 40, https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/scholarly-journals/music-r-tographic-tonality/docview/1367079780/se-2?accountid=12085.

[26] Yin, Case Study Research, 196.

a hybrid approach to code generation, the researcher created *a priori* labels as a starting point and generated additional labels in the first pass of coding. The strategy types used included *in vivo, descriptive,* and *values-based* coding. This initial pass of coding, which Saldana terms as the "first cycle," served to determine the code labels and categories.[27] A second cycle is built on this data to identify higher-level themes. In addition to manual coding, the study incorporated the use of Atlas.ti (23.2.1 for Mac) software to organize data and develop additional themes from qualitative data.[28] CAQDAS software empowers researchers to compare various qualitative data in diverse and efficient ways. Researchers benefit from the use of analysis software as an important tool to manage files, identify patterns, and assist the researcher in disassembling the data.[29]

Trustworthiness

Qualitative research provides data and analysis that is diverse, complex, and personal to the participants. To authentically and reliably represent these findings, the researcher employed strategies to increase internal and external validity, expand reliability, and contribute to the study's overall trustworthiness.[30] These strategies were utilized to increase the effectiveness of study findings and translatable value.

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[27] Johnny Saldaña, *The Coding Manual for Qualitative Researchers*, 4th ed. (Los Angeles: Sage, 2021), 40.

[28] ATLAS.ti Scientific Software Development GmbH, *ATLAS.ti Mac.*, v. 23.2.1. ATLAS.ti Scientific Software Development GmbH. 2023.

[29] Yin, Case Study Research, 201.

[30] Ibid., 43.

Credibility

Researchers can enhance the credibility of their research design and results by employing strategies that counter threats to validity, including triangulation, prolonged engagement, thick descriptions, and respondent validation.[31] This research gathered qualitative data through surveys and interviews along with quantitative data to achieve a convergence of evidentiary findings. Yin states that data triangulation, in particular, strengthens the construct and validity of a case study.[32] Through prolonged engagement, this study made possible an extended natural observation of classroom phenomena. In addition to gaining relevant context, Lincoln and Guba suggest that prolonged engagement assists the researcher to "detect and take account of distortions that might otherwise creep into the data."[33] Additionally, the researcher strove to exploit the design in providing rich data and "thick descriptions," a metaphor popularized by Geertz.[34] Yin posits that "when successful, the thickness of the description helps to move the interpretation away from researcher-centric perspectives."[35] Finally, the researcher incorporated a strategy for respondent validation, giving participants the opportunity to review and comment on the study's major findings.

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[31] Joseph Alex Maxwell, *Qualitative Research Design: An Interactive Approach*, 3rd ed., vol. 41 (Thousand Oaks, Calif.: Sage Publications, 2013), 126–129.

[32] Yin, Case Study Research, 128.

[33] Yvonna S Lincoln and Egon G Guba, *Naturalistic Inquiry* (Newbury Park, CA: Sage Publications, 1985), 301.

[34] Clifford Geertz, *The Interpretation of Cultures* (New York: Basic Books, 1973), 5.

[35] Yin, Case Study Research, 200.

Transferability

Transferability is the concept that research findings can be relevant outside of the studied case. According to Yin, transferability "rests on the thick description of the case and its complexities…and has to do with the reader's capacities to extend the findings to other instances and settings."[36] This study strove to maintain an appropriate level of transferability by generating rich data and explanations so that the reader may draw their own conclusions about related circumstances.

Reliability

The ability to replicate and confirm research findings is an important test of a study's reliability and depends on clear documentation of procedures. This case study incorporated documentation strategies that accounted for the nature of dynamic data, procedural changes, and other factors that represented an ever-changing research environment.[37] A clear explanation of study materials and treatment will serve to provide contextual understanding for the reader, allowing for a consistent interpretation of results.

Confirmability

Confirmability is an important building block for validity, as readers seek to corroborate research results through clearly verifiable accounting of findings. This research study utilized multiple strategies to affect confirmability including partnering with a fellow faculty member as peer debriefer and by creating accessible mechanisms for data and file management by using a

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[36] Yin, Case Study Research, 121.

[37] Mitchell Robinson, "Changing the Conversation: Considering Quality in Music Education Qualitative Research," in *The Oxford Handbook of Qualitative Research in American Music Education*, ed. Collen M. Conway (New York: Oxford University Press, 2014), 94–110, 97.

case study database.[38] By using dependable systems to manage internal data, and external accountability for key moments of study development, the researcher strove to increase study trustworthiness through mechanisms of confirmability.

Summary

This chapter outlines the protocols and procedures of the study. The researcher employed approved instruments to collect data from a student sample comprising participants from his music appreciation classes. Within the prescribed study scope, the researcher analyzed qualitative and quantitative data to determine themes and results and utilized diverse measures to increase the study's internal and external validity.

[38] Creswell and Creswell, *Research Design*, 201; Yin, *Case Study Research,* 130.

Chapter Four: Results

Introduction

The first goal of this illustrative case study was to investigate the effect that technology may have on student learning in an undergraduate music appreciation class. Using DAW software as a virtual instrument, students completed creative projects to learn about and kinesthetically connect with featured elements of music. Students independently utilized the cloud-based SoundTrap platform to explore the topics of melody and harmony through researcher-designed projects. In-class demonstrations and video tutorials supported their efforts.

This case study dealt with two questions that guided the execution and interpretation of the research. How may a technology-as-instrument approach with creative activities benefit musically students' interpretive and aural identification skills in a college-level music appreciation course? And how do students perceive their learning, comprehension and creative process when using a technology-as-instrument approach? To address these questions, the researcher collected both quantitative data about students' improvement and qualitative data about students' perception of their learning.

Participant Group Description

Participants in this case study consisted of students in the researcher's music appreciation class representing a cross-section of the general KSU student population. Their background and skill level were important variables that were thoroughly investigated so that deeper analysis was possible. Beyond the typical demographic survey, the screening tool for this study included questions that probed students' background and experience with music, allowing the researcher to consider results in light of other relevant variables.

Consenting participants totaled thirty-eight students and were largely in their freshman year (90%), representing many programs of study. Particularly valuable for this study was the students' varied backgrounds in the arts. Those who participated previously in band, orchestra, or choir during middle or high school represented 60% of the participant group, while 40% had not enrolled in traditional performing arts ensembles or classes (Figure 4). Additionally, the screening survey showed the following:

- 36% of students took private music lessons
- 76% reported some level of notational literacy, from beginning to advanced level
- 68% had used DAW software
- 55% reported teaching themselves to play an instrument

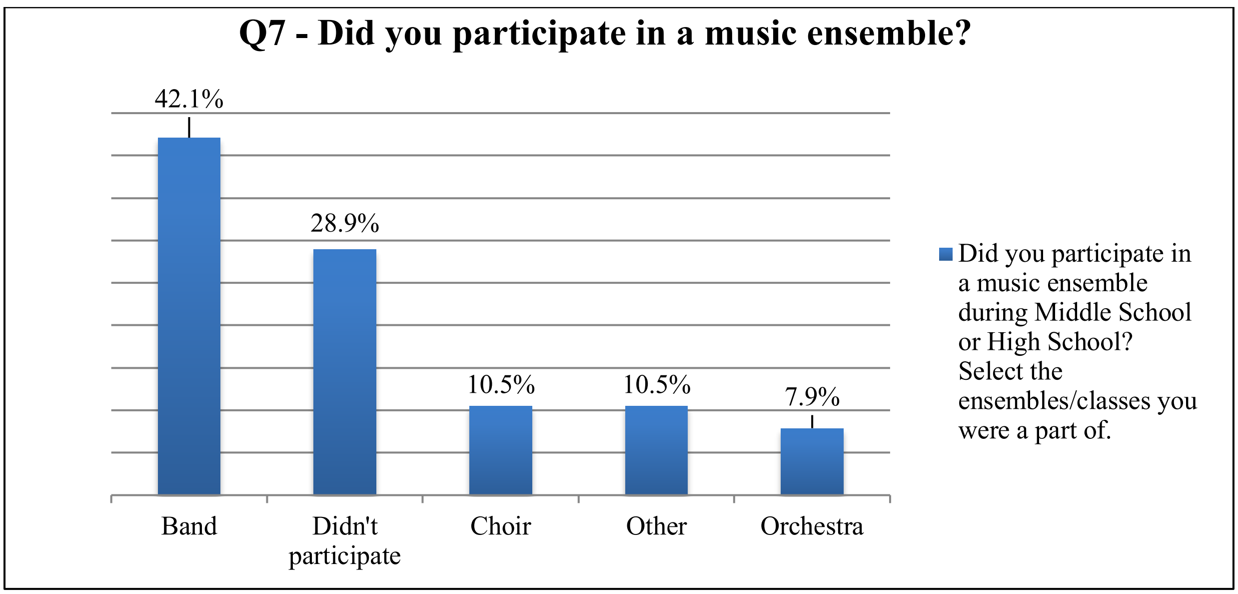
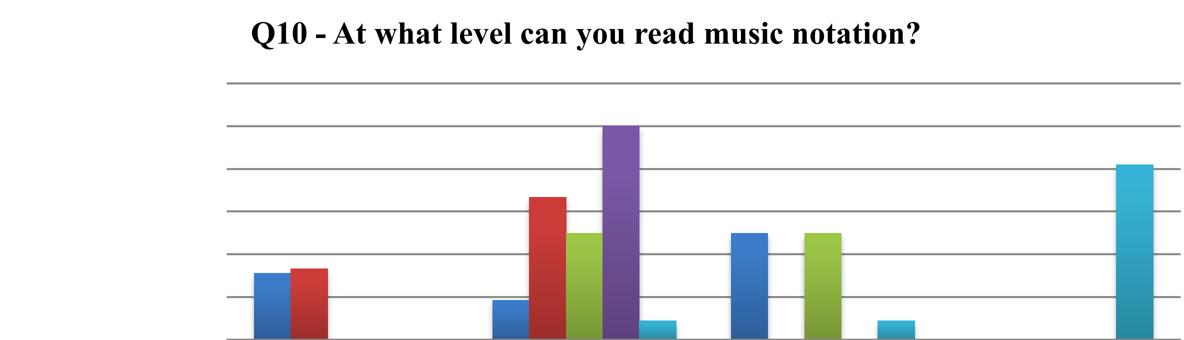


Figure 4. Ensemble Participation

The researcher separated students into study categories based on their reported experience with ensembles, notation (Figure 5), music lessons (Figure 6), DAW software (Figure 7), and self-taught skills (Figure 8).

These experience and skill levels and their criteria are as follows:

- NONE: no participation in traditional ensembles or music lessons; self-rated notational literacy that is beginning or less.
- BEGINNING: participation in at least one traditional ensemble; self-rated notational literacy that is beginning.
- INTERMEDIATE: participation in a traditional ensemble; participation in music lessons or self-taught skill; self-rated notational literacy as intermediate.
- ADVANCED: participation in a traditional ensemble; participation in music lessons or self-taught skill; advanced self-rated notational literacy.



	Advanced	Beginning	Intermediate	No experience
Band	31.3%	18.8%	50.0%	0.0%
Orchestra	33.3%	66.7%	0.0%	0.0%
Choir	0.0%	50.0%	50.0%	0.0%
Other	0.0%	100.0%	0.0%	0.0%
Didn't participate	0.0%	9.1%	9.1%	81.8%

