

2026

TPACK development through self-directed technology learning: music technology educator perceptions and experiences

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BOSTON UNIVERSITY
COLLEGE OF FINE ARTS

Dissertation

**TPACK DEVELOPMENT THROUGH
SELF-DIRECTED TECHNOLOGY LEARNING:
MUSIC TECHNOLOGY EDUCATOR PERCEPTIONS AND EXPERIENCES**

by

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Submitted in partial fulfillment of the
requirements for the degree of
Doctor of Musical Arts

2026

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DEDICATION

This work is dedicated to my family. You have watched me tirelessly commit to this process and without your constant support, encouragement, and love, I never would have accomplished this lofty goal. The words “thank you” do not seem to cover the immense gratitude I possess for you. To my husband, Matias, you have consistently and without complaint picked up my slack in order for me to research and focus on this process. To my son, Noah, you have provided me with rays of sunshine and perfectly timed brain breaks I’ve needed to get me through any day. To you both, I love you to the moon and stars and back again!

ACKNOWLEDGMENTS

The following work would not have been possible without the support and guidance of my dissertation committee. To Dr. Bryan Powell, I'm not quite sure I will ever be able to thank you enough for your candor, constant guidance, NJMEA meet ups, and sense of humor through this process. Your ability to inspire and pose meaningful questions drove the course of this dissertation. I am forever grateful to you!

To my second reader, Dr. Gareth Dylan Smith, I would not have gotten through this without your insight and your ability to make me laugh with your ever-so-clever cheekiness! I cannot express to you how much I have appreciated your critiques and constant support to make this study the best it could be. Thank you, again!

Finally, I would like to express my sincerest thanks to my third reader, Dr. Kerry Renzoni. Your expertise and sincere feedback helped to guide me across the finish line. Thank you for providing another fresh set of eyes and insights. I am grateful to you for your assistance in completing this arduous process. Again, the words "thank you" do not seem to measure up!

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ABSTRACT

The purpose of this study was to examine the impact of self-directed technology learning habits on technological, pedagogical, and content knowledge (TPACK) through the perceptions and experiences of five high school music technology educators. This study used collective case study design. Data were collected over a six-week period in the summer of 2024 through participant interviews and a focus group discussion. Follow up questions regarding participants' use of AI occurred in the summer of 2025. These follow up questions were added to capture emerging trends related to generative AI, which had become increasingly relevant in music education and technology, ensuring the study remained current and reflective of the evolving field. The findings of this study provide support to extant research suggesting that music technology educators are resilient, self-reliant, self-motivated, and possess a willingness to learn new technologies in order to best serve their students through engaging and thoughtful instruction. The study contributes valuable insights into how self-directed learning practices shape music educators' technological proficiency and pedagogical approaches, highlighting the need for adaptive professional development in an evolving technological landscape.

TABLE OF CONTENTS

DEDICATION	iv
ACKNOWLEDGMENTS	v
ABSTRACT	vi
TABLE OF CONTENTS	vii
LIST OF FIGURES	xiii
LIST OF ABBREVIATIONS	xiv
GLOSSARY	xv
CHAPTER ONE: INTRODUCTION	1
The Challenges of Music Technology Integration	1
Defining Music Technology	2
A Brief History of Music Technology in K–12 Education in the United States	2
Benefits of Music Technology	5
Pre-Service and In-Service Teacher Training	7
Framing TPACK as the Research Lens	10
Why TPACK is Useful	13
The Need for this Study	14
Purpose Statement and Guiding Research Questions	17
Summary	18
CHAPTER TWO: LITERATURE REVIEW	20
Introduction	20
Technological Pedagogical and Content Knowledge (TPACK)	21

TPACK in Practice	23
Generative AI and TPACK	25
Roles of Technology in 21 st Century Music Education.....	32
Roles of Generative AI in Music Education.....	36
Teacher Perceptions of Technology Integration.....	41
Self-Directed Learning	43
TPACK-Based Professional Development.....	49
Music Technology Professional Development.....	51
Technology and Pre-Service Music Education	59
TPACK in Pre-Service Education	62
Summary.....	63
CHAPTER THREE: METHODOLOGY	65
Introduction	65
Restatement of Research Questions	65
Research Design	65
Context and Participants.....	67
Data Collection.....	70
Data Analysis.....	75
Trustworthiness	77
Preparation and Qualification of Researcher.....	78
Summary.....	79

CHAPTER FOUR: FINDINGS	80
Introduction	80
Portrait of Ari	81
Portrait of Ari’s Music Technology Program.....	82
Portrait of Rick	83
Portrait of Rick’s Music Technology Program	84
Portrait of Bill.....	86
Portrait of Bill’s Music Technology Program.....	87
Portrait of Alice	88
Portrait of Alice’s Music Technology Program	89
Portrait of Theo.....	90
Portrait of Theo’s Music Technology Program.....	91
Findings Addressing Research Question One	92
Self-Directed Technology Learning.....	93
Self-Reliance	93
Trial and Error Learning.....	94
Need for Broad Range of Technology Knowledge	95
Changing Technology Landscape	95
Technology Funding and Sustainability.....	96
Resources.....	98
Colleague as Resource.....	98
Networking as Resource.....	99

Social Media as Resource.....	99
Manufacturer as Resource	100
Website Resources and YouTube.....	100
Student as Resource.....	101
Pedagogical Change and Growth	102
Reflecting on Curricular Design and Teaching Practice	102
Creating Resources	104
Student Opportunities and Growth.....	105
Findings Addressing Research Question Two	106
Perceptions of Confidence.....	106
Confidence from Doing	107
Comfort Admitting the Unknown	107
Confidence in Troubleshooting	109
Music Technology Professional Development.....	109
Perceptions of Formal Music Technology Professional Development Offerings...	110
Professional Development Funding	111
Delivering Professional Development.....	112
GenAI Integration: Current Perceptions and Practices	113
GenAI as a Planning and Efficiency Tool.....	114
Cautious Optimism Toward GenAI in Music Education	114
AI Used to Support Creativity	115
Ethical Concerns and Criticism of GenAI in Education	115

Limited or Skeptical Adoption	116
GenAI as Support for Accessibility.....	117
Learning Through Informal or District Provided Methods	118
Similarities in Initial Study Findings.....	119
Differences in Initial Study Findings	120
Summary.....	121
CHAPTER FIVE: DISCUSSION	124
Restatement of Purpose and Research Questions.....	124
Interpretation of Findings	125
Self-Directed Technology Learning	127
Music Technology Professional Development.....	131
Comfort and Confidence	133
Developing TPACK	136
Perceptions and Engagement with GenAI.....	138
Implications for Music Education	142
Implications for Future Research	144
Study Limitations	146
Conclusion.....	147
APPENDIX A	149
APPENDIX B.....	150
APPENDIX C.....	151
APPENDIX D	152

APPENDIX E	153
APPENDIX F	156
BIBLIOGRAPHY	158
CURRICULUM VITAE	176

LIST OF FIGURES

Figure 1 TPACK (Mishra & Koehler, 2008)22

LIST OF ABBREVIATIONS

AI	Artificial Intelligence
AP	Advanced Placement
CP	College Preparatory
CTE	Career Technical Education
DAW	Digital Audio Workstation
EQ	Equalizer
GenAI	Generative Artificial Intelligence
ICT	Information and Communication Technology
IRB	Institutional Review Board
IT	Information Technology
K–12	Kindergarten through 12 th Grade
MIDI	Musical Instrument Digital Interface
NAfME	National Association for Music Education
PCK	Pedagogical Content Knowledge
PD	Professional Development
SAMR	Substitution, Augmentation, Modification, and Redefinition
TAM	Technology Acceptance Model
TPACK	Technological Pedagogical and Content Knowledge

GLOSSARY

Capital: Resources, both tangible and intangible, that individuals possess and use to gain advantage or recognition within a certain social context or field.

Field: A social arena with its own rules, power dynamics, and forms of capital, where individuals and institutions compete for influence and resources.

Generative AI: A type of artificial intelligence that can create new content based on patterns learned from data.

Habitus: Deeply engrained dispositions shaped by one's upbringing and socialization.

Music Technology: Digital tools and equipment used to create, record, edit, and teach music, such as software, recording devices, electronic instruments, and AI-based learning tools.

Music Technology Educator: An educator who facilitates music learning through the intentional integration of digital technologies for music creation, performance, recording, and production, drawing on interconnected musical, pedagogical, and technological knowledge to support instruction in technology-mediated musical contexts.

Non-traditional Music Students: Learners who engage with music outside of conventional school programs or classical training.

Professional Development: Ongoing learning and training activities that assist individuals in improving skills, knowledge and effectiveness in their careers.

Self-directed Technology Learning: Individuals taking initiative to learn and use technology on their own, setting goals, choosing resources, and managing their

progress without formal instruction.

Technological Pedagogical and Content Knowledge (TPACK): A framework that describes the effective integration of technology into teaching by combining knowledge of the subject, teaching methods, and digital tools.

CHAPTER ONE: INTRODUCTION

The Challenges of Music Technology Integration

The integration of technology into teaching is continually evolving, reshaping how music educators engage with students and deliver instruction. As new tools emerge, music educators face pressures to adapt and find ways to stay knowledgeable and abreast of new technologies and how they may be beneficial to students in a myriad of contexts. Music educators face difficulties in several forms including limited technology professional development opportunities (Gorgoretti, 2019; Latham, 2020; McCusker, 2017), barriers to access (Leong, 2010, 2016; Liu et al., 2017), and difficulties conceptualizing practical applications of technology within specific teaching contexts (Gilbert, 2016; Latham, 2020; Lieberman & Pointer Mace, 2010; Stanley et al., 2014).

Additionally, music technology researchers reported in-service educator difficulties adapting music technology for use in traditional ensemble settings (bell et al., 2019; Musgrove, 2019) and a lack of technology application and modeling at the pre-service level (Gilbert, 2016; Meltzer, 2001). Many music educators have also had to seek out professional development learning opportunities on their own to develop their understanding of how to integrate technology in their teaching contexts (Bauer, 2007; 2013). Currently there is limited research exploring the use of the technological, pedagogical, and content knowledge (TPACK) framework in the context of music technology professional development.

Defining Music Technology

There are many ways to define music technology. Any tools, including musical instruments and writing utensils, could be considered music technology. Since there are many ways to define the term, it is helpful to define music technology for the context of this study. When defining the technology side of music composition, Beckstead (2001) referred, "...to specific composing technologies such as personal computers, synthesizers, and MIDI (musical instrument digital interface)" (p. 45). Wise et al. (2011) stated, "understanding as to what we mean when we talk of digital technology relative to music (often referred to as 'music technology) varies" (p. 119). The researchers go on to categorize classroom technology components into hardware and software. Webster (2011) similarly categorized music technology into hardware and software, but also identified pedagogical tools as a distinct category. Music technology, in this case, refers to all manner of digital technology used by the educators, including, but not limited to notation software, recording equipment, looping and sequencing software, internet-based music programs, websites, generative artificial intelligence (GenAI), external hardware such as recording devices, microphones, computers, electronic instruments, mixing boards, and pedagogical tools such as intelligent accompaniment and guided instruction of concepts.

A Brief History of Music Technology in K–12 Education in the United States

While an exhaustive examination of the history of music technology is beyond the scope of this research, it is beneficial to provide a brief overview of the evolution of technology use in K–12 education in the United States to contextualize teaching with

music technology. In the 1980s, microcomputer companies began to market to K–12 education, prompting early investments in classroom technology (Picciano & Spring, 2012). Computer assisted instruction (CAI) had already begun in the 1960s and 1970s with early programs like Programmed Logic for Automatic Teaching Operations (PLATO), offering interactive, self-paced learning experiences (Mandanici et al., 2023). Until the introduction of microcomputers, music education computer programs were limited to drill and practice formats which addressed ear training and aural skills (Mandanici et al., 2023). Technology in education changed significantly in the 1990s as more people began to rely on the Internet for various purposes (Picciano & Spring, 2012). The shift from Web 1.0 (read-only) to Web 2.0 (read-write) in the early 2000s allowed students and educators to interact in real-time and access vast online archives, audio sample libraries, and a number of resources for music learning (Mandanici et al., 2023).