Figure 5. Ensemble Participation and Notation

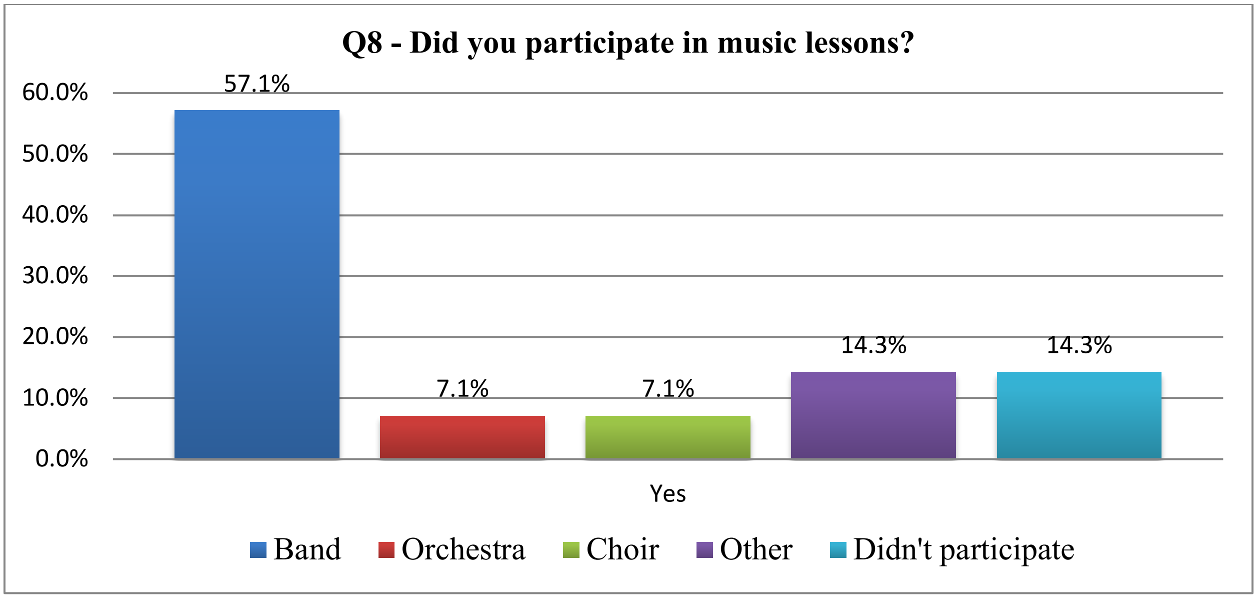


Figure 6. Ensemble Participation and Music Lessons

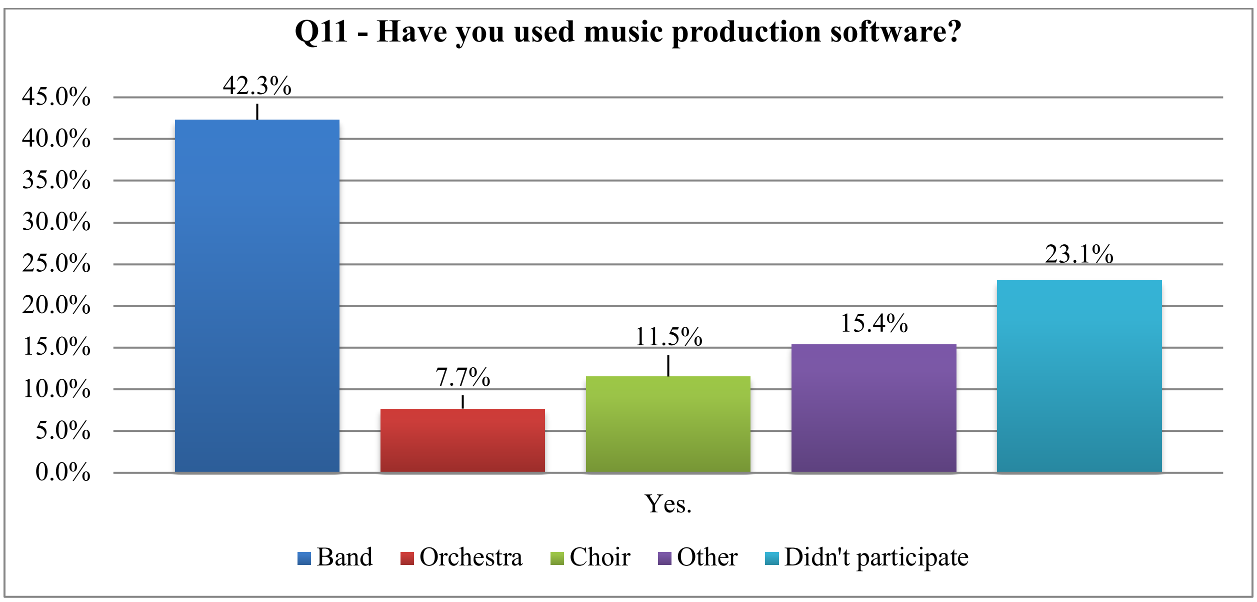


Figure 7. Ensemble Participation and DAW Software

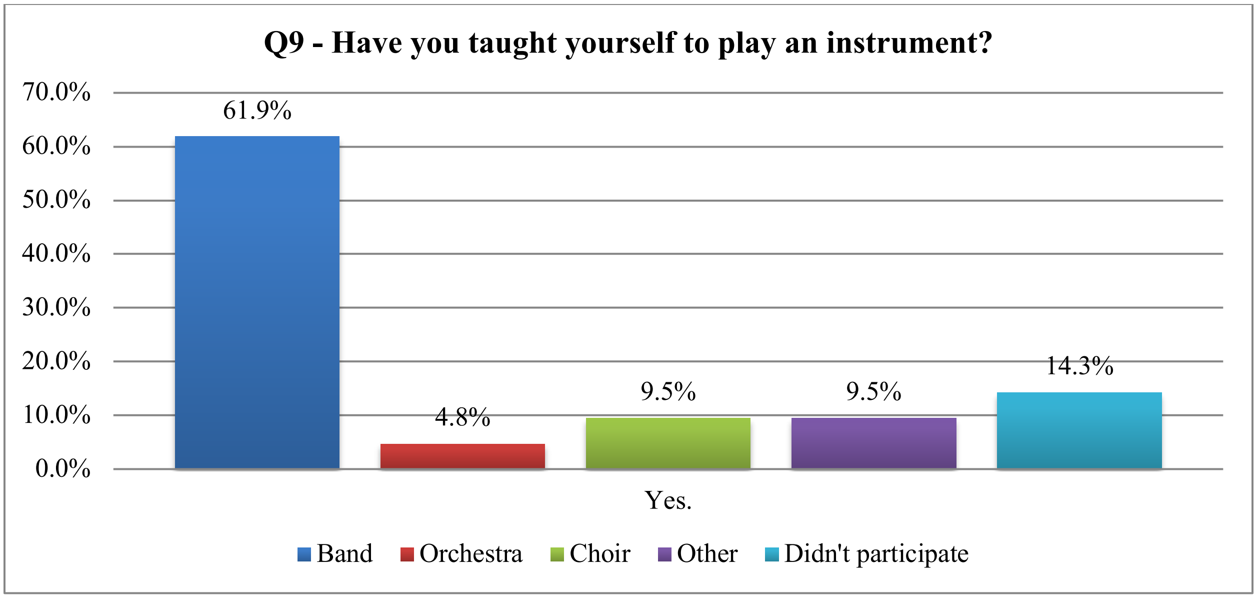


Figure 8. Ensemble Participation and Self-Taught Instrument

The Untrained and Non-Traditional Student

In this study, the cohort outside the experience of traditional performance ensembles describes students who are both "untrained" or "non-traditional." This combined group reported "no ability" to read music (57%) or a "beginning" level of notational literacy (28%). Most in this category lacked experience using DAW software and had not participated in private music lessons. These students also reported a different motivation for enjoying music, listing "the lyrics," the "performing artist," and "nothing in particular" as the typical explanation for their enjoyment. These observations align with William's description of the non-traditional student, described earlier.[1] Furthermore, students who selected "other" ensemble experience represented those who may have participated in a music technology class, guitar class, or in a modern ensemble. This group of students reported a high instance of music lesson activity (38%), independent instrument learning (56%), and DAW experience (52%).

[1] Williams, "The Non-Traditional Music Student," 144.

The Traditional Music Student

Those students who reported participating in performance ensembles in middle or high school grades are referred to in this study as the "trained" or "traditional" group. The highest notational literacy was reported by the members of band and orchestra (both, 40%) with only 14% of choir members reporting themselves to be advanced readers of music notation. These traditionally educated music students showed a propensity to independently learn a new instrument, experiment with DAW software, or participate in private music lessons. This cohort also included a small number of students from the KSU music programs (one music major, and three music entertainment business majors).

AMMA Results

To further illuminate the skill level of students beyond self-scoring, the researcher utilized the Advanced Measures of Music Audiation (AMMA). This testing instrument was administered to all study consenting participants before treatment began. The purpose of the AMMA is to measure musical aptitude by testing students' audiation ability.[2] This level of audiation test is designed for high school seniors and undergraduate freshman. Music educators often use audiation tests to categorize individual students into a skill level class that may assist instructors in predicting student potential and to customize their placement and instruction.

The AMMA test served two purposes in this study. The first was to illuminate the aptitude of the untrained, non-traditional cohort – those students outside of traditional performance ensembles. The second was to measure the aural and cognitive ability of all students to consider as a variable in research tasks. The test included thirty questions with two

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[2] Edwin E. Gordon, *Manual for the Advanced Measures of Music Audiation* (Chicago, IL: GIA Publications, 1989), 7.

music examples each. Students chose whether the examples were the same, were different tonally, or were different rhythmically. The researcher/instructor explained that it was appropriate to leave an answer blank instead of guessing when unsure. Students completed scantrons with their answers.

The researcher graded the tests manually with the provided scoring mask, which yielded the following scores: tonal raw score, rhythm raw score, and total raw score. The AMMA manual provided separate tables for music majors and non-music majors to determine percentile ranks for tonal, rhythm, and total. Generally, the test results showed varied results between minimum and maximum scores, allowing the researcher to analyze normatively and idiographically. According to the testing manual and test author Edwin Gordon, instructors may use four levels of aptitude to predict student achievement.

The provided score levels are as follows:

- 90^{th} + percentile: highest achievement expected
- 80^{th} + percentile: high achievement expected
- 21^{st} to 79^{th} percentile: average achievement expected
- 0 to 20^{th} percentile: low achievement expected[3]

Test results for the study's original thirty-eight participants yielded varied data. As a reminder for the reader, Gordon supposes that the level of musical aptitude, or potential that a student may possess stabilizes around age nine. Their achievement and learning can still progress but may not extend past the typical expectations of their category's potential.[4] The AMMA is described as an advanced stabilized aptitude test, having been designed for university students whose aptitude is stabilized.

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[3] Gordon, *Manual,* 34.

[4] Ibid., 10.

After scoring and normalizing participants' testing results according to the manual, the researcher sorted student scores into aptitude categories. The students' aptitude category results are shown below in Table 1.

Table 1. AMMA Results by Percentile Rank

Aptitude Category	Average	Min	Max	Count	Description
Level 1 HIGHEST				0	90th+ percentile; highest achievement expected
Level 2 HIGH	84	80	86	5	80th+ percentile; higher achievement expected
Level 3 AVERAGE	58.61	23	74	26	21-79th percentile; average achievement expected
Level 4 LOW	17.57	12	20	7	0-20th percentile; low achievement expected

No student scored above the 90th percentile – the category in which Gordon suggests instructors can expect the highest music achievement. The High Achieving category (80-89%) included five students, and the level at which average achievement may be expected (21-79%) included twenty-six students. It should be noted that the average for this level is quite high, at 58% for the average score. The Low Achievement level included seven students (0-20%).

Gordon makes it clear that an aptitude test is not an achievement test and typically should not be repeated. The questions have a large range of difficulty, and the test seems to exhibit a 'learning curve' for some students who were frustrated by the level of difficulty or by its unfamiliar framework. Unlike a developmental aptitude test, the AMMA's test questions required students to simultaneously analyze the tonal and rhythmic possibilities of a musical example. While challenging, Gordon designed the test to be accessible to all students within its intended age-range regardless of notational literacy, ensemble experience, or music training. [5]

Table 2 shows the Total Percentile rank of the AMMA by student category. Similarities include substantial differences within each category of minimum and maximum scores. Focus group conversations confirmed that this may account for the 'learning curve' mentioned earlier. Multiple students expressed initial confusion about the question examples and test format. The researcher chose not to adjust the test data because any confusion was equally distributed among groups.

Table 2. AMMA Scores by Achievement Category

Aptitude Category	Min	Max	Average	Count	Category Description
Level 1 - HIGHEST				0	90th+ percentile: Highest Achievement expected
Level 2 - HIGH	80	86	5	5	80th+ percentile: High Achievement expected
Level 3 - AVERAGE	23	74	26	26	21-79th percentile: Average achievement expected
Level 4 - LOW	12	20	7	7	0-20th: Low achievement expected

[5] Gordon, *Manual,* 8.

Table 3 shows percentile rank results by study category. One may expect that students who have ensemble experience or who report the highest notational literacy score the highest on a music aptitude exam. Certainly, students from the Advanced participant category (*n* = 6) and the High Achievement percentile group populated these categories, but none of the highest aptitude scores were from music majors. Additionally, one student outside the traditional ensemble experience scored the second-highest result overall. In the "higher achievement" percentile group, the researcher observes two abnormally low scores for the advanced participant category and considers them outliers. Interestingly, these two low scores were from students who are music/music business majors. Because these outliers were not removed from the average calculation, the advanced PR average may be lower than expected. If removed from the calculation of the average, the advanced PR average would be seventy-six.

Table 3. AMMA Percentile Rank Results by Study Category

Study Category	PR Average	PR Max	PR Min	Count	Category Description
ADV	56.83	86	17	6	Ensemble participation; advanced self-rated notational literacy; experience with DAW software
INTER	55.38	84	12	13	Ensemble participation; participation in music lessons or self-taught skill; self-rated notational literacy as intermediate
BEG	59	62	53	7	participation in at least one traditional ensemble; self-rated beginning notational literacy
NONE	50.02	74	16	12	no ensemble participation or music lessons; self-rated notational literacy that is beginning or less.

The Intermediate participant group (*n* = 13) also showed student scores in the Higher Achievement percentile. The average participant scores of Intermediate and Beginning groups were closely situated and may suggest little difference between the two categories. A notable difference is that the average test result of the Beginning group is higher than that of the Intermediate group. Perhaps most surprising is the average score of the Beginning participant group.