More widespread technology adoption was amplified by the No Child Left Behind (NCLB) Act of 2002, which prioritized data-driven decision-making and school report cards. These requirements also compelled schools to upgrade their record-keeping and monitor students' academic progress. The microcomputer ratio rose from 4:1 in 2004 to 1:1 by 2015 (USDOE, 2016). The widespread availability of student devices contributed to the rise of project-based learning (Markham, 2011) and blended-learning ideologies (Siemens et al., 2015). In 2015, the Every Student Succeeds Act (ESSA) was passed, requiring all students to receive an education with high academic standards that prepare students for success in college and careers (USDOE, 2016). With this came an educational shift toward teaching employability and 21st century skills (P21, 2015). New

technology standards began to be adopted at the national and state levels with equity and accessibility at the forefront to ensure personalized learning (NETP, 2017).

Beckstead (2001) asserted that early public school music education in the United States focused almost exclusively on performance, especially singing. Music education in schools separated the roles of composer and performer, which in turn led educators to believe that composition was outside the scope of student capacity (Beckstead, 2001). As music tastes and styles progressed, genres like jazz, blues, and rock and roll began to blur the lines between these two roles (Beckstead, 2001). As Randles (2024) stated, "...songwriting has been a musical gold mine that the profession has underexplored in school and community settings" (p. 94). This education shift created opportunities to use technology as a composition tool, particularly as the role of traditional music notation diminished (Mark & Gary, 2007). However, early digital tools were costly and often lacked practical classroom applications (Webster, 2011). Despite rapid technology innovation in the music industry, music education has lagged behind as these tools are rarely integrated into music classrooms (Mandanici et al., 2023).

In 1994, the Music Educators National Conference (MENC), now the National Association for Music Education (NAfME), released *The School Music Program: A New Vision*, which identified technology as one of seven areas of focus that differed significantly from traditional music curricula (Roblyer & Doering, 2010). However, Wise et al. (2011) pointed out:

Many secondary school teachers are products of the Western classical tradition, which is based largely on the conservatoire and associated skills and traditions that this brings with it (p. 121).

As a result, K–12 music educators often integrate technology into instructional models shaped by this classical performance tradition (Webster, 2002; Dammers, 2012).

Williams (2017) emphasized that school instrumental and vocal music instruction has remained virtually unchanged over the last 100 years, with minimal technology usage within traditional ensemble settings. Williams argued that many music educators, particularly those rooted in performance ensembles, are hesitant to abandon the comfort of these longstanding teaching models, despite significant changes in the broader music landscape. He further noted that popular music technologies have reshaped how music is conceived, produced, and consumed, yet these tools remain underutilized in U.S. music education, creating a disconnect between classroom practice and real-world musical engagement (Williams, 2017). Mandanici et al. (2023) similarly observed that the rise of affordable and accessible digital audio workstations has opened music-making to individuals with no formal training, challenging the exclusivity of notation-based instruction and enabling new creative opportunities in music education.

Benefits of Music Technology

Understanding the benefits of technology integration across diverse music teaching contexts is essential to recognizing its role in enhancing student engagement, creativity, and access to learning. Students interact with music through technological means on a daily basis outside of the classroom (Albert, 2015). For music education to remain relevant, it should mirror this technological use (Albert, 2015; Benedict & O’Leary, 2019). Music technology-mediated composition creates a more inclusive environment, offering non-traditional music students greater opportunities to participate

(Dammers, 2012; Williams, 2011). Music technology allows students who may not read Western-standard music notation or play an instrument the ability to contribute to the creative process, using their technological and experiential knowledge (Clauhs et al., 2019).

Many researchers have sought to understand the impact of music technology on student learning outcomes. Several researchers have found a correlation between music technology usage and increased student engagement (Chen, 2020; Garrison, 2024; Tobias, 2015). Similarly, researchers have also found that the use of music technology can aid in the speed of mastery of musical concepts (Cremata & Powell, 2016). The integration of music technology tools such as digital audio workstations and composition software has allowed educators to step into the role of facilitator (Cremata, 2017) allowing for student autonomy in creative decision-making and increased social capital by promoting collaboration and peer interaction among students (Albert, 2015).

However, Elpus and Abril (2011, 2019) studied music program enrollment in United States high school ensembles and noted that roughly 80 percent of school populations are not involved in traditional band, chorus, or orchestra courses. Williams (2019) echoed these findings stating that music courses are often not a requirement of graduation. Wish (2020) identified the need to reach non-traditional music students in order for music education in K–12 schools to remain relevant. Many researchers have pointed to the gaps regarding in-school music education and out of school, lived musical experiences and have emphasized the need to bridge this divide to make music education more relevant and inclusive for students (Albert, 2015; Burnard, 2010; Powell, 2019).

Pre-Service and In-Service Teacher Training

Despite recognition of the value of music technology in education, many educators continue to face challenges in effectively integrating technology into their teaching practices, including limited exposure to music technology in undergraduate curricula (Blackwell, 2018), pandemic-related changes, and lack of music technology-specific school district professional development.

Researchers studied several institutions of higher education to ascertain how music technology was addressed in pre-service curricula and found that many institutions only offer stand-alone technology courses (Dorfman, 2016a; Haning, 2016) that were not a requirement of graduation (Susko, 2015). Haning (2016) also identified that these courses offered very little in terms of practical application of the technology covered and that “participants’ comments about the use of technology in their degree programs indicated that some participants sought out and learned about technology resources on their own” (p. 84).

According to Gall (2013), pre-service music educators identified a lack of music technology modeling in their undergraduate methods courses. Likewise, participants also noted that their cooperating teachers did not model technology use during practicum experiences (Gall, 2013). Gilbert (2016) noted that faculty may also hold harmful presuppositions regarding students’ daily technology usage, assuming that this usage automatically translates into students’ ability to teach effectively with technology. This dichotomy could be perpetuating the difficulties associated with technology usage for in-service music educators.

The onset of the COVID-19 pandemic forced technology to the forefront of education as remote learning became a necessity. As Camlin and Lisboa (2021) pointed out, “with the need for state-of-the-art studio equipment down to home computer systems of laptops and headsets, educators were faced with pedagogical demands never before envisaged” (p. 134). This shift caused a steep learning curve (Joseph & Lennox, 2021). Calderón-Garrido and Gustems-Carnicer (2021) discussed the difficulties of adapting computer-mediated systems to live music classes due to considerable technological issues and limited digital skills. Furthermore, the researchers used the Substitution, Augmentation, Modification, and Redefinition (SAMR) model (Puentadura, 2015), to evaluate participants’ teaching activities during the pandemic and found that most were at the lowest SAMR level of substitution. At this level, technology merely replaces more traditional tools without significantly changing the instructional design. Calderón-Garrido and Gustems-Carnicer suggested that initial teacher and in-service teacher training needed to be adapted with regard to developing digital capabilities. Although these studies are situated outside the U.S. context, both Daubney and Fautley (2021) and Calderón-Garrido and Gustems-Carnicer (2021) highlighted the issue of extremely vague and late guidance from local governments and school administrations with regard to training educators for emergency online teaching. This mirrors similar issues within the United States during the shift to remote learning (Hash, 2021). Moreover, Daubney and Fautley (2021) suggested that despite the lack of guidance, music educators remain resourceful and adaptable, traits found among educators across various educational systems during the pandemic.

Many public school districts within the United States have been outfitted with Internet connectivity (NCES, 2021) and school-issued student devices (USDOE, 2017). To accompany these affordances, national and local technology initiatives have become commonplace (NETP, 2017), often changing from school year to school year. Frequently, educators are expected to learn and use these new technologies arbitrarily with limited training or support (Kontkanen et al., 2016).

For music educators, many district-wide technology initiatives have limited relevance to music instruction, yet technology use is often a component of teacher observations (Nielsen, 2013). To fill that gap, music educators repeatedly seek out-of-district technology professional development (Bowles, 2003; Davis et al., 2009). However, often these professional development programs are not offered as multi-session workshops (Stanley et al., 2014) and are considered one-size-fits-all (Wallace, 2018). Unfortunately, much of the technology professional development offered does not include time for reflection (Bernard et al., 2018), contains limited practical application (Bauer, 2007), and/or does not include continued supports (Leong, 2016; Minott, 2015).

To seek a deeper level of training, many music educators have turned to online communities of practice (Bernard et al., 2018; Waldron, 2016) and self-directed technology learning (Bauer, 2013) as a means of developing knowledge of the practical application of the music technology available within their teaching contexts. A community of practice refers to a group of individuals who share a common interest or profession and engage collaboratively to exchange knowledge, experiences, and resources in order to improve their practice (Wenger, 1998). Music educators often

engage in peer and informal learning within these online spaces (Bauer, 2010; Diel, 2021; Doherty, 2021). These self-directed and collaborative approaches allow teachers to tailor their learning to immediate professional needs while remaining current with rapidly changing digital tools and pedagogical methods (Bauer, 2010; Diel, 2021; Doherty, 2021). Together, online communities of practice and self-directed learning provide educators with meaningful ways to develop professional practice in technology-enhanced music education.

Framing TPACK as the Research Lens

In an attempt to better understand the intersections and interactions of the domains of technology, pedagogy, and subject-specific content knowledge, Koehler and Mishra (2005) developed the Technological Pedagogical and Content Knowledge framework (TPACK). The TPACK framework, which stems from Shulman's (1986) Pedagogical Content Knowledge (PCK), helps explain the knowledge teachers need to integrate technology into their teaching practice. The goal of TPACK is to guide educators in thoughtfully integrating content, pedagogy, and technology to design effective learning environments and choose the most suitable tools for teaching specific subject matter. Building knowledge across the three domains allows for more informed selection and application of technology than relying on general familiarity or isolated technical skills alone.

Several music education researchers have attempted to measure different aspects of the development of TPACK among pre-service and in-service music educators. For example, Bauer (2013) developed and administered a survey instrument to measure

music educator TPACK as well as their levels of technology integration in the classroom. Bauer found that there was a moderate significant positive correlation between the two measures; however, the technology domains had the lowest scores of the three domains. Doherty (2019) used Bauer's survey to measure teachers' self-efficacy in using technology in teaching contexts. The researcher found that factors such as years of service, gender, grade level, and content area influenced the development of teachers' TPACK.

Angeli and Valanides (2009) asserted that TPACK is worth teaching educators explicitly, as they believe it to be a valuable framework for effective technology integration. The researchers proposed technology mapping, the process of identifying, categorizing, and aligning technological tools with instructional or pedagogical goals, as an approach to the development of TPACK. Building from this research, Macrides and Angeli (2018a) explored Angeli and Valanides' addition of affect to the TPACK domains. The researchers asserted that, unlike Mishra and Koehler's model, the domains should be viewed as distinct yet complimentary knowledge areas that individually contribute to the overall development of TPACK. Despite this assertion, Macrides and Angeli (2018b) found that teacher participants were relegating the use of technology to peripheral tasks and that teaching practice was not reflecting the potential that technology has for transforming music education.

Researchers have used TPACK to assess music teachers' attitudes toward technology (Gudek, 2019), the effectiveness of technological professional development (Bauer, 2007), and the effect of building TPACK on teaching practice (Doherty, 2019).

For instance, Bauer (2013) used the TPACK framework to explore pre-service music teachers' perceptions of their undergraduate coursework regarding building their knowledge of teaching with technology. Bannerman and O'Leary (2020) used the TPACK framework to explore pre-service music teachers' daily technology usage, their perceptions toward technology usage in their teaching, and their overall experiences with technology. Bauer and Dammers (2016) administered a modified M-TPACK survey developed by Bauer (2013) to university heads of music programs. This survey tool was used to measure music-specific TPACK and the researchers found that in the technology domains, participants expressed a lack of pre-service teacher preparation. Tejada and Morel (2019) used the TPACK framework to design and evaluate a technology course for pre-service music educators. Student participants favored the course and considered the content to be necessary to initial music teacher education. The participants also commented on the benefits of the learning outcomes and many planned to use technology within their own classrooms.

However, there is an inherent lack of empirical research regarding the development of TPACK in music education (Doherty, 2019; Tejada & Morel, 2019). While the TPACK framework has been applied in general education, few studies have investigated how music educators acquire, apply, or refine this knowledge specifically in music technology education. This gap indicates a need for research on how music technology educators build TPACK in both formal and self-directed learning experiences. A more in-depth description of the TPACK framework and related research will be presented in Chapter Two.

Why TPACK is Useful

Building music educator TPACK allows for more technological knowledge in order to evaluate specific technologies and their overall usefulness in teaching contexts (Roblyer & Doering, 2010). This knowledge affords educators the ability to assess how effective certain technologies might be in educating their student demographic.

According to Roblyer and Doering:

TPACK in any discipline is the perfect union of three knowledge domains (content, pedagogy, and technology) to develop a knowledge base from which a teacher can view a lesson and see how technology can enhance the learning of content (p. 366).

Additionally, building TPACK increases the skills needed to learn and utilize other technologies creating a larger tool kit from which the educator can choose (Roblyer & Doering, 2010). Researchers have suggested that increased comfort with technology correlates with increased attempts to use technology with students, despite fear of failure (Gudek, 2019; Liu et al., 2017).

While many districts evaluate teachers on their use of technology in the classroom (Nielsen, 2013), state-level requirements for teacher licensure often do not reflect these expectations. Roblyer and Doering caution:

Until states begin requiring that teacher candidates demonstrate proficiency with technology, teacher preparation programs will have a difficult time making a case for including required technology courses in their curricula. Teacher preparation programs, already overloaded with content, would be reluctant to displace a more traditional course with one whose skills remain in the ‘optional’ category with respect to licensure (2010, p. 367).

The juxtaposition of district-level and state-mandated licensure requirements points to a need to prepare music educators with a strong foundation in TPACK, which supports

meaningful technology integration regardless of inconsistent mandates.

The Need for this Study

There is currently a lack of research regarding the TPACK framework and music technology professional development. Many educators have expressed the difficulties with technology integration due to a lack of funding and institution support (Blackwell, 2018; Brudvik & Hebert, 2020; Gudek, 2019; Koehler et al., 2013), a lack of continued technology support (Gudek, 2019), inadequate reflection and implementation time (Bauer et al., 2003; Leong, 2016; Minott, 2015), a lack of appropriate professional development opportunities, and a one-size-fits-all approach (Bauer, 2007; Bowles, 2003; Davis et al., 2009; Leong, 2016; Minott, 2015). Despite these challenges, technology in music education expands access to creative tools (Burnard, 2010), enables differentiated instruction (Clauhs & Cremata, 2020), and supports student engagement through composition, recording, and collaboration (Chen & O'Neill, 2020). As discussed previously, many educators seek online communities of practice due to ease of use and the ability to connect with other despite isolation (Macia & Garcia, 2016). Further research regarding the TPACK framework and music technology professional development is warranted to understand if TPACK is a viable lens for addressing the issues associated with technology integration within music education.

This study is intended to contribute to the existing body of literature regarding music educator TPACK and the perceived effectiveness of technology professional development on practical application in teaching contexts. The need for this study is rooted in three areas of justification: personal, professional, and theoretical. While I have

personal reasons to pursue this study, the research will add to literature pertaining to building music educator TPACK and the benefits and challenges associated with music technology integration in teaching practice.

This study is closely connected to my struggles as a middle school choral director and the difficulties I faced with integrating engaging and meaningful technology use in my classroom. As Bauer (2013) suggested, I have found that a majority of my TPACK has developed from self-directed technology learning of various software and websites. Due to limited experiences with music technology in my undergraduate career (Leong, 2016), the pressures of meeting district technology initiatives, and district evaluations of effective technology usage (Nielsen, 2013), I have found myself seeking answers for how best to enhance my teaching practice to meet the needs of my students.

As Bauer (2013) suggested, self-directed technology learning is the most significant means of developing TPACK among in-service music educators. I often searched for out-of-district professional development in music technology as those opportunities did not exist within my school district. My experiences have been echoed in research regarding online music education communities of practice, primarily used for professional development (Bernard et al., 2018). Through participatory culture of online communities, collective knowledge is socially constructed and resources are formed (Bernard et al., 2018; Biasutti, 2011; Tobias, 2015). With limited support within my district, I have sought online communities to learn from others in similar fields, as well as contribute my knowledge when possible.

Researchers have suggested that music educators desire to use technology within

their classes, but do not always have the means or knowledge in best practices to do so (Dorfman, 2008; 2016; Leong, 2016). Researchers have found that music educators use technology more for clerical purposes and with limited student interaction (Devaney, 2019). Pre-service music educators have been known to feel a disconnect between methods courses and their practicum experiences (Abrahams, 2009). Researchers have discussed pre-service teacher perceptions of their TPACK development in undergraduate programs (Abrahams, 2009; Davis et al., 2009; Joo et al., 2018; Reese et al., 2016). This study may contribute to the existing literature relevant to pre-service music teacher education and the addition of TPACK and effective technology integration.

This study is also intended to contribute to the existing literature regarding effective music technology professional development. Several researchers have found positive correlations between technology professional development and effective usage in the music classroom (Bauer et al., 2003; Davis et al., 2009; Wolf & Younie, 2018). Leong (2016) attested to the need for differentiated professional development that is not one-size-fits-all. Leong advocated for professional development that addresses differing content areas, includes systems of support, participant choice, and opportunities to reflect on learning (Leong, 2016). With this study, I intended to offer future researchers valuable insights for designing effective professional development and integrating technology into music teaching practice.

Because TPACK is a practice-based theoretical framework, this theoretical justification is also rooted in practice, emphasizing that experiential learning is essential to TPACK development (Mishra & Koehler, 2006). Researchers have documented a

strong relationship between computer self-efficacy and attitudes toward technology to be a predictive factor in classroom usage (Gudek, 2019; Joo et al., 2018). Tonduer et al. (2019) found that music teachers with low information and communication technology (ICT) profiles need extra supports to develop TPACK. The ongoing development of teacher TPACK contributes to more comfortability, creativity, and engagement through technology within the music classroom (Mishra & Koehler, 2006). The researchers' extension of PCK (Shulman, 1986) into TPACK (Mishra and Koehler, 2006) aided in addressing new avenues to explore best practices for teaching a student population of digital natives (Prensky, 2001). The addition of formalized training in TPACK in pre-service music teacher education coupled with the ability to develop and practice the specific skills gained from this training, may assist researchers in furthering suggestions for the preparation of novice teachers. Moreover, given the strong link between self-efficacy and TPACK development (Doherty, 2019), training models might also prioritize building confidence and competence through sustained, experiential learning opportunities. As well, ongoing, targeted professional development not only strengthens technological skills, but also deepens pedagogical reasoning (McCusker, 2017). In this study, I highlight the importance of aligning theoretical constructs like TPACK with practical, context-specific support structures that empower music educators to teach effectively in evolving digital environments.

Purpose Statement and Guiding Research Questions

The purpose of this collective case study was to examine how five music technology educators engaged in self-directed learning, focusing on their perceptions of

professional development and their confidence in integrating technology into their teaching.

The following research questions guided the study through the course of my research:

- (1) How has self-directed technology learning contributed to music technology educators' development of the technological domains within the TPACK framework?
- (2) In what ways has self-directed technology learning influenced the music technology educators' perceptions of their preparedness and willingness to integrate technology into their teaching practice?

Summary

The domains of TPACK (technology, pedagogy, and content knowledge) influence the ways in which music educators select, evaluate, and use technology within their teaching practice. A deficit regarding technology modeling and practical application may contribute to hardships music educators face in building TPACK. By conducting this study, I aimed to better understand how current music technology educators adapt to technological advances and how this knowledge affects their comfortability with technology in their teaching practices.

In chapter two, I present an in-depth review of the literature regarding TPACK and music education, difficulties researchers have identified regarding music technology professional development, and deficits researchers have found in pre-service curricula that contribute to lacking music technology usage in in-service teaching. Chapter three

contains the methodology. In chapter four, I review the collected data from participant interviews and focus group discussion. Finally, in chapter five, I discuss my findings, their significance to music education, and implications for future research.

CHAPTER TWO: LITERATURE REVIEW

Introduction

The use of technology in daily life has accelerated in the past two decades (LeBlanc et al., 2017). According to a study conducted using detailed logs from mobile phones and tablets, on average, participants (N = 29,270) had 60 interactions per day with smartphones being used almost three times more than tablets (Hintze et al., 2017). Many educators have taken to finding new and innovative ways to integrate technology in their teaching practice. Technology is now being used for assessment, student performance portfolios, and even as a means for students to take charge of their knowledge and growth through learning autonomy (Criswell, 2017; Henry 2015). Specifically in music education, teachers are learning and developing new ways to engage students through music technology by creating more composition opportunities not previously afforded without extensive theoretical knowledge (Nielsen, 2013).

In this chapter, I review the literature that informs and frames this study. I explore the intersections of technology integration, music education, and teacher development through the lens of the technological, pedagogical, and content knowledge (TPACK) framework. I begin by outlining the components of TPACK and how the framework has been applied in practice. I present research as it pertains to TPACK and generative artificial intelligence (GenAI) and provide a summary of research on GenAI in music education. I then examine the role of technology and GenAI in music education followed by research pertaining to music educators' perceptions of technology integration. Next, I review how technology is addressed in pre-service music education and then the ways in

which professional development supports in-service teachers' ongoing growth in this area. I conclude with a summary of the key themes and highlight gaps in the literature that I sought to address with this study.

Technological Pedagogical and Content Knowledge (TPACK)

Technological Pedagogical and Content Knowledge (TPACK) is a framework in which the domains of technology, pedagogy, and content knowledge interact to assist music educators in selecting and utilizing technology to aid in student comprehension and autonomy. Shulman (1986) developed the Pedagogical Content Knowledge (PCK) framework after examining the dichotomy between pedagogy and content knowledge in pre-service teacher examinations. Shulman asserted that to blend pedagogy and content knowledge, attention needed to be paid specifically to both processes and how they constrained and informed one another. As described by Shulman, PCK is subject matter knowledge for teaching that includes understandings of what makes learning certain concepts easy or difficult for students, as well as understandings of student age, development, and a knowledge of teaching strategies.

Building from the PCK framework, Koehler and Mishra (2005) added the domain of technology to create the TPACK framework. Koehler et al. (2013) asserted that TPACK is essential for teaching with technology and encompasses knowledge of student learning, subject matter, and technology (see Figure 1).

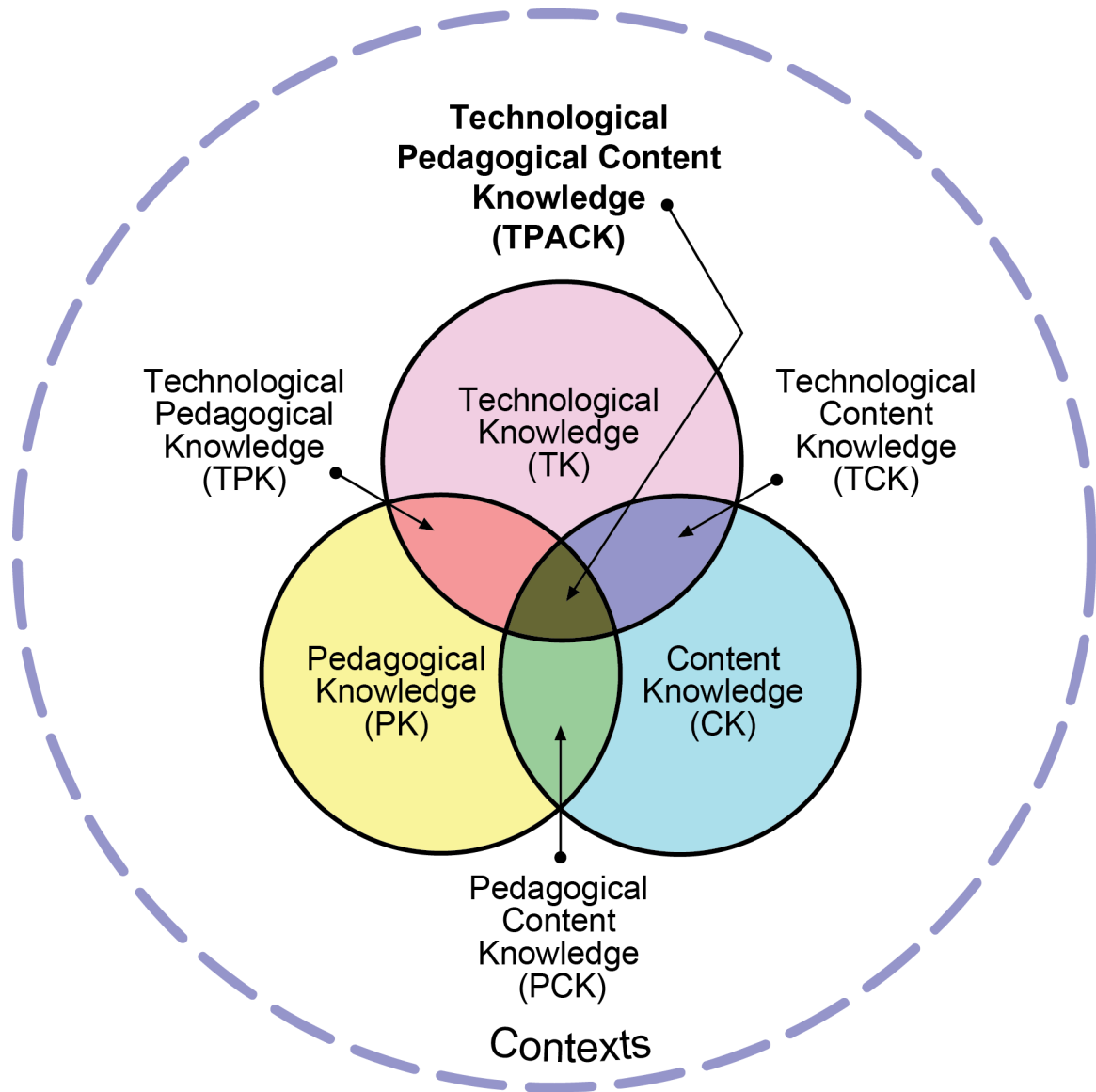


Figure 1. Technological Pedagogical and Content Knowledge (Koehler & Mishra, 2008)

Due to the constant evolution of technology, the authors declined to define the technological domain to avoid it becoming quickly obsolete. Rather, the authors define technological knowledge as an open-ended, continuous interaction with technology.