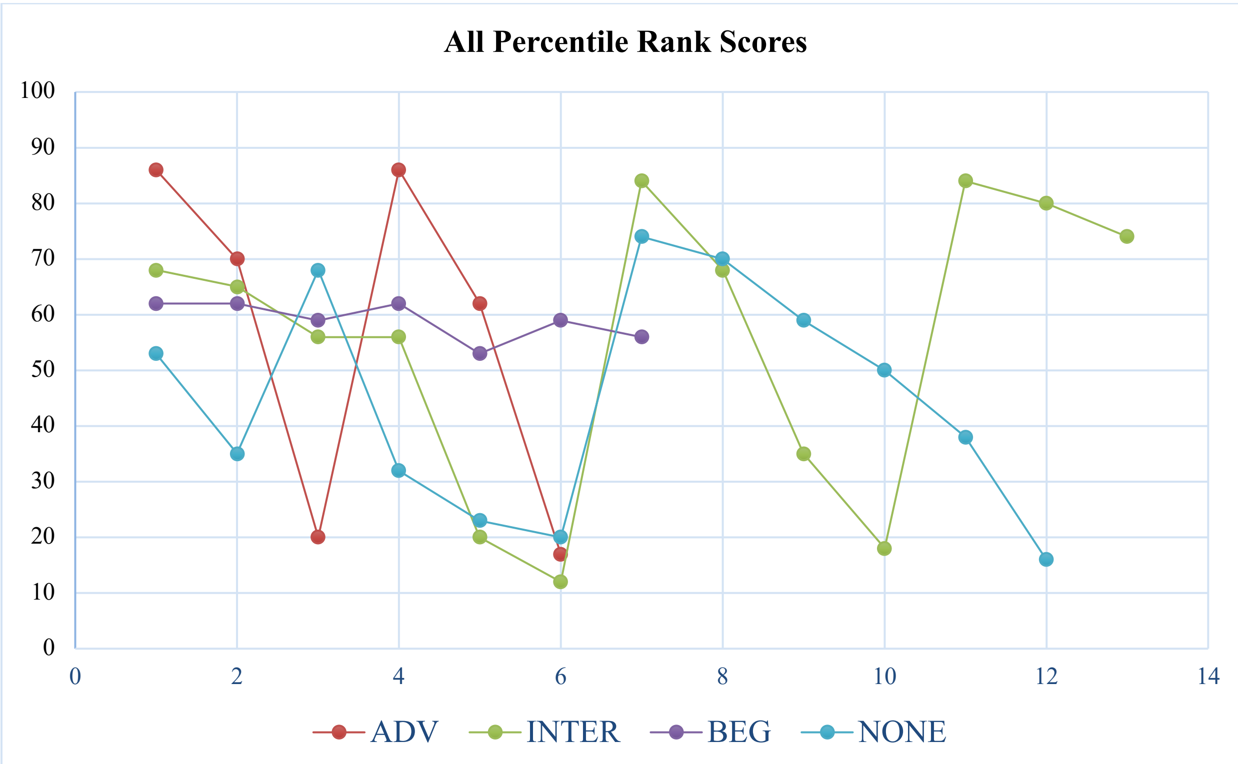
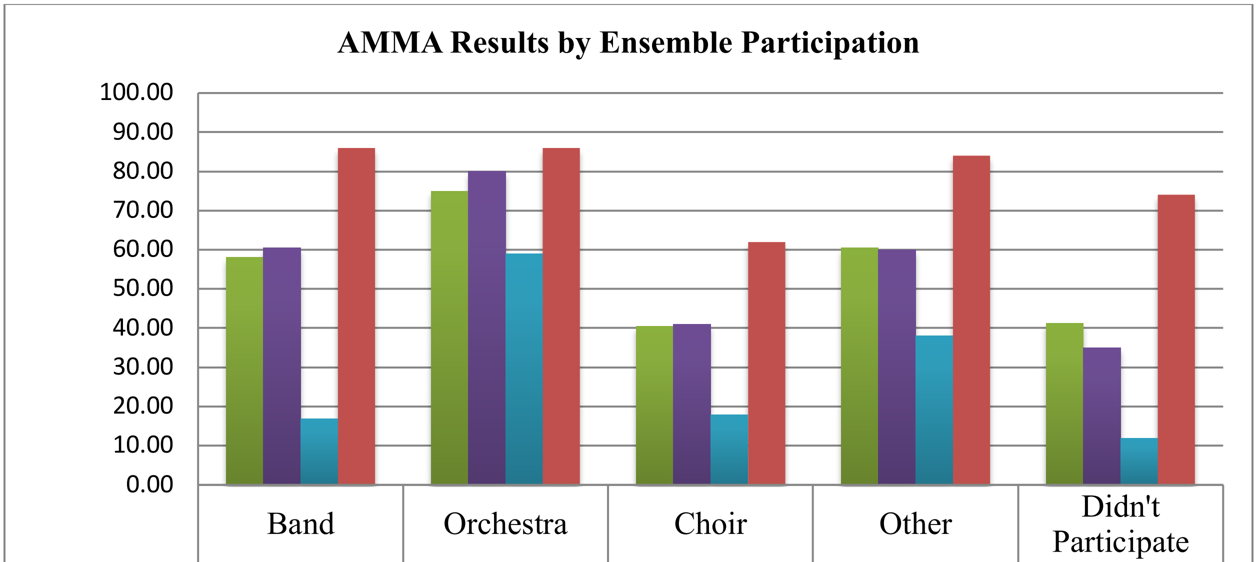


Figure 9. Scatter Plot of All PR Scores



	Band	Orchestra	Choir	Other	Didn't Participate
Average	58.06	75.00	40.50	60.50	41.27
Median	60.5	80.0	41.0	60.0	35.0
Min	17.0	59.0	18.0	38.0	12.0
Max	86.0	86.0	62.0	84.0	74.0

Figure 10. AMMA Results by Ensemble Participation

Considering the student results in light of their ensemble participation (Figure 10) shows that maximum scores were equally distributed between all categories. Those who didn't participate in an ensemble did not score in the high achievement percentile. Alternatively, among minimum scores, a notable result is also evident. The participant categories of Band, Choir, and Didn't Participate all included students in the low achievement percentile block, but in the Orchestra and Other groups, the lowest scores settled in the average achievement percentile. Orchestra showed the highest trends in score results but also included the smallest sample size (*n* = 3). The lowest results appear in both the Choir and Didn't Participate categories to varying degrees, and both show similarities between their average and median scores.

Quantitative Results

As audiation is key to one's ability to sense and analyze music, this research project sought to gather data about how students' listening skills may benefit in this area after using technology-as-instrument activities. As previously described, students completed two attempts of the Super-Listener activity. Between these attempts, students explored the concepts of melody, harmony, and rhythm in a researcher-designed SoundTrap creative activity. The Super-Listener assessment prompted students to identify audio prompts as the same or different. The online game presented audio examples at three levels that awarded points based on answer choice and selection speed. Each "tone scramble" pattern is best described as a randomized arpeggiated melody.

- Level One: a tone scramble outlined a minor or major chord. Students pressed the "F" key for major and the "J" key for minor.
- Level Two: two-tone scrambles played that were the same in mode or different. To show sameness (two minor arpeggios, two major arpeggios), students pressed the "F" key. For 'not the same' (a minor then major arpeggio, or vice versa) students pressed the "J" key.
- Level Three: Students were asked to memorize 2 audio scrambles. One or the other was played and students identified them by pressing the "F" or "J" key. The tone scrambles were very similar, with the first a slightly consonant arpeggio and the second as a more dissonant example.

The researcher chose this particular activity because it's design, examples, and answers were similar to the AMMA aptitude assessment. The Super-Listener examples were very challenging and more complex than the AMMA's examples, but similarly used music patterns that were essentially melodies. Students used tonal memory and audiation to analyze these prompts. Participants completed the Super-Listener activities on their own, reported their individual level scores and total scores, and uploaded screenshots of their score results. Students reported nineteen first-attempt scores and twenty-three second-attempt scores. Fourteen participants reported both first- and second-attempt scores reflected in Figure 11.

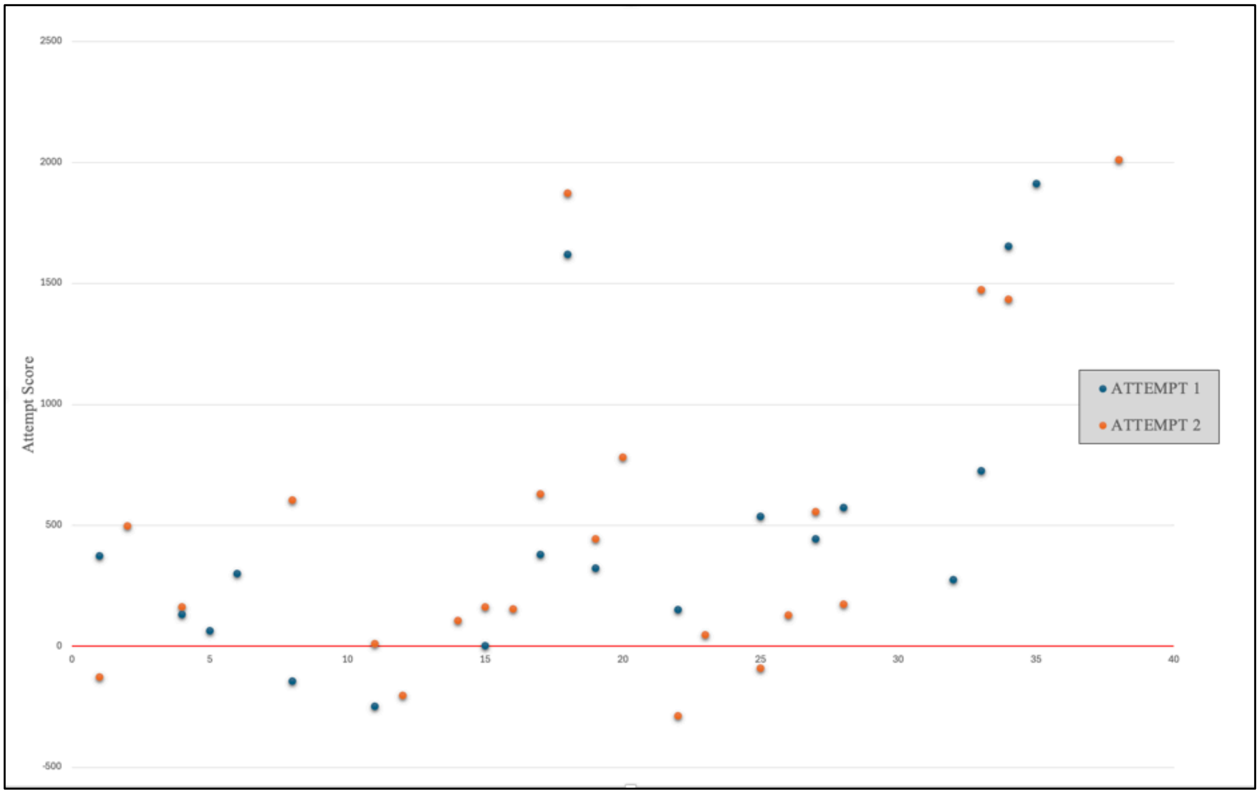


Figure 11. Super-Listener Scores Scatterplot

As the initial aptitude data suggested a substantial learning curve for students to overcome, so it was with the Super-Listener assignment. While the 'gamified' interface and controls had a straightforward design, and the underlying concepts were simple, the speed and perceived complexity of the audio examples muddied some category trends. This occurrence may be manifested by negative scores in both attempts. For context, the reader can keep in mind that a score of 300 translates to a percentile ranking of 50.1% "better than other students" according to The Music Lab website.[6] In Table 4, students with the advanced skill category and those with no skill category show substantial improvement in the average scores of first and second attempts. Average scores for students in the intermediate and beginning skill categories

[6] The Music Lab, "The Music Lab," *The Music Lab*, https://www.themusiclab.org/about.

show negative change between attempts. A different data point that may reflect student improvement may be the maximum scores for each student level category. In each student category, a significant increase in the average maximum score was demonstrated upon analysis. Broken down by activity section, 28% of students increased their scores in Super-Listener's Level 1 and 2, and 14% of students increased their score in Level 3. One may conclude that students whose scores were raised may have benefited from repeating the Super-Listener activity. Alternatively, one may conclude that this increase was due to students' exploration and learning by participating in the SoundTrap assignments.

Table 4. Super-Listener Score

Study Category	Aver. 1st Attempt	Min.	Max.	Count	Aver. 2nd Attempt	Min.	Max.	Count
ADV	1432	727	1913	3	1640	1436	2011	3
INTER	496	2	1622	5	435	-287	1875	9
BEG	458	275	536	4	193	-89	558	4
NONE	80	-248	375	6	158	-202	498	6

Individual Super-Listener score results are shown below, in Figure 12.