Koehler et al. (2013) expressed that educators' understanding of how technology impacts

their teaching practice is essential to developing new technological tools to benefit student learning outcomes. However, measurement of TPACK has proven to be an elusive construct. Voogt et al. (2013) analyzed TPACK-related research articles and determined that measures of self-assessment were the most prevalent means of reporting data, but with varying results. This is consistent with Abbitt's (2011) suggestions that self-assessment designs have contextual limitations and rely on respondents' accuracy in reporting honestly. Additionally, calls for performance-based assessment of TPACK have proven limitations in that they only measure domain specifics and not the whole (Abbitt, 2011; Voogt et al., 2013). Despite this, TPACK has proven a useful framework in uncovering the benefits to student learning and teacher development. The TPACK framework highlights the complexities between technology, pedagogy, and content knowledge, providing a comprehensive model for effectively integrating technology in teaching practice. An in-depth discussion of the findings related to the usefulness of measuring TPACK will be provided in the following section.

TPACK in Practice

Using the TPACK framework, Joo et al. (2008) examined the relationship between self-efficacy, perceived usefulness, and intention to use technology among pre-service teachers. The researchers employed the Technology Acceptance Model (TAM) developed by Davis (1989), to measure pre-service educators' training and awareness of TPACK in three Korean universities (N = 296). The researchers found that prior training and awareness of TPACK positively affected all three domains. Joo et al. (2018) stated the importance for teachers to remain critical of technology and continue to evaluate its

benefits for teaching and learning. Koehler et al. (2013) echoed this point in their suggestion that it is important for educators to look beyond common uses of technology for more transformative means, which allows movement past technology as simply an add-on. An understanding of how technology and content influence and constrain one another is central to the TPACK framework (Koehler & Mishra, 2005).

Building on the foundational understanding of TPACK's impact on technology use intentions, researchers have also sought to specifically measure TPACK competencies within music education contexts. There have been several variants of the TPACK framework applied to music education. Bauer (2013) sought to develop and administer an instrument to measure music educators' TPACK. Bauer designed one questionnaire (MTPACK-Q) to measure TPACK and a second questionnaire to describe participants' technology integration practices. Participants (N = 284) were music educators who enrolled in a week-long music technology workshop held in various locations throughout the United States. Bauer found that high MTPACK-Q scores correlated with more technology usage in participants' teaching. Building from this, Gall (2016) asserted that the areas of general pedagogical knowledge, music pedagogical knowledge, general technological knowledge and music technological knowledge are all relevant additions to the music TPACK framework. These additions would distinguish between general knowledge for teaching and knowledge in music education.

Other fields of study have been combined with the TPACK framework in order for researchers to gain a more holistic understanding of how TPACK affects motives toward technology usage. Macrides and Angeli (2018b) applied the TPACK model

described in Angeli and Valanides (2009) to their study as a means of addressing the missing fields of emotion and affect in the original TPACK framework. Angeli and Valanides (2009) asserted that the use of information communication technologies (ICT) provided added values, chosen for specific learners in specific contexts. Huffman (2016) conducted a mixed-methods study using the Higher Education-TPACK (HE-TPACK) survey and interview data to assess arts and sciences faculty perceptions of experiences with technology, opportunities they provide to students to integrate technology through assignments, and any transformative experiences that caused them to view technology in a different way. Dorfman (2016a) administered an online questionnaire (N = 169) to examine music education faculty perspectives and how their pre-service music students gained technology experiences. Both Huffman (2016) and Dorfman (2016a) discussed their participants' fears of a tech-takeover; however, the TPACK model addressed this by maintaining the importance of content and learning outcomes. Bauer and Mito (2016) concurred, stating that the TPACK framework was a way to inform the National Core Arts Standards of creating, performing, connecting, and responding to music (NAfME, 2014). As researchers continue to develop the TPACK framework to adapt to emerging educational technologies, recent attention has turned toward the integration of GenAI, highlighting new possibilities and challenges for music educators.

Generative AI and TPACK

While an exhaustive overview of generative artificial intelligence (GenAI) usage with regard to the TPACK framework is outside the scope of this research, it is important to recognize GenAI as a growing technological tool and contextualize the benefits and

concerns related to its utilization in educational environments. GenAI technologies are increasingly used within the field of music education to offer real-time feedback, adaptable practice environments, and support for composition (Yu et al., 2023). The usage of these tools helps educators to create new opportunities for personalized, student-centered learning (Wang, 2025). At the same time, GenAI use prompts ethical concerns regarding creativity, assessment, and the evolving role of educators (Väkevä, 2025).

Due to the recent emergence of GenAI tools, there are limited research studies that examine the impact on teachers and students. Most publications to date approach AI from a philosophical standpoint, highlighting the opportunities and challenges that this technology presents. The following studies, though outside the field of music education, deal specifically with the TPACK framework and highlight a growing interest in how GenAI technologies might best be approached in educational contexts.

GenAI is reshaping education through personalized learning, real-time data analysis, and automation of teaching tasks (Oved & Alt, 2025). In their study, Oved and Alt explored the TPACK profiles of (N = 514) Israeli teachers using a self-rated TPACK scale consisting of 37 items measured on a six-point Likert-type scale (one = strongly disagree to six = strongly agree) to determine the effects on teachers' intentions and behaviors toward educational AI tools. The intention to use AI tools was assessed using the same six-point Likert-type scale, while actual usage of Educational AI Tools (EAITs) was measured on a five-point Likert-type scale (one = never to five = always). The researchers found a significant positive correlation between the core TPACK rating and teachers' intentions to use educational AI tools. Interestingly, Oved and Alt found that

the technological pedagogical knowledge domain was the strongest predictor of education AI tool usage. Oved and Alt asserted that teachers' perceptions, experiences, and skills are central to AI integration.

Contrastingly, in a study of teachers ($N = 200$) from diverse educational contexts in Indonesia, Ismaniati et al. (2025) found that there was no direct link between TPACK and the intention to adopt AI. Using a survey instrument with constructs measured on a 5-point Likert-type scale, the researchers sought to analyze the relationships among variables and specifically test the mediating effect of self-efficacy on the relationship between TPACK and AI adoption intention. Their findings revealed that several factors, including self-efficacy, institutional support, support systems, and peer collaboration, mediated the relationship between TPACK and the intention to integrate AI in teaching practice.

The AI-TPACK framework helps to evaluate teacher readiness for AI integration across the technological, pedagogical, and content knowledge domains (Runge et al., 2025; Xu et al., 2025). Runge et al. (2025) studied pre-service teachers ($N = 142$) from various German universities using a survey tool measuring participation in AI-related courses, perceived AI-related usefulness, and self-reported AI-TPACK scales to determine their behavioral intention to use AI in future teaching. The researchers found that pre-service teachers who took AI-related courses reported higher AI-TPACK and higher perceived usefulness, but found no link between course participation and perceived ease of use. Runge et al. also found that perceived usefulness significantly predicted behavioral intention to use AI. The researchers suggested teacher training

programs should integrate AI-focused courses that emphasize pedagogical intention and instructional improvement.

Similarly, Xu et al. (2025) explored the mediating role of AI attitudes and the effect on pre-service teachers' self-efficacy and overall AI-TPACK. The researchers administered a survey with three scales measuring AI-TPACK, teacher self-efficacy, and AI attitudes to participants (N = 520) from eight different universities across China. Consistent with Oved and Alt (2025), Xu et al. found that low AI-TPK predicted difficulties in integrating AI with pedagogy. The researchers found that this was due to limited practical training in AI. Xu et al. stated that the AI-TPACK framework was a reliable and valid tool for assessing pre-service teachers' readiness to integrate AI in teaching and recommended the use of the framework in teacher education programs for designing workshops and training sessions.

Pre-service teachers largely support AI use, but often lack balanced TPACK development to fully implement in teaching practice (Bautista et al., 2025; Karataş & Aksu Ataç, 2025). Bautista et al. (2025) studied pre-service teachers (N = 429) from one university in the Philippines. The researchers used a face-to-face survey to determine the readiness of the pre-service teachers to integrate AI-based tools in their future teaching. Bautista et al. found that pre-service teachers demonstrated readiness to integrate AI tools supported by their technological knowledge, technological pedagogical knowledge, technological content knowledge, and overall TPACK. The researchers concluded by stating that integration of AI tools requires a balanced development of the TPACK domains as well as development of ethical competency. Karataş and Aksu Ataç (2025)

similarly studied pre-service English language teachers (N = 304) to examine skill levels in both TPACK and AI-TPACK. Through survey results the researchers determined that the participants had lower proficiencies in TPACK, technological knowledge, and AI ethical knowledge. Karataş and Aksu Ataç concluded that the pre-service teachers possessed strong foundational technological skill; however, full pedagogical integration remained a challenge. They suggested ethics in AI education was an underdeveloped area requiring curricular attention.

Hava and Babayiğit (2025) found similar results amongst in-service teachers. Hava and Babayiğit administered a correlational survey to public school teachers in provinces of Turkey (N = 401) using AI-TPACK and digital proficiency scales. The AI-TPACK scale consisted of 27 items measured using a seven-point Likert scale that was divided into five subscales measuring each AI-TPACK domain. The digital proficiency measurement again employed a seven-point Likert scale to measure four domains including technological background, comfort with multitasking, reliance on graphics for communication, and thriving on instant gratification and rewards. The researchers found that teachers demonstrated lower AI-TPACK competencies, lacked skills to effectively integrate AI tools in teaching practice, and that teachers mostly learned AI tools informally which led to misconceptions about the tools.

Several factors contribute to pre-service and in-service teacher motivation for integrating AI tools. Self-efficacy significantly influences AI tool adoption, with higher TPACK scores supporting stronger self-efficacy (Ismaniati et al., 2025; Xu et al., 2025). Xu et al. also found that positive attitudes towards AI moderately mediated the

relationship between self-efficacy and TPACK. The anticipated benefits, perceived ease of use, and AI literacy all influence teachers' intentions to adopt AI in teaching practice.

Ethical considerations in educational AI use have been a leading topic of concern within the research (Celik, 2023; Karataş & Aksu Ataç, 2025; Lan et al., 2025) Celik (2023) expanded the TPACK framework to include ethical considerations. The researcher utilized a survey (Intelligent-TPACK) to measure teachers' (N = 428) knowledge and skills for integrating AI in K–12 educational contexts. Celik found that ethical knowledge supported all key components of TPACK and concluded that teachers who grasp ethical issues surrounding AI gain stronger integration capabilities.

Using the Intelligent-TPACK scale developed by Celik (2023), Lan et al. (2025) extended the TPACK framework by introducing technological ethical assessment knowledge (GenAI-TEAK). The researchers studied university teachers (N = 265) from several provinces of China. Lan et al. found that acceptance of GenAI does not guarantee effective usage in teaching practice and that teachers lacking strong technological knowledge struggled to fully benefit from GenAI tools. Lan et al. suggested professional development should focus on building all domains of TPACK, ethical skills, and an emphasis on the teacher's role as an ethical assessor and user of GenAI tools.

Assessing GenAI as a means of professional development, Lakhe et al. (2025) used a narrative inquiry approach with English language educators (N = 4) from different institutions in Nepal. Through in-depth interviews, Lakhe et al. found that participants highlighted the ability for GenAI to enhance pedagogical innovation by designing interactive activities and personalized learning experiences. The participants in the study

shared that GenAI had supported continuous professional development by helping to refine teaching strategies. However, the researchers shared that the participants warned against an over-dependence on AI, which may hinder critical thinking, creativity, and teacher-student rapport. Lakhe et al. suggested TPACK was a useful framework to harmonize GenAI integration while maintaining human-centric education. They recommended AI literacy programs, ethical training on data privacy and algorithmic transparency, peer-learning networks, and curricular redesign to harden the adaptive capabilities of GenAI in education.

The studies reviewed had several implications for pre-service training needs and in-service professional development. Teachers in Xu et al. (2025) struggled most with AI-TPK, indicating a gap in training on integrating AI into pedagogy. Both Hava and Babayiğit (2025) and Ismaniati et al. (2025) found that institutional support is key to effective integration suggesting that teachers require time, funding, infrastructure, and expert guidance to succeed with AI integration. Researchers have suggested particular focus on developing TPK, AI-TPK, and GenAI-TEAK within professional development and pre-service training (Lan et al., 2025; Oved & Alt, 2025). Others have called for embedded ethical training and critical evaluation of AI tools in preparation programs (Celik, 2023; Lakhe et al., 2025). Several researchers have also suggested the importance of practical AI tool application (Runge et al., 2025), peer-learning and mentorship (Karataş & Aksu Ataç, 2025), and experiential learning (Ismaniati et al., 2025) in developing both TPACK and ethical competencies for AI tool adoption in teaching practice.

Roles of Technology in 21st Century Music Education

An understanding of some of the roles technology plays in engaging students and the importance of selecting the most applicable tools is essential to a comprehensive music education. In this section an examination of recent trends in technology integration and in-service teacher perspectives on technology usage in music classrooms outlines the challenges and opportunities present in music technology professional development.

The use of technology in music education is well established. As more districts adopt one-to-one initiatives and as technology usage continues to be an integral part of teacher evaluations, music teachers are continuing to adapt and find creative uses for technology in the rehearsal space. For instance, Powell (2019) examined the usage of music technology in K–12 popular music ensembles in an attempt to understand teacher perceptions and benefits of technology integration. Powell collected survey data from participants in a modern music workshop (N = 168). The participants in Powell's study stated that despite difficulties with access to or damaged technology, the successes with increased student engagement and agency outweighed the struggles. Criswell (2017) discussed the ease in using technology in performance assessment and the affordance of student self-critique and progress monitoring facilitated through technology. Nielsen (2013) surveyed and interviewed two music technology educators and students (n = 10) enrolled in their courses. By identifying how the use of composition through technology resources could bring about the students' personal preferences while also building confidence in their original thoughts and ideas, Nielsen (2013) discussed the idea of meeting 21st century skill standards and teaching creativity through music technology.

However, Nielsen noted several implications including teacher training in music technology lesson design, teaching methodologies, and assessment practices. Music technology has provided students with many opportunities for student-centered learning approaches and student agency.

In terms of technologically mediated music composition, Musgrove (2019) asserted that technology allowed students to use sounds not usually possible in traditional performance ensembles. Musgrove went on to state that barriers to technology-mediated composition existed in the form of pedagogical constraints, as traditional ensembles focused heavily on performance standards. The author suggested:

In a traditional ensemble context, progress is often displayed through performing standard repertoire; rethinking the format and purpose of concerts may aid in restructuring classrooms to incorporate popular musics (p. 494).

Brudvik and Hebert (2020) studied music teacher perceptions ($N = 4$) of four popular music technology products; Rocksmith 2014, Soundation, GarageBand, and Skoog. Brudvik and Hebert noted four main barriers to the inclusion of music technology in popular music education. These were expense, accessibility, teacher attitude, and usability. In terms of computer-mediated composition, Devaney (2019) found additional constraints in the form of prioritizing time and stated that ensemble directors in the study felt pressure to use technology only for the sake of completing the task faster. Devaney utilized a mixed-methods approach using data from five case studies and survey responses ($N = 112$) from music teachers in upper secondary schools in England to explore how and why music technology was being used for composition. Much like Musgrove suggested, Devaney noted participants felt undue constraints from

preconceived notions of expected performances. Devaney's findings, based on research conducted in England, align with Benedict and O'Leary (2019), whose study in the United States similarly warned that music educators need to reconceptualize instruction through modification of existing and new technologies. Benedict and O'Leary asserted that the current population of students are engrossed in constant engagement with technology and therefore, educators need to adapt curricula to support this new learning style.

When used effectively, technology-mediated music composition can increase student motivation (Chen, 2020), student voice in learning objectives and outcomes (Chen & O'Neill, 2020), and addresses the inclusion of student-possessed cultural capital (Albert, 2015). Clauhs et al. (2019) discussed the many affordances of technology-mediated music composition including leveraging student interests, relevance to outside music experiences, greater reach to non-traditional music students, and little to no prerequisite knowledge needed to participate and create. Albert (2015) discussed the idea of extending learning to where students live in his assertion that social media could be a viable option in facilitating learning through constructivist principles. This addition allows school music to reflect students' current cultural practices, furthering relevance to their lives (Albert, 2015). The idea of deterritorialized space was discussed in Cremata and Powell (2017) in their research of an online music collaborative project stating that students could access the online collaborative space outside the walls of the classroom, much the same way they interact with music outside of school.

A recurring theme in the existing research on technology-mediated composition is the teacher's new role as a facilitator, guiding and supporting students through both the creative and technical aspects of the composition process. Cremata (2017) explained:

The facilitator helps a group improve the way it identifies and solves problems and makes decisions. Facilitators are cognizant about the use of their power, authority, or control and place limitations on its uses. They help individuals and/or groups lead themselves, incorporating notions of diversity and democracy (p. 64).

The role of facilitator requires a different positionality than that to which many educators are accustomed. As Gilbert (2016) asserted, teacher-centered models are perpetuated at the collegiate level in the United States. Because music educators may not have been exposed to teachers-as-facilitators in their undergraduate careers, they may struggle with stepping into the role of facilitator in their teaching contexts (Cremata, 2017). However, the role of facilitator allows for student voice and choice within music classrooms (Clauhs & Cremata, 2020).

Despite these opportunities, several difficulties have also been identified in terms of teacher preparation and skills for teaching with music technology. Dorfman (2016b) found that music teachers in settings with district-issued student laptops struggled to find authentic and advantageous ways to use the devices within performing contexts. Instead, the participants only dedicated a portion of their classes to technology-focused activities, mostly dealing with composition and listening. Likewise, Njiku et al. (2019) asserted the use of technology in education currently has not been able to transform educational practices, which may be due to lacking content of professional development and teacher attitudes toward usage. As music educators continue to navigate these evolving

opportunities and challenges, the emergence of generative AI presents new possibilities and questions regarding technology integration in music education.

Roles of Generative AI in Music Education

Integration of artificial intelligence (AI) into music education poses a pedagogical shift by reconceptualizing the roles educators and students play within music classrooms. As AI tools become increasingly prevalent in educational contexts, researchers have begun to explore their implications across theoretical, practical, and ethical dimensions. In the following section, I review current contributions to the field and examine the ways in which AI is being used, critiqued, and reimaged within music education. Central to the discussion are questions about how AI reshapes notions of creativity, student engagement, and access to music creation without prerequisite theoretical knowledge.

Holster (2024) discussed the potentials of practical AI usage in music education. The author suggested ChatGPT use for lesson planning, rubric creation, crafting communication, curating composition exercises, generating feedback, and customizing lesson content based on student interests. Holster suggested that prompt engineering was key to effective AI use. Prompt engineering is the practice of designing and refining input prompts to effectively guide AI models' responses toward desired outcomes. However, Holster warned that GenAI technologies lack human traits like empathy and intuition, claiming that AI use must complement and not replace educators. Holster also cautioned about critical ethics literacy and concerns about protecting student data, recognizing bias, and ensuring inclusivity. The author concluded that with thoughtful application, AI can reduce educator workload and enrich pedagogy.

One of the main concerns surrounding AI integration is the concept of ownership over the creative process. Väkevä and Partti (2025) used action-network theory as a framework to explore AI as a co-creative agent in music making and learning. This approach helped the researchers imagine the creative process distributed across human and non-human actors. The authors stated, “this reconceptualization also allows us to explore new models of educational practice that integrate GenAI and other technologies as active participants entangled in the pedagogical process” (p. 22). Väkevä and Partti addressed fears of the potential for AI to displace human creativity by emphasizing that AI lacks the ability for moral reasoning and thus, necessitates human intervention to be educative. The researchers highlighted the need for continuous critical and ethical reflection on the educator’s part to evaluate AI outputs and its uses in music education.

Cheng (2025) discussed the opportunities and risks associated with AI adoption using a conceptual and policy-focused review. Cheng identified personalized learning, enhanced accessibility and creativity, increased student engagement, and pedagogical support as the benefits to AI integration. The author suggested that GenAI use democratized creativity, allowing student to generate music via text prompts, which opened avenues and lowered barriers to musical creation. However, Cheng also noted that several risks existed in the form of cultural bias of AI toward Western music traditions, creativity erosion through over-reliance, equity gaps due to cost and digital access, and lacking teacher training and preparedness to utilize this new tool in their teaching contexts. The author also strongly cautioned about ethical issues including copyright, misuse, and academic integrity, as well as the difficulties in evaluating and

interpreting AI models and their outputs. Much like Väkevä and Partti (2025), Cheng recommended policies that address AI critical literacy and investment in teacher training.

Although fears of over-reliance and creativity erosion have been expressed, Wang (2025) found that the use of ChatGPT among Chinese piano education enhanced creativity among participants. Wang identified a research gap with limited research on AI's direct role in developing creativity. Wang studied piano students (N = 566) at a conservatory in Shanghai to determine if pre-test and post-test scores would vary among students in the control group versus the experimental group. The experimental group used ChatGPT with guided, theory-informed prompts during half of their lecture period, while the control group did not use AI at all. The researcher found that although there was no significant difference in groups based on the pre-test, the experimental group showed significantly higher creativity scores after the post-test. Wang found a strong positive correlation between ChatGPT usage frequency and creativity gains. Like Väkevä and Partti's (2025) and Cheng's (2025) claims, Wang's findings demonstrated a scalable model for human-AI collaboration in creative learning environments.

Exploring the democratization of music creation, Jiang (2025) reported on the case of Participant Q, a friend with an IT background, but limited formal music training. Participant Q designed an AI model for inclusive, notation-free music creation using Mubert AI to access a vast music library. The researcher noted that AI helped to bridge the gap between Participant Q's aspirations and theoretical capabilities; however, the findings raised questions surrounding authenticity and bias within the AI model. Jiang asserted, "to comprehensively build a music AI model for inclusive music representation,

not only is music knowledge needed from the developers' end, but also musicians' voices in guiding the model training from aesthetic perspectives" (p. 67).

Speaking to the concerns about authorship and voice in AI usage, Dong and Younker (2025) used the I-Thou framework applied to the co-author dynamic between human and AI. The researchers explored the changing roles of supervisor and supervisee during Dong's doctoral work using ChatGPT for grammar assistance. As English is the researcher's second language, Dong utilized ChatGPT to curate varied vocabulary and clarity in the academic writing. Dong would then have Younker, the supervisor, review the writing to assess the output and help to maintain the author's authentic voice. The researchers observed that ChatGPT would reorder statements and needed restructured, specific prompting to maintain authorial voice. While Dong and Younker believed ChatGPT performed productively, they noted the importance of preserving voice, integrity, and authenticity through consistent dialog with each other. The researchers highlighted the dialogic potential of AI usage, but affirmed the importance of the role of human mentorship in maintaining and preserving authorship.