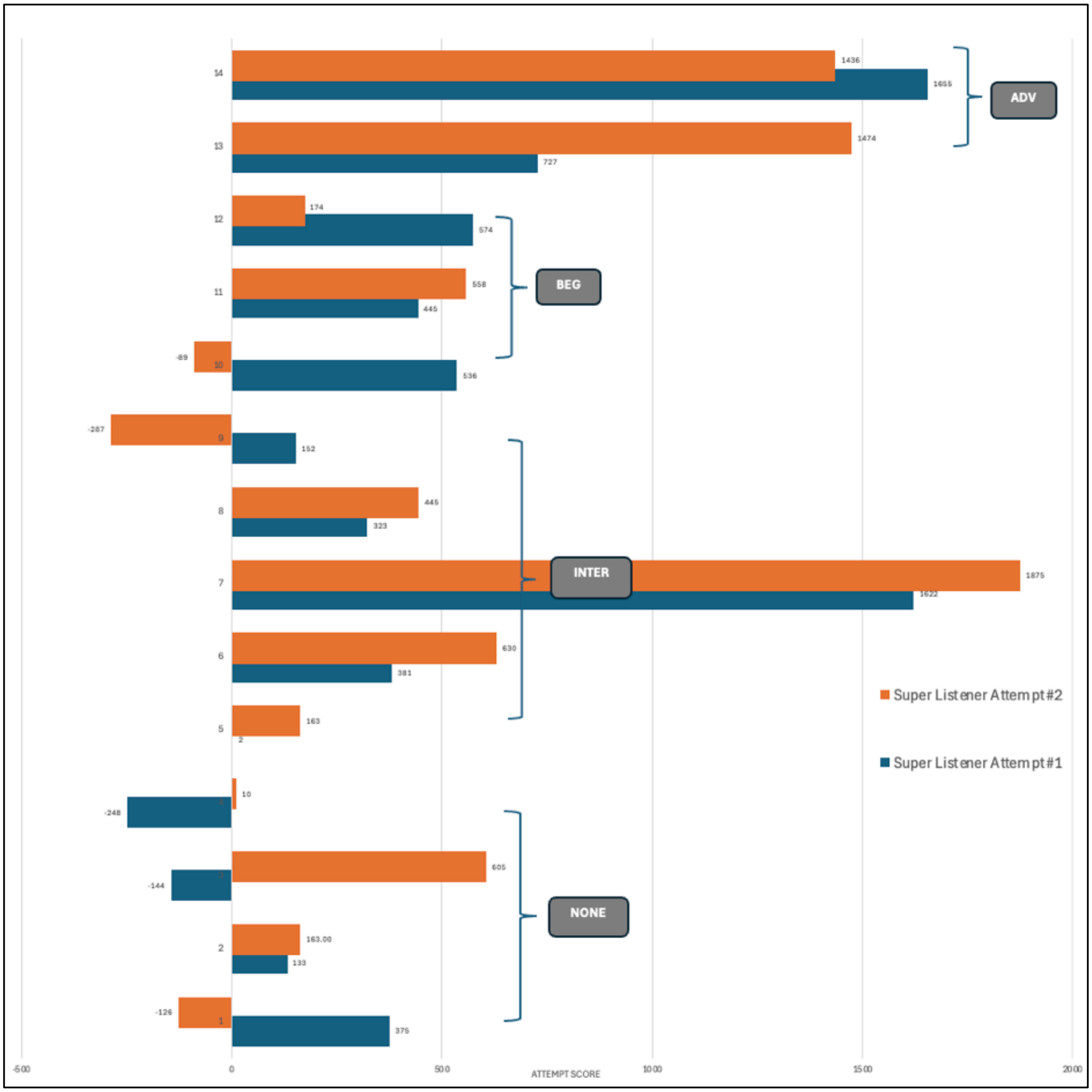


Figure 12. Super-Listener Individual Attempt Comparison

Qualitative Results

Qualitative data for this study included survey responses and focus group discussions. Following the completion of the research treatment (Super Listener activity, SoundTrap Melody Project, SoundTrap Melody+Harmony Project, and the repeated Super Listener), twenty-four participants completed a Qualtrics survey that included questions outlining their learning experience with SoundTrap. The researcher imported these responses into a CAQDAS platform for coding and analysis.

Survey Results

Survey responses (24) yielded substantial data that was easily coded due to students' clearly worded responses. This data was of higher quality as students had more time to refine and communicate their responses compared to the improvisational conversation of the focus group. When considering the survey prompts, some readers may consider them to be "leading" in their nature, as they included concepts and terminology that respondents may not have used when unprompted. The researcher found it appropriate to guide responses in this way to better focus on research questions and to adopt a common terminology. Through manual coding and software-aided analysis, the researcher noted multiple themes regarding students' perceived learning and comprehension. Survey questions investigated students' comprehension of featured musical elements and of their creative and learning process.

Survey questions included the following:

- Q7 How did the "Melody Workshop" activity in SoundTrap help you understand the concept of Melody (the tune)?
- Q8 Did you notice qualities of experimentation and craftsmanship in your creative process? How did the SoundTrap activities contribute to your ability to explore and refine your work?
- Q9 Did the "Melody+Harmony" activity in SoundTrap assist you in understanding how melody and harmony (chords) work together? Unpack and explain this effect.
- Q10 Rhythm and timing is an important part of music. Did the SoundTrap activities help you consider and better understand rhythm concepts? If so, give some examples that you can remember.

The researcher used a Qualtrics survey to gather responses to the above questions. Responses were imported into Atlas.ti software for coding and analysis.[7] A link to response data can be accessed in Appendix H.

The questions of this research project investigated how DAW software may affect students' learning of featured music concepts. Students completed multitrack projects in a DAW that explored the concepts of melody and harmony. According to their responses, SoundTrap projects benefited student comprehension by making space for the manipulation of these concepts in the SoundTrap interface. Multiple responses showed that students gained a new understanding of how melody and harmony coordinate and complement one another. Additionally, students found that the DAW interface allowed them to visualize, experiment, and understand how melody and harmony were also subject to rhythm and timing. This mix of experiences allowed students to grow their aural awareness and listening skills.

Survey data also illuminated the benefits and challenges associated with a DAW interface. Students found SoundTrap to be accessible and user-friendly, allowing them to focus on learning and exploration. SoundTrap's visual layout of song components was a recurring theme in response data, allowing students to see notes and timing more clearly and to better understand musical concepts. Responses also highlighted a learning benefit regarding creativity, with students finding time and space to explore the assignment and their own creative impulses. Participants also highlighted challenges with the DAW interface and navigating the assignments. Comments regarding difficulty with melody creation and chord placement revealed an inability for SoundTrap to benefit the learning experience for some students when they struggle to

[7] "ATLAS.ti Scientific Software Development GmbH. ATLAS.ti Mac. V. 23.2.1. ATLAS.ti Scientific Software Development GmbH. Mac. 2023.

manipulate the interface. For a few students, this centered around their struggle to time and synchronize components correctly. Survey data suggested that some share of these challenges centered on a lack of listening skills and musical awareness.

The research group representing students who did not participate in a traditional ensemble (NONE), reported gaining fundamental insight about the featured musical concepts of melody and harmony. They reported that the visualization benefits of a DAW interface helped them understand the nature of these concepts and the relationships between them. They enjoyed experimenting with the SoundTrap assignments but were sometimes uncertain if their result was correct. Some responses suggested continued confusion with identifying melody while other students grew in their understanding and could identify its difference from chords and the accompaniment. All students in this group recounted difficulty with rhythmic timing and whether chords sounded right. Many students observed an increase in their creative process while exploring music activities in SoundTrap.

Focus Group Results

Twelve students participated in focus group discussions on each of KSU's campuses. Using researcher-designed discussion prompts (Appendix G) students participated in an informal discussion about the SoundTrap projects, concept comprehension, and learner experience. Those present were representative of each research group, from advanced musicians with high experience to those with no musical experience. The researcher recorded the discussions with a GoPro camera and DJI wireless microphones. Recording sources were combined in Final Cut Pro, and a transcript was produced and imported into Atlas.ti for coding and analysis (Appendix H). Students described personal and authentic learning in the SoundTrap environment, with detailed accounts of the benefits and challenges encountered, the creative processes they experienced, and the level of comprehension they achieved. The data from these twelve students, along with their survey responses, resulted in patterns and themes outlined in the next section.

Themes

This research study collected qualitative data from two main sources: a survey (23 respondents) and focus groups (12 participants). Students completed both after the Super-Listener and SoundTrap activities. Survey results and focus group transcripts were both manually coded and analyzed by the researcher and by utilizing the Atlas.ti software. The codes used for these documents are listed in the study codebook (Appendix H). Analysis of these codes showed multiple themes in two main categories.

Beginning: Comprehension of Featured Elements

The most basic benefit to students' comprehension started with a clearer understanding of melody and harmony. For some participants, the "Melody Workshop" project presented an opportunity to interact with a musical concept that was very unfamiliar. NB admitted that pre-activity, melody was a murky topic and one he enlisted ChatGPT to "explain it to me like a third grader." AC, stated her initial confusion also, sharing that "I was really confused during the whole melody section and I could not (understand) for some reason." Both NB and AC were musically inexperienced with music terminology and concepts of music analysis but found value in the ability to explore the concept in the Melody Workshop activity. AC stated, "You can't fake a process…I picked up on it and put my logic to paper, or put it to the computer, to create a melody." Similarly, NG recounted that "the Melody project…helped me get an idea what I was looking for when I was listening to that (melody). Multiple students explained that the DAW learning space benefited their learning in a similar way. MM, a guitarist with no ensemble experience, offered that he "had a grasp of melody, but being able to isolate it in comparison to all the other things. (It) helped me really put it into perspective…what I needed to do next for it to sound better."

The benefit to baseline concept understanding seemed to benefit those participants in the OTHER category the most. Students outside an experience of singing or playing a melodic instrument showed the most confusion about defining or identifying it. A display of co-occurrence codes in Atlas.ti showed a strong relation between this student group and responses regarding self-efficacy and positive experience. The participant group overwhelmingly used the term "melody" in the focus group discussion and survey responses. Nearly all students reflected a growth in their understanding of the concept, often linking it to their ability to explore its function in a multitrack environment.

Intermediate: Coordination of Musical Elements/Events

Above the base level of concept comprehension, students' comments illuminated an intermediate understanding of featured elements. By comprehending individually what melody and harmony are and how to identify them in a song, observers unlocked their ability to observe their use and coordination. All students showed interest and benefit from exploring the melody/harmony relationship. DB, with a background in orchestra, explained this effect: "It helped me internalize and practice where chords are supposed to go and how chord progression works in different ways." She shared that observing their interaction helped extend her beginning knowledge of music theory since she "was able to see how the melody and the harmony chords work together or clash against each other." Not all students found success with the nuances of harmony. SS typically sidesteps any music involvement due to diagnosed dyscalculia which affects her ability to comprehend musical concepts, including rhythm and timing. "I had a lot of difficulty with that. I was even looking up chords and listening to them where I was just trying to find like any similarity. I've learned how tone deaf I really am in this class. To this day, I don't know if I put any of those chords in the right place."

Some students noticed melody's complementary presence alongside other elements of music. NB noticed melody's interaction with lyrics and discovered that "by using chords along with the melody, my understanding of how the harmony can enhance the lyrics and the melody, within the song itself (as) each individual chord matched the lyrics in the song giving the words more power and emotion." Although rhythm was not an official featured concept, students closely situated their learning about melody and harmony within the utility of timing and rhythm. DB explained this benefit by stating that "the activity helped me to visualize the ways that chords come in on specific beats, and if it is delayed or on an offbeat. For example, if you don't put the chord in the exact correct spot, in terms of coming in on time, it will sound a bit funky." Describing the melody+harmony project, CM found success by noticing chord events and their timing to lyrics: "when you're dragging the cords in place, it has to be on time – like 'Ha-le-LU.' It has to go on the 'lu.' It has to be in time." EB shared that "The activities did help me to understand rhythm concepts. I had to make sure that the rhythms of the notes made sense and that I was not rushing or dragging behind the accompaniment." While untrained and inexperienced students did not always feel confident in their finished work with melody and harmony, their comments showed strong trends toward comprehending their synchronization, noticing the 'wrongness' or 'rightness' of a match, and understanding the value of timing chords to melody and lyrics.

Advanced: Understanding of Roles and Hierarchies

In the course of the researcher's instruction students are introduced to more advanced and structural elements of music like key, texture and form, later in the semester. Advanced topics such as these were not among the featured elements of the research study, but students often commented on these related concepts. While holding advanced notational skills and experience in band, CS explained how the SoundTrap activities illuminated new music theory knowledge: “The melody and harmony activity did help me to understand how melody and harmony work together by giving me the ability to understand the relationships between chords and how harmony is used to satisfyingly resolve a melody.” SG, a student with some notational knowledge and an orchestra background, explained that “The SoundTrap assignment helped me understand chord progressions and why some notes are commonly paired with others. It allowed me to better recognize the idea of music as a puzzle, and why formulaic music is predictable, as there are often choices that are ‘correct.’” Similarly, DB took time to learn about how the overall chord progression worked for the song: “It helped me internalize and practice where chords are supposed to go and how chord progression works in different ways.” Guitarist MM recalled his learning process about how “harmony can strengthen (melody) with its chords by resonating with accompanied sounds. When put together they create something explosive or vibrant depending on the timbre and scale the chords follow.” Students reported noticing these additional qualities of music based on their ability to observe song components in isolation. CK explained “I normally haven't thought about how a song would sound separating the melody and harmony...(it) allowed me to hear the different and niche aspects of the harmony on its own, as well as the melody on its own.” Finally, some students like CS reported a new appreciation for the advanced topic of key – “when I was doing the melody project, (I was) making sure that the notes of the melody worked in the key of the song.” These comments connecting learning to advanced topics came from a plurality of student backgrounds, but students with little to no experience in music seemed to take more joy in reporting this learning.