Critical AI literacy and bias awareness have been expressed as concerns for AI usage in music education (Cheng, 2025; Väkevä and Partti, 2025). Treß (2025) explored the outputs of three AI platforms, ChatGPT for lesson planning, Midjourney for generative visuals, and Suno.ai for music creation to determine if the platforms contained biases. Treß found that the AI platforms reinforced cultural norms toward the Western music traditions. ChatGPT output were teacher-centered and theory-heavy, requiring students to possess quite a bit of prerequisite theoretical knowledge in the lessons it

crafted. The images created through Midjourney again favored the Western music tradition by using visuals with Western musical instruments. Suno.ai consisted of a strong orientation toward Western contemporary popular music in music produced and the website design which mimicked sharing platforms like Apple Music and Spotify. Treß asserted that in order for AI to be beneficial in music education one should take a critical stance against AI superiority over human judgment and maintain ethical engagement of preserve human artistic expression.

O’Leary (2025) asserted that technology integration requires a behavior change on the part of the educator. The author suggested that teachers may adopt AI for productivity, but risk disengagement from pedagogy. O’Leary also critiqued the existing frameworks of TPACK and SAMR as inadequate for ethical AI integration. O’Leary advocated for a critical curriculum in teacher training that addresses AI source biases and ethical considerations. Likewise, bell (2025) critiqued the corporate influence and company curriculum of the many products available for music education and inherent ethical issues. bell examined three AI applications, MusicFX DJ, Music AI Sandbox, and Udio and identified preexisting and emergent bias in the algorithmic outputs for each. bell stated:

Although generative AI models built into music applications do not operate in the same way as a search engine, algorithmic biases are still a part of their design. Whatever sound is produced from a prompt is the result of several human- and machine-made decisions (p. 220).

The author claimed that as a profession, music educators need to continually examine AI outputs critically.

The integration of AI into music education represents a pedagogical shift, prompting scholars to explore its theoretical, practical, and ethical implications (Cheng, 2025; Holster, 2024; Väkevä and Partti, 2025). As a relatively new phenomenon in the field, the adoption of AI in music education is still emerging and the literature remains developing, but limited. In the existing studies, AI has been positioned as both a supportive tool and a co-creative agent, with the potential to enhance creativity (Wang, 2025), personalize learning (Cheng, 2025), and democratize access to music making (Cheng, 2025; Jiang, 2025). Researchers have highlighted applications of AI ranging from lesson planning, feedback generation, and inclusive, notation-free composition (Holster, 2024; Jiang, 2025). However, concerns persist regarding authorship (Dong & Younker, 2025), algorithmic bias (bell, 2025), data privacy (Holster, 2024), and the erosion of human creativity (Cheng, 2025). Researchers have emphasized the importance of prompt engineering, critical AI literacy, and sustained human oversight to ensure ethical and effective use (O’Leary, 2025; Väkevä and Partti, 2025). Collectively, the researchers called for a reflective, equity-minded approach to AI adoption that centers pedagogical intent and artistic authenticity in music education (bell, 2025; Treß, 2025).

Teacher Perceptions of Technology Integration

Teacher perspectives and perceptions play a large role in the success of technology integration in music classrooms. Mertala (2019) used a meta-ethnographical approach to synthesize 35 studies focused on teacher beliefs about technology in early childhood education. Mertala identified teacher beliefs about technology to be shaped by the broader cultural sphere in terms of global views regarding technology and educational

policies and standards. The researcher found both digital natives and seasoned teachers had similar hopes and anxieties relating to technology usage and suggested that teacher beliefs be considered when designing training. In an attempt to understand how the school environment affected teacher beliefs about technology integration, Perrotta (2013) found that teacher respondents (N = 683) were more apt to believe in the benefits to usage if administration was also supportive of these initiatives. Likewise, Konstantinou (2016) asserted that music teachers' perceptions (N = 10) of utilizing technology grew in a positive nature after having more experience with said technologies. Similarly, Sawyer (2017) found that as teacher perceptions (N = 51) of technology increased, so did the level of technology integration in their teaching practices.

Several researchers have attempted to measure the self-efficacy and attitude of educators toward digital technology to ascertain if this plays a larger role in usage in teaching practice. Njiku et al. (2019) explained that confidence, anxiety, belief of benefits, professional development, and productivity were all aspects weighed by teachers in determining if technology was worth using in teaching situations. Gudek (2019) studied music teacher candidates (N = 102) and their computer self-efficacy perceptions and attitudes toward teaching with technology. Gudek found four main factors had positively contributed to teacher perceptions of computer self-efficacy: a) resources available, b) institutional and administrative support, c) education and experiences, and d) attitudes and personal computer skills. Liu et al. (2017) utilized a multilevel path analysis to collect data from K-12 teachers (N = 1,235) in 41 districts throughout the state of Florida to design and test a model of classroom technology

integration. Liu et al. asserted that classroom technology integration relies on factors such as teacher confidence and comfort, as well as access. A common thread in the aforementioned studies is teacher experience with technology. This warrants a closer look at how educators utilize self-directed learning and professional development opportunities to enhance their pedagogical practice and integrate technology within their teaching contexts.

Self-Directed Learning

Self-directed learning has been recognized as an effective professional practice to develop technological knowledge and adaptability among educators (Diel, 2021; Ezell, 2017; House, 2025). Across contexts ranging from K–12 to higher education settings, researchers have reported that educators and students who exhibit self-directed learning readiness are more capable of integrating technology, engaging in lifelong learning, and adapting to evolving pedagogical demands (Pan, 2020; Sumner, 2018; Tzeng et al., 2022). The following sections address self-directed learning in relation to professional autonomy, technology knowledge, pedagogical growth, motivation, and lifelong learning. This section concludes with ties from self-directed learning to music technology education.

Self-directed learning is deeply connected to educators' adaptability to act autonomously and construct their own professional growth pathways. House (2025) explored the perceptions of 17 higher education adjunct faculty at a public online university in the southwestern United States to gauge levels of technology integration through the TPACK+XK framework. This framework is an extension of TPACK to

include and understanding of teaching context as another important knowledgebase needed to further develop teacher TPACK and make informed decisions about technology integration. House found that self-directed learning was a core practice of adjunct faculty participants, many of whom lacked formal pedagogical training. The participants also relied heavily on experiential learning and many identified themselves as lifelong learners. Participants independently explored new technologies, participated in webinars, and engaged with online professional communities. House also found that limited institutional training led the adjuncts to develop peer-driven and independent learning strategies. House asserted that self-directed learning was essential to the professional growth and technological knowledge essential to the adjuncts' teaching responsibilities.

A similar sentiment emerged from Ezell's (2017) mixed-methods study of K–12 educators (N = 375) in Georgia. Ezell examined the relationship between self-directed learning, technology and professional development (PD). Teachers in the study, who engaged in self-directed, technology-enhanced PD, including podcasts, social media, and online learning communities, reported higher engagement and effectiveness compared to those in traditional PD workshops. Ezell reported that those participants who voluntarily directed their learning were more likely to apply new strategies in the classroom. Likewise, Bauer (2010) described Web 2.0 technologies (e.g., blogs, wikis, and podcasts) as tools enabling educators to construct personal learning networks. Bauer described these personal learning networks as self-created systems of people and tools supporting ongoing, individualized professional learning. These digital professional learning

networks transformed professional development into a participatory, social, and self-directed process, which allowed the music educators in the study to pursue continuous growth outside of institutional boundaries.

Research also connects self-directed learning with technological growth and pedagogical innovation among educators. Diel's (2021) interpretive study of three music educators extended self-directed learning theory into music technology contexts, framing learning as a learner-centered, autonomous process. The participants viewed self-direction as a process involving goal setting, resource identification, and outcome evaluation, supported by metacognitive reflection. Diel found that motivation, metacognitive awareness, and reflective self-assessment were central to sustaining self-directed engagement among participants. Notably, the music educators in Diel's study claimed that flexible, technology-enhanced environments allowed the teachers to exercise autonomy over pacing, sequencing, and resource selection. This led to increased intrinsic motivation and academic resilience. However, Diel cautioned that some educators may require scaffolding to develop self-regulatory and reflective competencies, an important consideration for music technology educators transitioning from formal PD to self-guided inquiry.

Bauer's (2013) study on the acquisition of music TPACK, further supports Diel's findings. Among music teachers, formal undergraduate coursework contributed minimally to TPACK development. Instead, Bauer found that most participants built technological expertise through self-motivated, experiential learning, such as attending workshops, exploring tools independently, and reflecting on classroom applications.

Similarly, Doherty (2021) observed that music teachers often learn technology independently, outside of school hours, indicating that self-directed professional learning, rather than structured PD, drives technological growth.

The psychological dimensions underpinning self-directed learning including motivation, grit, and self-efficacy, also feature prominently in recent research. Lan (2022) reviewed literature which emphasized that teachers' motivation and grit sustain long-term self-directed professional development. Motivated teachers displayed greater autonomy and goal-orientation, while grit fostered persistence in the absence of administrative oversight. These psychological traits align with findings from Pan (2020) and Tzeng et al. (2022), both of whom demonstrated that self-efficacy, motivation, and technological acceptance significantly predict learners' self-directed behaviors.

Pan's (2020) quantitative study of Chinese undergraduates (N = 322) in a technology-enhanced English course found that technology acceptance and self-efficacy positively influenced attitudes toward technology-based self-directed learning. Motivation acted as a mediator, linking positive perceptions of technology to stronger engagement in self-directed learning. The theory of planned behavior (Ajzen, 1991) posits that an individual's behavior is driven by their intention to act, which is shaped by attitude toward the behavior, perceived social expectation, and perceived control over the behavior. Tzeng et al. (2022), using survey data collected from South Korean undergraduates (N = 281), applied the theory of planned behavior and found that students who exhibited stronger self-directed learning traits, such as self-management and self-control, demonstrated higher critical thinking and problem-solving abilities. Tzeng et al.

found that critical thinking served as a bridge between self-directed learning and problem-solving, suggesting that reflective and analytical self-regulation is key to effective self-directed learning in digital contexts.

Among adult learners, self-directed learning supports lifelong learning and professional advancement (Abou Said & Abdallah, 2024; Curran et al., 2019). Abou Said and Abdallah (2024) surveyed university educators in Kuwait (N = 117) to examine the mediating role of self-directed learning between lifelong learning and professional growth. The researchers found that self-directed learning partially mediated this relationship, meaning educators with strong motives, conditions, and attitudes toward learning demonstrated greater professional development. Similarly, Curran et al. (2019) interviewed adult learners (N = 55) from four professional groups. These groups included physicians, nurses, pharmacists, and social workers. The researchers identified digital and mobile technologies as critical enablers of self-directed learning in continuing professional education. These technologies enhanced access, personalization, and flexibility. However, the researchers also emphasized the need for supportive organizational policies to sustain self-directed learning practices in the digital age.

In higher education and online learning contexts, researchers such as Sumuer (2018), Lai et al. (2023), and Simanjuntak et al. (2025) have explored self-directed learning readiness and its relationship to technology use and lifelong learning. Sumuer (2018) surveyed education students in Turkey (N = 153) and found that self-directed learning readiness and the use of Web 2.0 tools were significant predictors of self-directed learning with technology. The use of digital tools also mediated the influence of

computer and online communication self-efficacy on self-directed learning. The researcher emphasized the need for scaffolded instruction to strengthen both technical and self-regulatory capacities. Lai et al. (2023) surveyed undergraduates in mainland China (N = 348) to explore how individual interests and self-regulation might interact and relate to self-directed learning. The researchers found that individual interest and self-regulation distinctively influenced self-directed learning activities beyond the classroom. Students' engagement with instructional, informational, and social technology-based activities was shaped by personal interest, suggesting the motivational diversity must be considered in promoting self-directed learning. Similarly, Simanjuntak et al. (2025) found that among Indonesian university students (N = 365), self-directed learning readiness strongly predicted lifelong learning orientation and academic success. The researchers reinforced the role of autonomous reflection, goal setting, and self-monitoring in fostering enduring learning habits.

The presentation of previous studies illustrated that self-directed learning thrives in flexible, technology-rich environments that value autonomy, reflection, and ongoing growth. The findings in Diel (2021), Bauer (2013), and Doherty (2021) closely mirror the reality that music teachers integrate technology primarily through self-directed exploration rather than formal PD. The music educators in these studies relied on self-initiated inquiry, experimentation, and professional networking to sustain their self-directed learning efforts. Similar to the findings from Ezell (2017) and House (2025), the researchers suggest that professional autonomy and peer-driven learning communities are key mechanisms for sustained professional learning. Overall, the findings presented by

the researchers of the aforementioned studies underscore that the cultivation of self-directed learning habits supports adaptability, reflection, and innovation within music technology education in an ever-evolving digital teaching landscape.

TPACK-Based Professional Development

The TPACK framework has served as a guiding model for structuring technology integration in teacher professional development, underscoring the importance of aligning technological tools with both pedagogy and content. In response to the need for educators to continue to develop their pedagogical practices in integrating technology into their classrooms, several researchers have attempted to apply the TPACK framework to teacher professional development. Researchers have suggested that the best TPACK professional development designs incorporate content-specific support in small groups (Wallace, 2018), teacher voice and choice (McCusker, 2017), customization (Nazari et al., 2019), active and inquiry-based learning (Hofer et al., 2016), and student-centered pedagogical anchoring (Koh, 2019). These design features are situated within the integrated nature of TPACK, where knowledge domains are not isolated, but interconnected. However, Wallace's (2018) study of higher education faculty found that small group TPACK professional development was rarely offered, and large-scale workshops were often too broad in scope to be beneficial for participants.

Researchers have reported the benefits of TPACK-based professional development in the form of self-agency and pedagogical change. In studying K–12 educators' perceptions of TPACK-based professional development, Baran et al. (2016) and McCusker (2017) discovered that participants in their respective studies planned to

take what they had learned and encourage technology integration in their own schools by leading seminars. Hofer et al. (2016) reported on multiple iterations of technology-enhanced instruction professional development using participant survey and final assessment data. Interestingly, Hofer et al. (2016) discovered that 91 percent of participants in their TPACK-based professional development programs stated that the course would influence their teaching practices. Latham (2020) and Nazari et al. (2018) found parallel results regarding the benefits of differentiated professional development based on career stage. Nazari et al. (2018) stated that novice teachers in their study (N = 156) had high technological knowledge, but needed growth in the content knowledge and pedagogical knowledge domains. Contrastingly, the veteran teachers in their study (N = 270) had high content and pedagogical knowledge, but needed growth in the technological knowledge domain. These findings suggest that teachers may enter into professional development settings with uneven strengths across the domains of TPACK.

Odajima (2019) found that TPACK-based professional development afforded high school teacher participants (N = 9) the chance to think about how to use technology to move toward learner-centered activities. Although the benefits of TPACK-based professional development have been well documented in other fields of education, a lack of TPACK-based professional development studies exist specific to music education. This gap in the literature reveals an urgent need to apply the TPACK framework to music-specific contexts, where unique pedagogical and content considerations require targeted supports.

Music Technology Professional Development

Most educators, regardless of subject matter, are generally required by their state to fulfill a specified number of professional development hours each school year. Many school administrations also expect a specified amount of professional development hours, which are frequently a requirement of yearly evaluations; however, scant offerings in specialized music technology professional development have often sent teachers to outside professional organizations for workshops and conferences. Many music educators have been left to fend for themselves and often seek out their own professional development through self-learning (Bauer, 2013) and online communities of practice (Bernard et al., 2018).

Researchers have attempted to decipher the impacts of music technology professional development on teaching practice (Bauer et al., 2003; Bond, 2015). For instance, Bauer et al. (2003) studied the effects of a week-long music technology professional development and found that while teachers gained comfort and knowledge with the technology covered, gains were gradual. The researchers reported that despite comfort, classroom usage was still scarce and teachers used the technology more for clerical tasks than with students. These findings suggest that possessing technological knowledge alone does not ensure pedagogical transformation. However, both Bond (2015) and Merrick and Joseph (2022) found that professional development interventions that focused on students use, rather than teacher presentation models, increased the level of technology integration in teaching practice.

Other researchers have focused their attention on technology deficits in pre-

service programs and the implications for needed technology training as in-service teachers. Leong (2016) discussed the lacking technology instruction in pre-service education for generation Y (born between 1981 and 1994). Leong asserted that the acceleration of technology has made teacher preparation curricula obsolete and discussed the need for these educators to now seek out professional development to stay ahead of the issue. Holliman (2021) reported complementary findings to Leong's assertions. The researcher surveyed K–12 public school music educators (N = 480) from four southeastern states in the U.S. to determine the state of technology integration in music classrooms. Holliman found that 60 percent of respondents reported little to no formal professional development in music technology. Likewise, only 20 percent of respondents had completed coursework specific to music technology. Hewitt (2018) conducted a case study of one music teacher's process to enact change within her classroom and found that ownership in professional development added to a sense of strengthening existing capital. Hewitt found that meaningful change was self-initiated by the educator and that continuous, rather than isolated professional development, aided the educator in curricular and pedagogical change. Even so, Hewitt suggested that available music teacher training continues to perpetuate Western classical habitus.

Applying Bourdieu's (1977) sociological framework, particularly his interrelated concepts of habitus, capital, and field, offers a lens through which to expound upon how music educators perceive and engage with technology in their teaching practice. Habitus, described as the deeply engrained dispositions shaped by one's upbringing and socialization, influences both teachers' and students' orientations toward music. Wright

(2008) found that students in Welsh schools frequently disengaged with school music because it failed to reflect their lived musical identities. The students (N = 30) viewed school music, which was centered in classical genres and formal instruction, as irrelevant compared to the popular music and informal practices they valued outside of school. Drawing on Bourdieu, Wright explained this disconnect as a mismatch between students' musical habitus and the symbolic capital promoted in formal music education. Similarly, Rimmer's (2012) study revealed that students from differing socioeconomic contexts developed contrasting musical dispositions. Studying youth (N = 36) in Northern England from a rural village, the inner-city, a suburb, and a declining industrial town, Rimmer found that youth from musically enriched homes exhibited broad musical tastes and confidence, while those from deprived areas often lacked early exposure and felt alienated by school music despite valuing music as a form of identity. Wright's (2008) and Rimmer's (2012) findings demonstrate how musical habitus, formed through early socialization, shaped both perception and participation in music education.

Teachers' own habitus also plays a role in their pedagogical decision-making. Söderman et al. (2016) emphasized that educators bring cultured dispositions into the classroom, which influenced their valuation of different genres and tools. Teachers trained in classical traditions may view digital tools and popular music as pedagogically inferior, whereas others with more diverse musical socializations may see technology as integral to their teaching (Söderman et al., 2016). This was echoed by Zavitz et al. (2024), who found that in-service teachers (N = 5) enrolled in a popular music education course often reoriented their habitus to embrace more student-centered, create, and

technology-enhanced pedagogies, particularly when these approaches validated their students' musical identities. Such shifts illustrate how reflective teacher education can challenge ingrained dispositions and reveal new pedagogical possibilities (Zavitz et al., 2024).

The role of capital, including cultural, social, and technological capital, is equally important in explaining educators' differing capacities to adopt technology. Capital can be described as resources, both tangible and intangible, that individuals possess and use to gain advantage or recognition within a certain social context or field. Guided by Bourdieu's framework, Green and Jones (2025) surveyed postsecondary English language teachers (N = 139) in the United States using an adapted TPACK scale consisting of 36 Likert-type questions to ascertain whether TPACK was influenced by social structures. The researchers demonstrated that teachers with frequent technology use and longer teaching experience possessed higher levels of TPACK and suggested that personal and professional capital heavily shapes technological engagement. In music-specific contexts, Zavitz et al. (2024) found that access to music technology varied by the socioeconomic status of one's school. This influenced whether teachers could adopt technology-rich teaching practices. The researchers claimed that educators who had access to tools such as DAWs, MIDI controllers, and online platforms reported broader student engagement and more inclusive learning environments. Romele (2021) offered a conceptual map for understanding technological capital through three forms: embodied (technological skills and fluency), objectified (access to tools and software), and institutionalized (formal training and credentials). Romele asserted that these layers of

capital highlight how structural inequalities in resources and training constrain or enable teachers' abilities to integrate technology effectively.

The concept of field is a distinct, but interrelated concept that conceptualizes the dynamics between habitus and capital. Field can be defined as the structured social and institutional spaces where music education operates. Field in the case of the present study encompasses the music technology educators' school districts and the music technology programs they lead. Perkins (2016) claimed that conservatoire students' career paths and learning practices were shaped by their position in the hierarchical field of the conservatoire, illustrating how access to capital and opportunities depend on one's location within institutional structures. Likewise, Zavitz (2022) described a higher education music school (N = 1) as a contested field, where ideological division between musical disciplines and traditions hindered curricular innovation. In Zavitz's study, faculty and students alike reported hesitation with disrupting pedagogical norms, especially in private instruction settings that remained resistant to reform. What counts as legitimate teaching or learning can restrict integration of new approaches including technology. Wright (2012) reinforced this point using Bernstein's (2000) educational rights and argued that true inclusion in music education required not just access to content, but meaningful participation and empowerment. These principles often align with student-centered, technology-enhanced learning. However, traditional fields in music education often favor Eurocentric practices and performance-based models over culturally responsive practices (Hewitt, 2018; Zavitz et al., 2024).

These studies illustrate how Bourdieu's concepts explain both the variation in

teachers' technological engagement and the structural barriers they may face. Teachers' dispositions (*habitus*), access to resources and legitimacy (*capital*), and the institutional logics shaping music education (*field*) interact to either support or hinder TPACK development (Greene & Jones, 2025). The literature strongly suggests that when educators critically reflect on their own assumptions and receive training that expands their cultural and technological capital, they are more likely to adopt inclusive, innovative, and student-centered uses of technology (Hewitt, 2018; Zavitz et al., 2024).

Much of the research regarding technology professional development suggests the need for differentiated learning opportunities. Davis et al. (2009) suggested the need for differentiated professional development based on technological skill and comfortability, while others suggest the need for differentiation based on content area, teaching responsibilities, and career stage (Bauer, 2007; Koehler et al., 2013; Latham, 2020; Leong, 2016). It is important to allow educators the autonomy to choose their own professional development (Bowles, 2003; Leong, 2016; Minott, 2015); however, as stated previously, educators often must find and fund their own professional development opportunities. In addition to finding professional development, researchers have often found that music educators must fund their own professional development opportunities (Bauer et al., 2003; Leong, 2016; Minott, 2015). Bauer (2007) proposed that for professional development to be considered successful, it should positively impact both teaching practice and learning outcomes.

Another area of particular interest to researchers is collaborative professional development. Studying mid- and late-career music teachers, Conway (2008) found that

professional development needs for respondents (N = 19) changed throughout the course of their careers. Respondents also noted that informal interactions with other music teachers were the most beneficial form of professional development. Similarly, in looking at the collaborative nature of a specific technology professional development mandate in Virginia, Welch (2013) reported respondents (N = 14) favored peer learning, especially in the context of increased frequency of technology use in teaching practice. Stanley et al. (2014) concurred, asserting that collaborative professional development which honors teacher knowledge, constructivist approached, and includes long-term supported allow for continued growth and comfort within teaching practice. Furthering these findings, Latham (2020) discovered that educators preferred teacher-centered, content-specific, collaborative professional development which focused on fewer technology tools, applicability, practicality, differentiation, and modeling.

The collaborative nature of social media in the context of online professional communities of practice has proven to be a draw for many music educators seeking easily accessible professional development (Bernard et al., 2018; Berry, 2019; Macià and García, 2016). These online music communities such as YouTube (Cayari, 2015) and Facebook (Bernard et al., 2018; Pellegrino et al., 2014) serve a broad variety of people from myriad ages, career stages, knowledge levels, and teaching backgrounds. In a world where growing technology encompasses more and more of our lives, these platforms serve to connect professional development opportunities across boundaries and barriers possibly not afforded in one's own district. Bernard et al. (2018) sought to understand the reasons in which a music educator might seek out an online community of practice and

found that one of the major motivators was insufficient professional development not specifically geared toward music educators. Bernard et al. also found that many educators felt isolated, were singletons within their building and sought online communities not only for camaraderie, but to expand their knowledge of resources, planning, and best practices from others in the field. Berry (2019) studied adjunct and full-time faculty perceptions of professional development offerings for an online course in a university doctoral program. Comparable to Bernard et al., Berry (2019) noted that participants identified the online community of practice created through weekly faculty meetings as the most beneficial form of professional development. The researcher also found that faculty of all career stages identified advantages in the ability to trade resources directly related to practice. These online spaces function as environment for targeted professional development, allowing teachers to experiment, reflect, and apply pedagogical strategies in real time.