DAW Learning: Creativity

A common topic among participants' comments was observations on their creative process Students reported various beneficial effects to their personal process of exploration and learning. Recalling her melody+harmony project, DB stated, "I think I was a bit experimental with some chord placement and potentially rhythm, and I think that the interface makes it super interactive and fun to compose and rearrange different musical tracks." MS explained, "It allowed me to explore and create so many different melodies out of a few notes just by manipulating the order of the notes and the rhythms." Speaking of the piano roll function, NB outlined his own creative process: "I took the very first melody and copied and pasted it two more times, right? And I just messed around with what was already there…But literally, I was there for like an hour, just dragging each and every note up and down a little bit, and like extending it a little bit more and more." CK described the multitrack environment's effect on his creativity by explaining, "I haven't tried to make a song before, but the interface on SoundTrap gave me multiple ways to try and create. The piano that you can play with your keyboard gave me a new way of thinking of sound…. I thought the amount of variability and options made me try things I wouldn't normally try to do." Musically uninvolved students like SS highlighted this newfound sense of creative agency: "I played around with what instruments I could use and the different ways I could arrange them. Using SoundTrap also made me want to potentially try independently making something using the software. I haven't made anything independently yet, but I've thought about it."

The creative tools of SoundTrap were shown to benefit students in their creativity by allowing them to physically play or program new melodies, but some participants used the microphone/record to add a more personal touch. EM added vocal expressions into his project, but also expanded the activity scope by recording himself whistling the provided motive, expanding and imitating the original melody. Focus group participants discussed their creativity in relation to concentrating on a final product and/or dwelling in the creative process. AC shared her proclivity to the latter by explaining, “The product is so important, of course, but I guess being an engineer major…I enjoy more the process of something and seeing how it comes along, versus the fulfillment of the product.” JB confessed his excitement about engaging in the process of creating – “the blank canvas was the most exciting part.”

Multiple students mentioned the refining aspects of their creativity, which was discussed as “craftsmanship” in the focus group. Speaking of this “slower creative process” KG highlighted that “it really did help work with the refining that you were talking about – being able to shorten it down to half a bar. Just listening to the same three notes until I found the one that worked just right.” A sankey diagram of co-occurrences revealed that inexperienced and untrained students more often commented on a creative effect, but all cohorts saw connections to their craftsmanship and creative process.

DAW Learning: Benefits

Many of the benefits mentioned by students in survey responses and focus group discussions are connected to their successful use of its interface and tools. Multiple students mentioned the value of SoundTrap’s visual layout of components and their arrangement. CM liked “seeing the things that I could do,” and LL found it helpful to “see the note layout of drum beats.” KG credited this visual benefit to his understanding of melody and rhythm and “each individual part of the song” helping him to understand “how it all fits together.” JB described how hidden complexities of drum beats could be examined: “I realized there were extra layers of complexity that I didn't hear but that I could see. I could go in and pick apart the high hat and cymbal parts that I hadn't noticed."

DB and others also explained the value of SoundTrap's immediate feedback: "it's nice to be able to see where it works and immediately get the feedback." In the focus group discussion, students KG and NB termed this effect as "instant gratification." NB found it valuable to be "able to quickly try, fail, and then try again." He explained that "it was a whole lot easier to see what I was doing wrong in that process and what I was doing right."

Some tools within the SoundTrap interface gave students a more physical experience of music making. In the melody project, students could utilize the keyboard function to play a new melody into the recording. Using the alpha-numeric keys of their computer, students could trigger the keyboard instrument in SoundTrap. CM chose to utilize this capability. "I really liked the piano tool where you just press the key. I just thought it was more fun. I just liked being able to do that and then delete it and try it again and just add something new."

DAW Learning: Challenges

While working in the SoundTrap DAW, participants reported several common challenges. Focus group discussions illuminated a hindrance of process, with students describing a procedure that was somewhat hard to manage as they were "very, very wrapped up in the process" to the point that it "got in the way of an end result." Alternatively, SC, a music major expressed frustration when the software didn't allow her to achieve the sound she envisioned, leading her to revert to playing the music herself. "Because I didn't have a full expanse of understanding of SoundTrap, I thought it was more hindering to the process. The product was, fine, but the process was really tedious." TW shared that "it made me realize that it isn't as hard to make a decent sounding thing as I thought it would be. The main trouble was more navigating the actual software, as it could be frustrating at times." SS shared, "I loved changing up what instrument was playing and all that sort of stuff, but I definitely would get stuck on something I wanted to do but couldn't quite make it work." This disconnection between a student's creative expectation and a result that was out of reach was a theme represented in student comments about project challenges.

Summary

The findings of this study outlined in this chapter include the themes of both qualitative analysis and quantitative results demonstrating the benefits and challenges that DAW technology may bring to students' experience and learning. The qualitative analysis highlighted the tools and strategies that students used in informal and authentic learning about featured musical elements. Quantitative results showed improvement in a majority of students' scores in an aural discrimination activity after engaging with creative learning in SoundTrap.

Chapter Five: Discussion

Summary of Study

This illustrative case study addressed questions of student comprehension and learning that DAW software (digital audio workstation) brought to undergraduates in a music appreciation classroom. While DAW software is not new to the music classroom, it represents an under-researched topic when used as a virtual instrument. With software technology in a more central role, educators must consider new questions about the structure of the classroom, the role of an instructor, and the design of the curriculum. This final chapter outlines the results of the current study in relation to its research questions and discusses conclusions for the undergraduate classroom, broader application, and future research.

Research Questions

RQ1: Does a technology-as-instrument approach result in measurable growth in students' comprehension and aural discrimination skills in an undergraduate music appreciation course?

A technology-as-instrument approach can benefit student comprehension and learning and measurably affect their improvement on an aural assessment. This improvement may be a combined result of a student's growth in listening skills and aural attention and their increased comprehension of musical concepts based on more precise identification and analysis.

RQ2: How do students perceive their learning, comprehension, and creative process when using a technology-as-instrument approach?

Through survey responses and focus group discussion, students outlined benefits and challenges to their learning in the DAW environment. Coding of this qualitative data showed themes between student perceptions of comprehension, listening skill and creative growth. Students describe diverse benefits and some challenges when using a DAW interface to explore and learn that positively affected an authentic and creative learning experience. Their ability to explore, experiment and construct both familiar and new learning.

Summary of Findings and Prior Research

As outlined in the previous chapter, this case study demonstrated the learning benefits that the participants in this research presented when incorporating a technology-as-instrument approach with creative tasks. The research sought to extend previous inquiries in the field and address a gap in the literature regarding instructors' use of technology as a learning strategy with undergraduates. The researcher gathered qualitative and quantitative data to gauge students' comprehension of musical concepts after engaging with these elements in a DAW-based creative project.

Participant Group Context

Utilizing a background survey and aptitude test, the researcher constructed a picture of student understanding and experience among the participant group. This contextual participant data confirmed prior research that learners in the music classroom represent diverse backgrounds, skill levels, and aptitude levels and arrive with refined, personal tastes and musical understanding.[1] The cohort of participants in this study who were outside of traditional music programs showed similarity to William's characteristics of the non-traditional student,

[1] Elliott, D. J., & Silverman, M. (2015). Music matters: A philosophy of music education (2nd ed.). Oxford University Press; Regelski, T.A. (2016). A brief introduction to music and music education philosophy as social praxis. Routledge.

representing lower notational knowledge and having no ensemble experience, but with many reporting independent music learning and a "musical life" outside of school.[2]

The results of the AMMA aptitude test allowed the researcher to gain further context about the research group, yielding data regarding students' music potential. The data partially confirmed the spirit of prior findings, in that aptitude scores were evenly distributed among participant groups (Appendix D).

1) Higher scores were not limited to experienced students
2) Lower scores were not limited to inexperienced students
3) A majority of students scored in the average percentile level

These results underline Gordon's broader point that many students outside of traditional music education demonstrate similar music potential, and instructors can expect similar achievement.[3] Piccioni also highlighted the need to research the cohort of amateur musicians who are outside the typical reach of traditional music education.

Technology-As-Instrument

This study sought to address a research gap regarding the use of technology-as-instrument in the music classroom. McElroy called for further research regarding the pedagogy of composition and creativity in the learning experiences of non-music majors.[4] Dorfman identified the interaction of technology with student learning as an area lacking in "practical, sequential, educationally sound curriculum."[5] This case study addressed these gaps in current

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[2] Williams, "The Non-Traditional Music Student," 144.

[3] Gordon, *Learning,* 43.

[4] McElroy, *Composition*, 307.

[5] Dorfman, *Theory*, 7.

literature by investigating the comprehension and learning of the researcher's undergraduate music appreciation students. As outlined in the previous chapter, the researcher found that most students improved their score on the Super-Listener assignment (Appendix I) after creatively exploring featured music concepts in DAW creative projects. In the analysis of focus group and survey data (Appendix H), the researcher identified themes that highlighted the value participants placed on their ability to explore, experiment, and create in multitrack projects. Their explanation of the specific benefits and challenges of the SoundTrap projects further clarified the learning experience.

The researcher aligned the multitrack projects used in this case study with the intentions of the TPACK instructional model.[6] Testa called for further investigation using TPACK techniques and "cross-platform tools for music technology instruction."[7] The current study sought to specifically expand this thread of inquiry by featuring a web-based, cross-platform multitrack tool in student learning. Student responses to surveys and in focus groups (Appendix H) highlighted the specific benefits of SoundTrap and the tools they used to increase their comprehension of featured concepts, amplifying their learning with experimentation and exploration. Identified challenges can be viewed through the lens of the TPACK instructional model as students experienced individual imbalances between technological, pedagogical, or content knowledge deficiencies.

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[6] Mishra and Koehler, "Technological."

[7] Testa, "Music Technology," 97.

Limitations

Music education research can represent a daunting task for the researcher as creative and personal learning represents a dynamic and complex process. The researcher used a case study design to quantify and qualify the learning benefits of the DAW interface.[8] An initial limitation that may exist in the results of this research is one's ability to generalize to other situations. Since case studies typically involve a limited number of cases, the ability of the reader to transfer findings to other situations may also be limited. A second limitation of this case study is the positioning of the researcher/instructor. While the researcher's proximity to participants may be reflected in a higher-quality open discourse, unintended effects could be diminished by duplicating the study among students not known to the researcher. A third limitation may be represented by the lack of any assessment of concept knowledge or musical experience beyond students' self-reporting. The AMMA provided one piece of assessment with its aptitude test, but additional achievement in comprehension-related assessments could improve the quality of participant data.

Recommendations for Future Research

Creative learning and its intersections with technology-as-instrument is a fascinating but endlessly complex topic of study. To expand this topic future lines of inquiry may focus on the utility of student learning with the development of curricular mechanisms that may be observed and tested more reliably, possibly in an experimental study. Additionally, future research may expand the utility of the DAW interface in exploring other elements of music. For example, the topic of instruments and tone color are often confusing concepts for those lacking an aural

[8] Barrett, Case Study Research, 114.

"library" of tone color memory. The element of form is also a natural expansion of technology-as-instrument inquiry. This study has demonstrated that the DAW offers a visual layout of music where students may watch the unfolding structure of a musical piece.

Implications for Current Practice

Theoretical Implications

The inclusion of technology-as-instrument in the music classroom is complementary to multiple learning theories and models. The results of this research study may be of relevance to constructivist, praxial, and aesthetic theories as students found benefit in structuring musical meaning, actively participating in exploration, and experiencing learning that is emotional and personal. Aligning with Webster's constructivist guidelines for music educators, the results of this study demonstrate how students constructed personal meaning through their active interaction with creative DAW activities.[9] The social-learning aspect of constructivism was also observed as students collaborated to complete creative assignments. Study results highlight the complementary value of constructivism and technology, as students were involved in "the *doing* of music, rather than solely focusing on learning *about* music."[10]

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[9] Richard Colwell and Peter Webster, *MENC Handbook of Research on Music Learning*, vol. 1 (New York: Oxford University Press, 2011), accessed February 2, 2024, https://ebookcentral.proquest.com/lib/liberty/detail.action?docID=829330, 38.

[10] Alex Ruthman, *Engaging Musical Practices: A Sourcebook for Middle School General Music.*, ed. Suzanne L. Burton, 2nd ed. (Rowman & Littlefield, 2022), 178.

Results of this study also align with Elliott's praxial approach to music learning. Participants' learning was observed as being personal, active, and authentic. [11] Regelski identified technology as a natural accompaniment for praxial learning and this study's findings may also help confirm this complementary connection. [12] Active participation in the laboratory of software technology allowed for both untrained and trained students to participate in the musical experience. And in a strong connection between students' confidence and personal learning, study results demonstrated the value of an aesthetic perception of music learning theory. As participants experienced learning that was familiar, they recounted their experience as having a deeper emotional and cognitive connection.[13]

As instructional models are strongly linked to theoretical positioning, the results of this study may also extend their application in the music classroom. The stages of Webster's creative thinking model were evident as students constructed their learning through convergent and divergent thinking and by experimenting, editing, and revising their work.[14] Green's tenants of informal learning were confirmed as students acquired knowledge through personal exploration

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[11] David James Elliott, *Praxial Music Education: Reflections and Dialogues* (New York; Oxford: Oxford University Press, 2005), accessed April 25, 2024, https://search.ebscohost.com/login.aspx?direct=true&db=nlebk&AN=138147&site=ehost-live&scope=site&custid=liberty&authtype=ip,shib, 16.

[12] Thomas A Regelski, *Teaching General Music in Grades 4-8: A Musicianship Approach* (New York: Oxford University Press, 2004), 4.

[13] Bennett Reimer, *Seeking the Significance of Music Education: Essays and Reflections* (Lanham, Md.: Rowman & Littlefield Education, 2009), accessed April 25, 2024, https://ebookcentral.proquest.com/lib/liberty/detail.action?docID=467328, 100.

[14] Peter R. Webster, "Creativity and Music Education," in *Creativity and Music Education*, ed. Timothy Sullivan and Lee Willingham (Edmonton, Canada: Canadian Music Educators' Association, 2002), 28.

and composing, improvised and composed, and learned by trial-and-error.[15] Additionally, the benefits and challenges of technologically creative activities were reflected through the TPACK model.[16] Considering the balance of technology, pedagogy, and content yielded diverse results as students of various backgrounds interacted with activities in personal and unique ways.

Practical Implications

The use of software technology in this research study did not merely represent a support for learning. Instead, students used a DAW interface as the featured instrument to arrange, program, and play their way to musical understanding. They used the multi-platform, web-based SoundTrap interface to complete activities that deepened comprehension of melody, harmony and rhythm. Their experience and resulting understanding allowed them to acquire deeper listening skill and to apply their knowledge to more advanced musical analysis. How may this type of pedagogy be deployed in the current spheres of music education?

For "the Other 80%"

Whether in the high school or with college students, many learners lack the experience of a traditional performance ensemble, and may show lower-level concept knowledge, notational skill, and familiarity with terminology.[17] As this study and others have shown (AMMA results, Appendix D), this category of the student population exhibits a similar level of musical aptitude

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[15] Lucy Green, Hear, Listen, Play!: How to Free Your Student's Aural, Improvisation, and Performance Skills (New York, NY: Oxford University Press, 2014), xvii.

[16] Jay Dorfman, *Theory and Practice of Technology-Based Music Instruction* (New York: Oxford University Press, 2013).

[17] Barbara Freedman, "Music Fluency: How Technology Refocuses Music Creation and Composition," essay, in *The Oxford Handbook of Technology and Music Education*, ed. S. Alex Ruthmann and Roger Mantie (New York, NY: Oxford University Press, 2020), 368.

as their musically experienced peers.[18] A technology-as-instrument learning approach, whether as a curriculum component or full course, can provide a new place for these students to experience music learning.[19] In middle and high school, learning approaches that use DAW activities complement coursework for the non-traditional ensemble, a piano lab, guitar class, the hip-hop curriculum, a songwriting course, and other informal and creativity-based classes.[20] For college students, this study and others have shown the unique benefit that software technology may provide learners in a music appreciation class, with active learning and compositional pedagogy in undergraduate classrooms.[21]

For the Untrained Student

The results of this research study convincingly demonstrate that DAW technology increases students' concept comprehension and listening skills (Figure 12, Super-Listener Individual Attempt Comparison). In qualitative data, less experienced students outlined specific benefits made possible by the multitrack environment, and most of these students improved

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[18] Edwin Gordon, *Learning Sequences in Music: A Contemporary Music Learning Theory* (Chicago: GIA Publications, 2012), https://ebookcentral.proquest.com/lib/liberty/detail.action?docID=5306413, 45.

[19] William I Bauer, Music Learning Today: Digital Pedagogy for Creating, Performing, and Responding to Music (New York: Oxford University Press, 2020), 65.

[20] Richard J. Dammers, "Technology-Based Music Classes in High Schools in the United States," *Bulletin of the Council for Research in Music Education*, no. 194 (2012): 73–90; David Brian Williams, "The Non-Traditional Music Student in Secondary Schools of the United States: Engaging Non-Participant Students in Creative Music Activities through Technology," *Journal of Music, Technology & Education* 4, no. 2 (2012):133.

[21]Rosemarie Piccioni, "Integrating Technology into Undergraduate Music Appreciation Courses" (2003), accessed August 26, 2023, https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/dissertations-theses/integrating-technology-into-undergraduate-music/docview/288363656/se-2?accountid=12085, 56; Jonathan McElroy, "Music Composition as Pedagogy: A Qualitative Case Study of Students' Experience with Composition" (PhD dissertation, New York University, 2022); Nancy Anne Kudlawiec, "The Effect of Active Music Making on Achievement and Attitude of College Music Appreciation Students" (2000), https://go.openathens.net/redirector/liberty.edu?url=https://www.proquest.com/dissertations-theses/effect-active-music-making-on-achievement/docview/304588233/se-2?accountid=12085.

assessment scores in quantitative results. These results demonstrate that the most valuable of the observed benefits is concept comprehension. The pedagogy of the informal and creative classrooms is of great benefit to untrained students requiring no notational knowledge or experience to enjoy and students benefit from discovering the basics like melody, harmony and rhythm, to support their further learning. The essentials of understanding are rooted in concept understanding, and without them, creative output is often vacuous and unstructured.

Results of the AMMA assessment provided valuable context to the untrained cohort in this study which allowed an important variable to be considered – that of music aptitude (AMMA Results, Appendix D). While none of the participants scored in the highest percentile block, a plurality of scores existed for all participant groups, regardless of their experience. A majority of those with little to no experience in traditional music education held average music aptitude. In light of this, educators should keep in mind Gordon's mantra: achievement is different than aptitude.[22] Those students who miss involvement in music ensembles and classes are often no different in their aptitude than those with a history of participation.[23] In addition, this case study has shown that the untrained cohort can includes students with high levels of self-education, non-traditional ensemble experience, and technology expertise (Tables 4-8). Finding a way to challenge all students can be an important task for educators but one that DAW technology can mitigate. Software such as SoundTrap and other multitrack music production software can allow beginners to take a direct path to creativity and exploration and to provide more extensive tools for higher level experimentation.

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[22] Edwin Gordon, *Learning Sequences in Music: A Contemporary Music Learning Theory* (Chicago: GIA Publications, 2012), https://ebookcentral.proquest.com/lib/liberty/detail.action?docID=5306413, 43.

[23] Ibid., 45.

For the Music Appreciation Curriculum

The TPACK instructional model assists educators in structuring learning for an efficient and balanced approach to student learning. Study findings demonstrate that planning for the proper proportion of content, pedagogy, and technological knowledge can maximize learning and minimize frustration. Beyond planning, the challenges that students reported in the moment of learning may also be viewed through this lens. Problems utilizing the interface could be the result of technology skills being out of balance; challenges with students realizing artistic vision may link to content misunderstanding; and confusion regarding assignment results could identify a pedagogical problem. Beyond the musical knowledge we pursue, educators must realize that not all students may feel like "digital natives," and technology knowledge may still present an impediment to learning for some students.[24] However, as Dorfman highlighted, it is also important to plan for content as of preeminent importance to both instructors and students.[25]

In the beginning of any educational effort, students will invariably reflect different levels of understanding, but with proper pedagogical content and beneficial use of a technology tool, a properly balanced TPACK activity can yield measurable results for everyone. In a music appreciation classroom, this is an important point to consider, as the student population represents diverse skills and experiences. An instructor should certainly expect a large number of skilled students of both traditional and non-traditional backgrounds.[26] Additionally, some students who bypassed music classes altogether and have no experience will be present. Planning

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[24] Bauer, *Music Learning*, 13.

[25] Dorfman, Theory and Practice, 46.

[26] Piccioni, "Integrating," 27.

instruction for this diverse body can result in broad success in key areas considered essential to appreciating the art of music.[27]

A proper application of instruction guided by an instructional model may compensate for the diversity of student backgrounds, allowing for flexibility of personal and authentic learning.[28] While many instructors choose to structure their classes in a traditional lecture format, it is the finding of this research that providing time and space for informal and creative activities can result in learning benefits that are difficult to achieve otherwise. For example, teaching and demonstrating the characteristics of melody and harmony is an acceptable start to teaching the fundamentals of music but does not encode physical meaning to the student experience.[29] Inserting activities that explore melody with hands-on tasks can fill this void and make all the difference to untrained students. DAW software, such as SoundTrap and others, can provide an extensive opportunity for learning, but other, lower-commitment solutions can also be utilized. As a micro-unit of learning, students can explore creative learning about melody through JummBox, a web-based piano roll tool.[30] Or, before a lecture about rhythm, students can create a pattern in an online rhythm generator like the OneMotion drum machine.[31] Many online activities such as these exist that turn phones, tablets, and computers into virtual instruments and may provide the kinesthetic experience that assist all students in building meaning in music.

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[27] Bauer, Music Learning, 13.

[28] Ibid.

[29] Ruthman, *Engaging,* 178.

[30] “JummBox,” *Jummb.us*, https://jummb.us/.

[31] “Drum Machine,” *OneMotion.com*, https://www.onemotion.com/drum-machine/.

Summary

The topic of technology in education is a constantly evolving topic and one that educators must grapple with constantly. Due to the speed at which these technological possibilities develop, classroom solutions are often out of date and misapplied. As a category, DAW software represents a solution that has demonstrated longevity in the market, studio, and classroom. Whether a digital native or digital immigrant, educators can depend on DAW software as a valuable learning tool for students' authentic learning. Coupled with the instructional approaches and models presented in this paper, they can expect benefits for student learning and comprehension. At its core, music is about listening, and our aural and cognitive sensitivities are necessary components for its appreciation. The students we teach have been refining their ability to interact with music far before they came into our classroom, but all can deepen their experience by enhancing their listening skills and comprehension through the tools of DAW technology.

Appendix A

Consent

Title of the Project: Technology-as-Instrument: An Illustrative Case Study of Undergraduate Students' Experience with DAW Technology in a Music Appreciation Classroom

Principal Investigator: Professor Brian Coski, Doctoral Candidate, School of Music, Liberty University

Key Information about the Research Study

You are invited to participate in a research study. To participate, you must be 18 years or older and a student in the researcher's *Music in Society* class at Kennesaw State University.

Things you should know:

- The purpose of the study is to observe the benefit that music technology may bring to the music comprehension of students. If you choose to participate, you will be asked to complete an in-person music aptitude test, a music lab activity, an online questionnaire, 2 Sound Trap Projects, a 2nd music lab activity, a 2nd online questionnaire, an audio- and video- recorded in-person focus group, and to confirm your collected responses through a "member check." It should take approximately 2-3 hours total to complete the procedures and some tasks represent normal classwork.
- Benefits include your increased comprehension of class material and contribution to professional understanding of the topic.
- Taking part in this research project is voluntary. You do not have to participate, and you can stop at any time.

Please read this entire form and ask questions before deciding whether to participate in this research.

What is the study about and why is it being done?

This study investigates the benefits of creative technology tasks for students in a music appreciation classroom. The topics investigated will include how you as a student comprehend and build musical skill with aural discrimination and understanding of musical concepts.

What will happen if you take part in this study?

If you agree to be in this study, I will ask you to do the following:

1. Complete an in-person music aptitude test (22 min.)
2. Complete 2 online aural skill activity (40 min.)
3. Complete 2 creative activities with music software (40 min.)
4. Complete 2 online questionnaires about the creative activity (15 min.)
5. Participate in an in-person, audio- and video-recorded focus group discussion (45 min.)
6. Perform a "member check" by reviewing your comments/explanations when used in the study. (15 min.)

How could you or others benefit from this study?

- Direct Benefits: The direct benefits participants should expect to receive from taking part in this study include knowledge about your music potential, additional feedback and collaboration beyond regular course material.
- Benefits to society include contributing to the understanding of student learning at your institution and within music education at large.

What risks might you experience from being in this study?

The expected risks from participating in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

How will personal information be protected?

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records.

- Participant responses will be kept confidential by replacing names with pseudonyms.
- Confidentiality cannot be guaranteed in focus group settings. While discouraged, other focus group members may share what was discussed with persons outside of the group.
- Data collected from you may be used in future research studies and/or shared with other researchers. If data collected from you is reused or shared, any information that could identify you, if applicable, will be removed beforehand.
- Data will be stored in password protected folders/files on the researcher's OneDrive and laptop. Only the researcher will have access to the data. Data will be retained indefinitely.
- Recordings will be stored on a password-locked computer until participants have reviewed and confirmed the accuracy of the transcripts and then deleted. The researcher will have access to these recordings.

Is the researcher in a position of authority over participants, or does the researcher have a financial conflict of interest?

The researcher serves as professor at Kennesaw State University. No study activity completed will result in a class grade. This disclosure lets you decide if this relationship will affect your willingness to participate. No action will be taken against an individual based on his or her decision to participate or not participate in this study.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Professor Coski, Kennesaw State University, or Liberty

University. If you decide not to participate, you are free not to answer any question or withdraw at any time without affecting those relationships.

What should you do if you decide to withdraw from the study?

If you choose to withdraw from the study, please contact the researcher at the email address included in the next paragraph. Should you withdraw, data collected from you, apart from focus group data, will be destroyed immediately and not included in this study. Focus group data will not be destroyed, but your contributions to the focus group will not be included in the study if you choose to withdraw.

Whom do you contact if you have questions or concerns about the study?

The researcher conducting this study is Professor Brian Coski. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact him at [redacted]. You may also contact the researcher's faculty sponsor, Dr. Donald Palmire, at [redacted].

Whom do you contact if you have questions about your rights as a research participant?

If you have any questions or concerns regarding this study and want to talk to someone other than the researcher, **you are encouraged** to contact the IRB. Our physical address is Institutional Review Board, 1971 University Blvd., Green Hall Ste. 2845, Lynchburg, VA, 24515; our phone number is 434-592-5530, and our email address is irb@liberty.edu.

Disclaimer: The Institutional Review Board (IRB) ensures that human subjects research will be conducted ethically as defined and required by federal regulations. The topics covered and viewpoints expressed or alluded to by student and faculty researchers are those of the researchers and do not necessarily reflect the official policies or positions of Liberty University.

Your Consent

By signing this document, you are agreeing to be in this study. Make sure you understand what the study is about before you sign. You will be given a copy of this document for your records. The researcher will keep a copy with the study records. If you have any questions about the study after you sign this document, you can contact the study team using the information provided above.

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

☐ The researcher has my permission to audio-record and video-record me as part of my participation in this study.

____
Printed Subject Name

____
Signature & Date

Appendix B

KENNESAW STATE UNIVERSITY
OFFICE OF RESEARCH
Research Compliance

08/05/2024

Brian Coski
Liberty University

Dear Brian Coski ,

The Kennesaw State University (KSU) Institutional Review Board (IRB) has administratively examined your study materials for the proposed research entitled "Technology as Instrument: A Case Study of Undergraduate Students' Experience with DAW Technology", that were reviewed and approved by the Liberty University IRB. You are granted permission to recruit participants for this research project on the KSU campus.

Although the IRB allows for the recruitment of participants for your study, the board cannot provide access to faculty, staff, or student email addresses as this information is not included as part of KSU's public directory and is protected under FERPA regulations. You are free to contact KSU faculty/staff members, Office of Student Affairs, or LISTSERV administrators known to you, asking that these individuals provide prospective participants with information regarding your research with the understanding that participation in the research project is voluntary and not a requirement.

Please note that permission to recruit is not an IRB review, and applying to recruit does not serve as or replace review by an IRB. The Liberty University IRB retains responsibility for conducting all required continuing reviews of the study, and all unanticipated problems or adverse events related to the study must be reported to the home IRB.

Should you have questions, please contact the board by email at irb@kennesaw.edu or by telephone at (470) 587-2268.

Sincerely,
[redacted]
Toni Jamison
Office of Research

585 Cobb Avenue, KH 3423, Kennesaw GA 30144
470-578-7721 work | 470/578-9110 fax | http://research.kennesaw.edu

Appendix C

Initial Participant Survey

Start of Block: Default Question Block

Q1 What is your name? (first and last as reflected in D2L)

Q2 Are you a student at Kennesaw State University?

- ◯ Yes
- ◯ No

Q3 Are you a student in the researcher's class?

- ◯ Yes - the MW 1:25 class
- ◯ Yes - the MW 2:30 class
- ◯ Yes - the MW 5:00 class
- ◯ No

Q4 Are you 18 years of age or older?

- ◯ Yes
- ◯ No

Q4 Please provide your school email address so I can contact you about your participation in this study.

Q5 What year are you starting at KSU?

- ◯ Freshman
- ◯ Sophomore
- ◯ Junior
- ◯ Senior

Q6 How do you typically experience and enjoy music?

- ☐ as an appreciator of music
- ☐ as a performer of music
- ☐ as a participator in music
- ☐ as a composer of music
- ☐ as a producer of music
- ☐ as a concert-goer
- ☐ as an intellectual exercise

Q7 Did you participate in a music ensemble during Middle School or High School? Select the ensembles/classes you were a part of.

- ☐ Band
- ☐ Orchestra
- ☐ Choir
- ☐ Other
- ☐ Didn't participate

Q8 2. Did you take private music lessons as a child or teenager? (or currently take lessons)

- ○ Yes
- ○ No

Q9 3. Have you ever taught yourself how to play an instrument?

- ○ Yes.
- ○ No.

Q10 At what level can you read music notation?

- ○ Beginning
- ○ Intermediate
- ○ Advanced
- ○ No experience

Q11 Have you used music production software to record, compose, or arrange music? (like GarageBand, FL Studio, SoundTrap, BandLab, etc.)

- ○ Yes.
- ○ No.

Q12 When you listen to music, what prompts higher level thinking?

- ▢ the performing artist
- ▢ the music
- ▢ the lyrics
- ▢ nothing in particular; I just enjoy it

End of Block: Default Question Block

Appendix D

AMMA data

Technology-as-Instrument: A Case Study of Undergraduate Student Experience with DAW Technology

TONAL Correct	TONAL Incorrect	RHY Correct	RHY Incorrect	TONAL Raw	RHY Raw	TOTAL	TONAL PR	RHY PR	Total PR	APTITUDE Level	NAME	STUDY RATING
17	3	14	2	34	32	66	93	75	86	LEV 2	CS	ADV
12	2	13	5	30	28	58	79	55	70	LEV 3	GF	ADV
10	7	9	3	23	26	49	22	22	20	LEV 4	SG	ADV
15	2	14	1	33	33	66	90	80	86	LEV 2	DB	ADV
12	7	12	2	25	30	55	56	65	62	LEV 3	CV	ADV
9	8	9	2	21	27	48	12	28	17	LEV 4	SC	ADV
15	4	14	2	31	32	63	70	65	62	LEV 3	CF	BEG
11	4	11	3	27	28	55	66	55	62	LEV 3	EM	BEG
10	4	10	2	26	28	54	61	55	59	LEV 3	AG	BEG
10	3	9	1	27	28	55	66	55	62	LEV 3	GS	BEG
11	8	11	2	23	29	52	44	60	53	LEV 3	DI	BEG
11	5	12	4	26	28	54	61	55	59	LEV 3	DT	BEG
11	5	12	5	26	27	53	61	50	56	LEV 3	WA	BEG
13	4	12	4	29	28	57	75	55	68	LEV 3	CK	INTER
12	7	12	1	25	31	56	56	70	65	LEV 3	CM	INTER
11	7	12	3	24	29	53	50	60	56	LEV 3	XS	INTER
14	3	13	3	31	30	61	70	50	56	LEV 3	MS	INTER
6	9	9	5	17	24	41	14	35	20	LEV 4	JB	INTER
6	7	7	9	19	18	37	24	7	12	LEV 4	KG	INTER
16	3	14	2	33	32	65	90	80	84	LEV 2	CH	INTER
12	4	12	3	28	29	57	71	60	68	LEV 3	LL	INTER
11	8	8	5	23	23	46	44	30	35	LEV 3	LF	INTER
7	12	7	2	15	25	40	7	40	18	LEV 4	EB	INTER
18	9	16	0	29	36	65	75	92	84	LEV 2	JB	INTER
14	4	16	3	30	33	63	79	80	80	LEV 2	SG	INTER
13	4	13	2	29	31	60	75	70	74	LEV 3	MM	INTER
8	5	12	3	23	29	52	44	60	53	LEV 3	MK	NONE
9	8	7	2	21	25	46	34	40	35	LEV 3	LG	NONE
10	2	13	4	28	29	57	71	60	68	LEV 3	AD	NONE
7	6	9	5	21	24	35	34	35	32	LEV 3	NB	NONE
7	8	7	4	19	23	42	24	30	23	LEV 3	CM	NONE
7	8	8	6	19	22	41	24	25	20	LEV 4	SS	NONE
11	3	15	3	28	32	60	71	75	74	LEV 3	OO	NONE
13	7	13	1	26	32	58	61	75	70	LEV 3	TW	NONE
12	4	11	5	28	26	54	71	45	59	LEV 3	JR	NONE
7	1	8	3	26	25	51	61	40	50	LEV 3	NR	NONE
10	7	9	5	23	24	47	44	35	38	LEV 3	DR	NONE
6	8	7	6	18	21	39	19	20	16	LEV 4	AC	NONE

Appendix E

Score Report #1: Music Lab Activity (Super-Listener)

Start of Block: Block 1

This survey allows you to report scores from the Super-Listener activity. How'd you do? Report your score by answering the following questions.

End of Block: Block 1

Start of Block: Default Question Block

Q1 What's your name? (first and last, as reflected in D2L)

____

Q2 What was your TOTAL Super-Listener score?

____

Q3 What was your score for Level 1?

____

Q4 What was your score for Level 2?

____

Q5 What was your score for Level 3?

____

Q6 Can you upload a screenshot of your score report?

End of Block: Default Question Block

Appendix F

Score Report #2 & Learning Experience: Super-Listener & SoundTrap

Start of Block: Directions

This survey allows you to report scores from the Super-Listener activity, (the second time through), and share a little about the SoundTrap learning experience. How'd you do??!!

End of Block: Directions

Start of Block: Default Question Block

Q1 What is your name? (as reflected in D2L)

____

Q2 What was your overall Super-Listener score?

____

Q3 What was your score for Level One? (don't include the %)

____

Q4 What was your score for Level Two? (don't include the %)

____

Q5 What was your score for Level Three? (don't include the %)

____

Q6 Save a screenshot of your results page and upload here.

End of Block: Default Question Block

Start of Block: Block 2

Explanation When using software like SoundTrap to produce music, the interface and tools may help you understand the melodies, harmonies, and rhythms that you're using. Consider how using production software affected your personal learning, aural skills and creative process. Explain the benefits of the SoundTrap activity regarding the below questions.

Q7 How did the "Melody Workshop" activity in SoundTrap help you understand the concept of Melody (the tune)?

____

____

____

____

____

Q8 Did you notice qualities of experimentation, and craftsmanship in your creative process? How did the SoundTrap activities contribute to your ability to explore and refine your work?

____

____

____

____

____

Q9 Did the "Melody+Harmony" activity in SoundTrap assist you in understanding how melody and harmony (chords) work together? Unpack and explain this effect.

____

____

____

____

____

Q10 Rhythm and timing is an important part of music. Did the SoundTrap activities help you consider and better understand rhythm concepts? If so, give some examples that you can remember.

____

____

____

____

____

End of Block: Block 2

Appendix G

Focus Group Protocol

Technology-as-Instrument: A Case Study of Undergraduate Student Experience with DAW Technology

GENERAL

What was your initial impression of being assigned a creative technology project?

Did technology allow you more success in your *product*?

Did technology allow you more success in your *process*?

Did music software tools assist in overcoming your lack of musical background and experience? Describe this effect.

Did music production tools help you connect to musical concepts that would otherwise seem abstract? Describe this result.

"Click and consequence" describes a kind of exploration that is a unique benefit from using music production software. Describe your experience exploring music through the functions of music production software.

"Craftsmanship" describes the unending editability of digital music creation. Describe how music production software allowed for extended refinement in your creative learning process.

What challenges did you encounter within the music production projects?

Do you feel that music production software offers enough benefit to learning that it be included as a tool for learning in a typical music appreciation class? Or is it too much trouble?

Getting "detailed" and "hands-on" with music may help you develop better listening skill? Do you feel SoundTrap activities helped you become a more detailed listener?

MELODY+HARMONY project

In the first SoundTrap activity we explored how different chords/harmonies synchronize to and support the melody of Leonard Cohen's *Hallelujah*. How did this project help you understand this concept?

Did you use the "Chords" function in SoundTrap? How did this tool affect you learning and experience for this project?

The melody of *Hallelujah* required some minor chords, and some major. Do you understand the difference between major and minor, by their sound? How did technology assist in your comprehension?

How did the visual layout of the multitrack interface help you understand this project and music in general?

Describe your creative process for this particular project.

What tools, components, or requirements of this project most benefited your comprehension of the featured concepts?

MELODY project

Did you have an earlier confusion about what melody was? Describe your confusion. Did you have trouble picking out which instrument was playing melody, or describing the movement of melody?

How would you describe your comprehension level with melody now?

Did you use the "piano roll" tool? How did this function help you comprehend the concept of melody?

Did you use the "instrument" tool to play melodies on your computer keyboard? How did this help you understand the concept of melody?

Even though this project wasn't necessarily about rhythm, did you gain greater comprehension regarding rhythm and the timing of music?

What tools, components, or requirements of this project most benefited your comprehension of the featured concepts?

Appendix H

Link to Survey Responses

https://www.dropbox.com/scl/fo/xuawwlzmaru10vxzhqb9u/AE1_-KmLU4Zhm0AciQs1CtQ?rlkey=lcn2ijosxhsf2nj9u4af73fbh&st=pe5h5kqc&dl=0

Link to Focus Group Transcripts

https://www.dropbox.com/scl/fo/xuawwlzmaru10vxzhqb9u/AE1_-KmLU4Zhm0AciQs1CtQ?rlkey=lcn2ijosxhsf2nj9u4af73fbh&st=pe5h5kqc&dl=0

Appendix I

SUPER-LISTENER Score Report Data

Technology-as-Instrument: A Case Study of Undergraduate Student Experience with DAW Technology

AMMA TOTAL	Total PR	APTITUDE LEVEL	NAME	STUDY RATING	LV. 1 FIRST	LV. 1 SEC.	LEV. 2 FIRST	LEVL 2 SEC.	LEV. 3 FIRST	LEV. 3 SEC.	SS1 (19 rsp)	SS2. (19 rsp)	% Change
46	35	LEV 3	LG	NONE	50	45	63	50	70	45	375	-126	-134%
52	53	LEV 3	KM	NONE		55		63		65		498.00	
42	23	LEV 3	CM	NONE									
35	32	LEV 3	NB	NONE	45	56	50	45	60	70	133	163.00	23%
57	68	LEV 3	AD	NONE	31		70		60		64		
54	59	LEV 3	JR	NONE	50		50		75		300		
47	38	LEV 3	DR	NONE									
58	70	LEV 3	TW	NONE	50	80	38	44	50	70	-144	605	-520%
51	50	LEV 3	NR	NONE									
60	74	LEV 3	OO	NONE									
41	20	LEV 4	SS	NONE	38	75	55	60	40	25	-248	10	96%
39	16	LEV 4	AC	NONE								-202.00	
65	84	LEV 2	JB	INTER									
53	56	LEV 3	XS	INTER		75		31		50		106	
57	68	LEV 3	CK	INTER	50	50	25	65	70	50	2	163	8050%
56	65	LEV 3	CM	INTER		63		50		60		156	
61	56	LEV 3	MS	INTER	81	65	40	63	60	90	381	630	65%
57	68	LEV 3	LL	INTER	75	86	95	95	95	95	1622	1875	16%
46	35	LEV 3	LF	INTER	55	55	63	57	55	70	323	445	38%
60	74	LEV 3	MM	INTER		56		45		90		782	
41	20	LEV 4	JB	INTER									
37	12	LEV 4	KG	INTER	56	40	70	19	35	60	152	-287	-89%
40	18	LEV 4	EB	INTER								48.20	
65	84	LEV 2	CH	BEG									
63	80	LEV 2	SG	BEG	55	56	63	60	75	25	536	-89	-117%
		LEV 3	AD	BEG		63		50		50		128.00	
63	62	LEV 3	CF	BEG	69	75	75	85	50	40	445	558	25%
55	62	LEV 3	EM	BEG	80	44	50	50	60	65	574	174	-70%
52	53	LEV 3	DI	BEG									
55	62	LEV 3	GS	BEG									
53	56	LEV 3	WA	BEG									
54	59	LEV 3	DT	BEG	50		60		55		275		
66	86	LEV 2	CS	ADV	69	95	80	81	55	80	727	1474	103%
66	86	LEV 2	DB	ADV	100	95	75	86	95	65	1655	1436	-13%
58	70	LEV 3	GF	ADV	100		94		90		1913		
55	62	LEV 3	CV	ADV									
49	20	LEV 4	SG	ADV									
48	17	LEV 4	SC	ADV		100		94		95		2011	

Appendix J

Date: 12-4-2024

IRB #: IRB-FY23-24-2217 Download
Title: Technology as Instrument: A Case Study of Undergraduate Students' Experience with DAW Technology
Creation Date: 6-19-2024
End Date:
Status: Approved
Principal Investigator: Brian Coski
Review Board: Research Ethics Office
Sponsor:

Study History

Submission Type	Initial	Review Type	Limited	Decision	Exempt - Limited IRB

Key Study Contacts

Member	Donald Palmire	Role	Co-Principal Investigator	Contact	[redacted]
Member	Brian Coski	Role	Principal Investigator	Contact	[redacted]
Member	Brian Coski	Role	Primary Contact	Contact	[redacted]

Appendix K

SoundTrap Project #1

Melody + Harmony

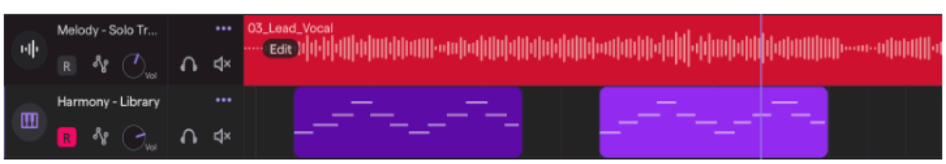
This project utilizes the capabilities of a digital audio workstation (DAW) to explore how melody is supported by harmony in music. You will arrange pre-recorded audio files to reconstruct the song *Hallelujah* by Leonard Cohen.

DIRECTIONS:

- Open the link in SoundTrap entitled "Assignment: Melody+Harmony."
- Listen to the narrated directions on Track 1.
- Listen to the original recording on Track 2.

- Listen to the library of accompaniment files on Track 3. Notice that some are major chord arpeggios, and some are minor.

- Each of these chord samples "fit" under the melody at a particular time. Listen to the original recording a few times.
- Copy/move the chord samples to the blank track under the solo/melody track to where you think they belong.



QUESTIONS? watch the project tutorial with tips and demonstrations.
SUBMISSION: If you opened this project with the provided link, just save the project.

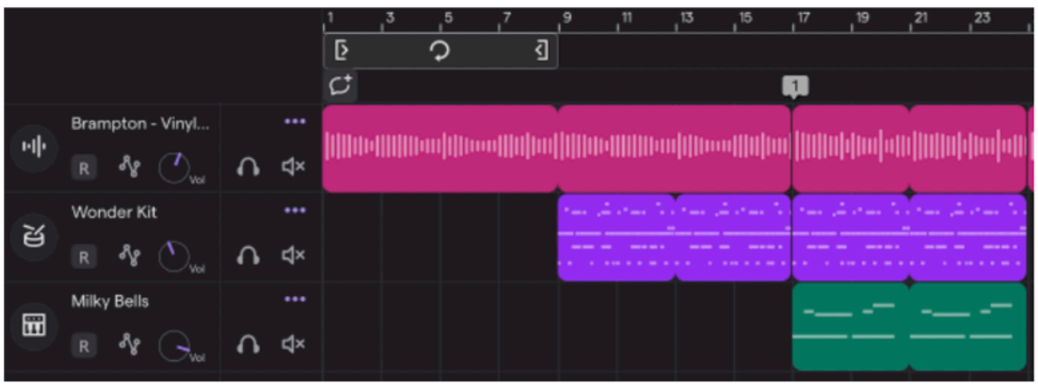
SoundTrap Project #2

Melody Workshop

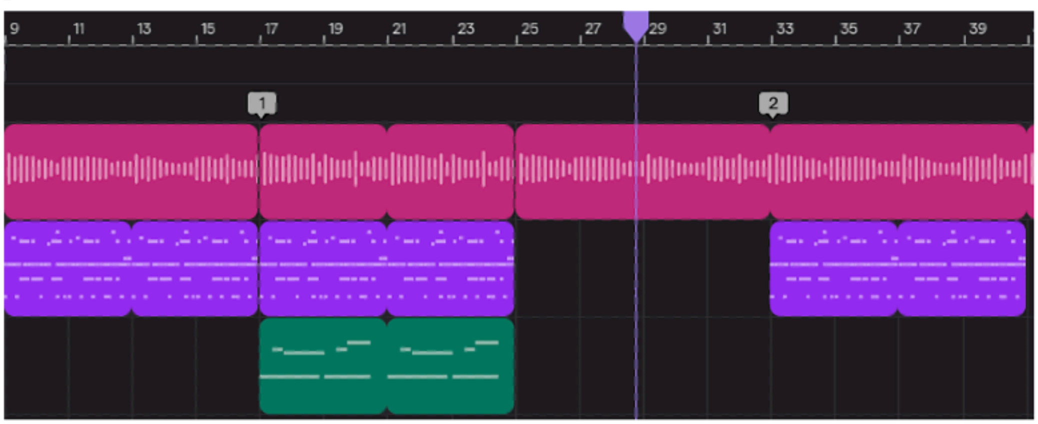
This project utilizes the capabilities of a digital audio workstation (DAW) to explore the construction of melody and how it develops. We will explore melodic development through the use of repetition, contrast and variation.

DIRECTIONS:

- Open the link in SoundTrap entitled "Assignment: Melody Workshop"
- Notice the 3 tracks in the project
  - Track 1: piano
  - Track 2: drums
  - Track 2: bells

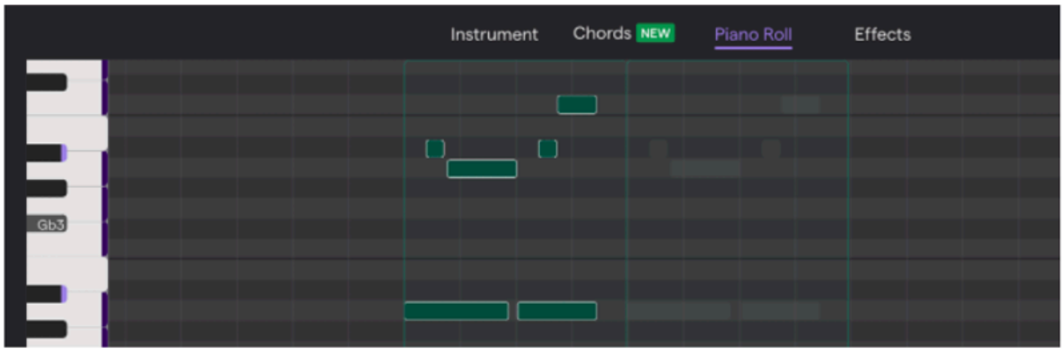


- One instance of the bell melody is included. Listen to the bell "melody A" and decide when it should enter next.
-



- REPETITION
  - copy/paste, or loop bell “melody A” when needed.

- DEVELOPMENT & CONTRAST:
  - Copy/paste the original audio to a new position. Utilize the piano roll to experiment with other notes.



  - Using the record function and the instrument tool, “play” a new melody to use in the project (the original melody is centered on keyboard letters X, C, V, B, N, and J).

- THE RESULT:
  - Repeat “melody A” as much as needed.
  - Compose 2 additional melodies by variation or contrast. Label them as “melody B” and “melody C” by clicking “edit” on the loop.
  - Repeat the loops in Track 1 and 2 as needed to fill the song’s structure.

QUESTIONS? Watch the project tutorial with tips and demonstrations.
SUBMISSION: If you opened this project with the provided link, just save the project!

Appendix L

Monday, December 9, 2024 at 20:46:24 Eastern Standard Time

Subject: [External] Re: Graphic of creative thinking model
Date: Wednesday, May 15, 2024 at 12:57:09 PM Eastern Daylight Time
From: Peter Webster
To: Coski, Brian Alan
Attachments: image001.png

[EXTERNAL EMAIL: Do not click any links or open attachments unless you know the sender and trust the content.]

Absolutely Brian I am grateful for your use of it. Please send me the results of our work if you can.

Peter R. Webster, Ph.D. (he/his/him)
Music Teaching and Learning Sciences
Former Scholar in Residence, University of Southern California
Emeritus Professor, Northwestern University
Adjunct, University of Florida, Gainesville
Emails: [redacted]
Websites: http://www.peterrwebster.com/   https://teachmusictech.com/

From: Coski, Brian Alan [redacted]
Date: Monday, May 13, 2024 at 8:30 PM
To: Peter Webster [redacted]
Subject: Graphic of creative thinking model

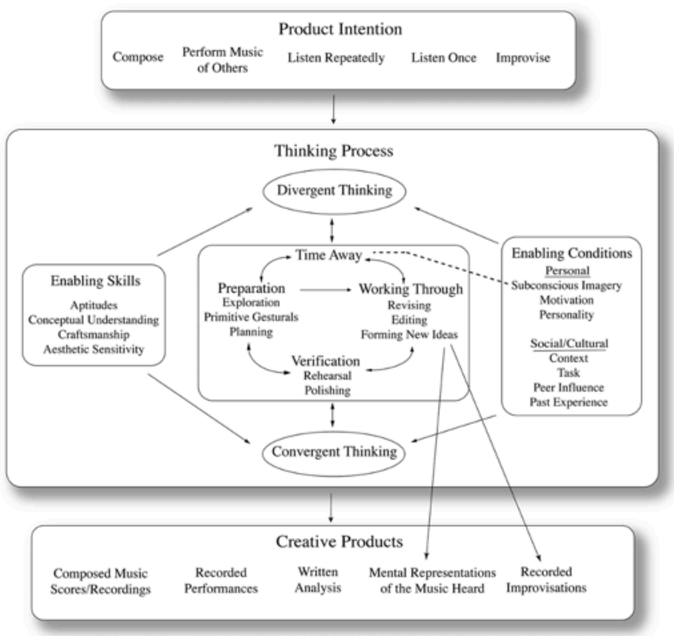
Hi Dr. Webster,

I'm writing regarding a particular graphic of yours (below) that I'd like to use in my doctoral thesis document. Your writing has been a great help in developing my topic (using a technology-as-instrument approach with creative tasks in an undergraduate music appreciation classroom), and I'd appreciate gaining permission to include this particular visual aid.

Thanks so much for considering.

Brian Coski

Model of Creative Thinking Process in Music. Peter R. Webster, "Creativity and Music Education," in *Creativity and Music Education*, ed. Timothy Sullivan and Lee Willingham (Edmonton, Canada: Canadian Music Educators' Association, 2002).



Appendix M

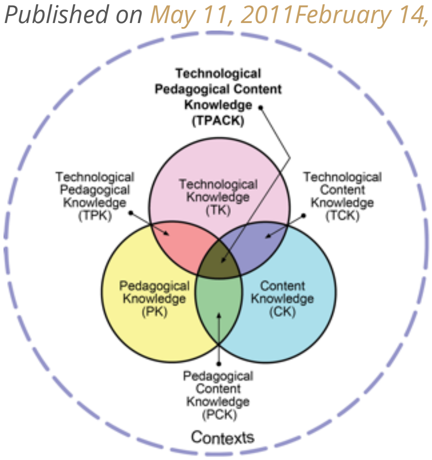
Skip to content

TPACK ORG

Menu

Using the TPACK Image

Published on May 11, 2011February 14, 2017 by mkoehler



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