Another motivator for educators in seeking online communities of practice is the ability to participate however one sees fit (Bernard et al., 2018). Tseng and Kuo (2014) studied the self-reported knowledge-sharing behaviors from members of a large online professional community of practice for teachers located in Taiwan. They found that member' self-efficacy beliefs contributed to the likelihood of more participation and knowledge contribution within the community of practice. Due to the ability for members of online communities to connect with others anywhere in the world and the ease of usage, a large resource may be formed from which all members may benefit. Macià and García (2016) discussed online professional communities and the importance of

members' perceived benefits as necessary for continued participation, especially regarding the lack of time allotted by traditional professional development programs for reflection. According to Macià and García, the community of practice must be seen as a useful tool for continued participation and growth. These communities allow for continued professional development, easy accessibility, and an area for continual self-reflection on teaching practice.

Technology and Pre-Service Music Education

Researchers have explored the current curricula for pre-service music educators regarding preparation for teaching with technology. Blackwell (2018) used data from three consecutive administrations of the Strategic National Arts Alumni Project survey to explore K–12 music teacher perceptions of readiness and preparedness from their pre-service teacher education regarding teaching practice. Participants in the study (N= 976) identified technological skills to be imperative to teaching; however, about 50 percent of participants stated they felt their institution prepared them very little in building technology pedagogy. To gauge music education major's current program offerings in technology, Haning (2016) surveyed students (N = 46) from ten higher education institutions in Ohio and concluded that stand-alone technology courses were most prevalent with focus on notation and mixing software. Additionally, Webster and Williams (2018) found similar results in their research on music teacher educators' perceptions of key competencies essential for undergraduate students. The researchers gathered data over a six-year period from results of five separate studies encompassing questionnaire responses (N = 772). These key competencies included knowledge in

recording and mixing, notation, understanding of copyright, creation of CDs/DVDs or streams, editing, understanding of acoustics, presentation software, and set up and troubleshooting of equipment. Susko (2015) surveyed and interviewed deans, teacher educators, librarians, instructional technology staff, and department heads (N = 54) to determine that many of the institutions (N = 11) did not have a technology requirement in place for graduation. Gilbert (2016) insisted that undergraduate music education programs require more comprehensive course work with practical application in technology usage to better prepare pre-service educators. These studies suggest that while technology may be present in curricula, it is often disconnected from pedagogical and content contexts.

Prensky (2001) problematized technology-based generation labels such as digital native and digital immigrant. With Prensky's ideas in mind, Bannerman and O'Leary conducted an online survey of collegiate NAFME members to examine pre-service teachers' (N = 360) personal technology usage. The researchers found that despite pre-service teachers' personal usage of technology, this was not a predictive factor in the ability for these students to effectively utilize technology during instruction. Despite being members of the net generation, many pre-service students do not see the practical applications of personal technology usage in teaching contexts (Kontkanen et al., 2016). Looking into higher education faculty perspectives, Dorfman (2016a) discovered that respondents in his study were unaware of the technology standards teachers might encounter in K–12 education. He suggested several governing standards, such as the National Core Arts Standards (NAfME, 2014) and the National Education Technology

Standards (ISTE, 2017), be used as a guide for technology modeling in music teacher preparation programs. Understanding faculty perceptions of what technological knowledge pre-service teachers possess before entering teacher preparation highlights possible preconceived notions that may affect undergraduate curricula (Bannerman & O’Leary, 2020). These misconceptions could inhibit the design of TPACK-informed curricula that purposefully cultivate technology use for instructional purposes.

Pre-service practicum experience plays a large role in teacher preparation programs. This is often the last step before moving into in-service teaching; however, Abrahams (2009) suggested a disconnect between clinical experiences and methods courses. Examining technology integration, Gall (2013) studied factors that restrict pre-service teachers from effectively using technology during practicum experiences. Gall found several factors including mentor teacher beliefs about technology, accessibility, and the ability to troubleshoot technology issues affected pre-service teachers’ confidence levels in their own abilities to teach with technology. Studying trainee teachers in North Cyprus, Gorgoretti (2019) found similar results regarding accessibility being a restrictive factor. Gorgoretti found that trainee teachers stuck with technology that was taught within the pre-service curriculum, suggesting that future curricula should include more practical and broad aspects of technology usage. bell et al. (2019) found similar issues within the United States, discussing the rigidity of many conservatories in their approach to teaching traditional ensembles and how this model is, in turn, being perpetuated by new teachers. These external influences could disrupt TPACK development, as the absence of modeling technology integration in real-world contexts could undermine

future classroom implementation and confidence.

TPACK in Pre-Service Education

As previously outlined, TPACK is a framework for building confidence and knowledge to utilize technology to teach and engage students. The lack of TPACK-based modeling in pre-service music education programs has proven a significant obstacle to the integration of technology within teaching contexts. This, in part, could be due to the preconceived notions that due to pre-service teachers' personal technology usage, they can translate that usage into teaching pedagogy. Bannerman and O'Leary (2020) used the TPACK framework to explore pre-service teachers' daily technology usage, their perceptions towards technology usage in their teaching, and their overall experiences with technology in music classrooms. Like Leong (2016), Bannerman and O'Leary asserted that technological skills are not innately based upon students' generational labels and suggested pre-service teachers might benefit from the modeling of technology integration by facilitators in their practicum experiences. In general education, Yurdakul (2018) examined the relationship between pre-service teachers' (N = 1,493) digital nativity levels and their TPACK competencies. Using two self-reporting Likert-type scales designed to measure technology integration and digital nativity levels, the researcher found that personal technology usage was not a significant predictor of TPACK competency, suggesting that practice is needed to build TPACK. Bauer (2013) similarly discovered that music education undergraduates cited coursework as beneficial to the development of the TPACK domains of content knowledge, pedagogical knowledge, and pedagogical content knowledge; however, less than a third of

respondents in the study (N = 284) indicated that their pre-service curriculum was a means to develop any of the domains regarding technology.

Researchers have suggested the importance of building TPACK domains through pre-service curricula because it equips future teachers with the skills and confidence to integrate technology effectively into their teaching at the start of their careers. Focusing on online instrumental teachers, Price (2020) found that the instructors in the study (N = 10) designed their lessons around their previous pre-service experiences. Kontkanen et al. (2016) and Reese et al. (2016) suggested that prior education experiences focused on teacher-centered technology usage and the need to allow pre-service teachers the ability to become active learners. While researchers suggest that trainee teachers require these experiences, they have also proposed the importance of determining faculty roles in building student TPACK. Huffman (2016) studied arts and sciences faculty in higher education to ascertain how faculty model technology integration. Huffman found a majority of faculty in the study lacked technological content knowledge from their own learning experiences. Tondeur et al. (2019) concurred, proposing to strengthen modeling in teacher educators, TPACK must be supported and further developed. A deficit in opportunities within pre-service curricula may account for the identified struggles faced by in-service music educators.

Summary

The sections of this literature review serve to contextualize the struggles currently surrounding in-service music educators with regard to utilizing technology within differing teaching contexts. Therefore, I presented studies regarding the TPACK

framework, GenAI's integration with the TPACK framework, the current state of technology and GenAI integration in varying music education settings, current issues in music technology professional development, TPACK-based professional development, technology modeling, and TPACK development at the pre-service level to highlight the identified struggles and the possible reasons as to why these issues may be perpetuated within music education. An exploration of studies regarding TPACK measurement linked the usefulness of the framework in regard to the current study. I aimed to clarify the issues brought forth in the research regarding technology integration in music classrooms by highlighting current technology practices in varying music education contexts, recent research on pre-service music preparation programs, and current studies on music technology professional development. Finally, I provided an analysis of TPACK-based professional development studies to identify benefits to this type of professional development as well as to highlight the need for further research specific to music education. The literature underscores the complex challenges music educators face in integrating technology effectively into teaching practice and demonstrates how the TPACK framework can serve as a valuable lens for understanding these struggles. In the following chapter I outline the research design and methods employed to investigate how music technology educators develop and apply technological pedagogical and content knowledge in their teaching practice.

CHAPTER THREE: METHODOLOGY

Introduction

The purpose of this collective-case study was to explore music technology educators' self-directed technology learning habits and their perceptions of how prepared and willing they were to then use said technology within their teaching practice. Through semi-structured interviews as well as a focus group with all participants, I intended to provide further insight into the expressed needs, concerns, and practices of current music technology educators. Through this study, I offer a further resource containing music educator suggestions in terms of training in technology, both at the pre-service and in-service levels.

Restatement of Research Questions

The following research questions were used to guide this collective-case study:

1. How has self-directed technology learning contributed to the music technology educators' development of the technological domains within the TPACK framework?
2. In what ways has self-directed technology learning influenced music technology educators' perceptions of their preparedness and willingness to integrate technology into their teaching practice?

Research Design

The qualitative methods I used for this study allowed me to better ascertain the use of self-directed technology learning and the reported benefits, concerns, and suggestions of the music educator participants while maintaining as neutral a position as

research as possible. Qualitative research, and specifically case study research, is appropriate for studies aimed at answering the how or why questions associated with a particular phenomenon (Yin, 2018). Additionally, qualitative researchers use a constructivist approach with the belief that through interpreting participant interactions and observing, knowledge may be constructed about the phenomenon (Stake, 1995). Villani (2014), in an appraisal of high school music teachers' use of notation software, similarly adopted a constructivist and collective-case study approach to explore participants' pedagogical understanding, which helped to uncover nuanced technological fluency across career stages. For these reasons, I employed qualitative methods to present a more detailed view of the role self-directed technology learning plays for current music technology educators.

I selected case study research because it enabled an in-depth examination of the secondary music technology educators' self-directed technology learning pursuits. Collective-case study afforded me the ability to explore this phenomenon within real-world contexts and across multiple data sources. This approach also aligned well with my goal to present a narrative exploration of the participants' perceptions (Glesne, 2007) as well as the use of explanation building and cross-case synthesis to illuminate the ways in which self-directed technology learning informed pedagogy (Stake, 1995; Yin, 2018).

The primary focus of this study involved five music technology educators who currently teach at least one section of secondary-level music technology. In this study, I utilized a collective case study design in which each case was carefully selected to further illuminate the research phenomenon (Yin, 2018). Collective case study "...draws a single

set of ‘cross-case’ conclusions” (Yin, 2018). Gall et al., (2007) suggested that the exact number of cases studied is up to the discretion of the researcher; however, Creswell (2007) cautioned researchers to limit the breadth of the study to encompass no more than four or five cases. This recommendation is reflected in Cremata’s (2010) study of music technology integration at two universities, which used five cases to produce thorough and particular understandings of individual experiences. Likewise, Prendergast and May (2020) utilized a multiple case study model with three modern band instructors to examine innovative curricular approaches, showing that small samples can still produce rich, comparative insights. Because of this, I chose a collective case study design to depict an array of perspectives through individual interview and focus group data to display a more detailed account and understanding of the five participants. By gathering information from a small number of participants, I was able to explore, in depth, their perceptions of the effects of self-directed technology learning on their teaching practice, allowing for rich, detailed insights while keeping the data manageable for the scope of the study.

Context and Participants

Following approval from the Boston University Institutional Review Board (IRB), recruiting participants took place through utilizing the email database of members of the Association of Popular Music Education (APME). I chose the APME database because it provided verified contact information for active music educators across the United States who specialize or have interest in popular music education, aligning closely with my study focus on technology integration in music teacher. I sent an initial, IRB-approved

email to members detailing the research project. Once I received interest from prospective participants, I used criterion and purposeful sampling to select five cases that were likely to be information-rich (Gall et al., 2007). This approach allowed for the intentional selection of participants who were most likely to provide detailed insights into the use of technology in secondary music education. Purposeful and criterion sampling are frequently employed in qualitative music education research, especially where specific access to technology use is central to the study (Villani, 2014). For example, Villani (2014) selected participants specifically known to utilize digital notation software and who varied in career stage, ensuring relevance and diversity in the data. Similarly, Prendergast and May (2020) emphasized purposive sampling to focus on university-level instructors teaching modern band pedagogy with technology. I sought participants who currently taught high school music technology courses within the continental United States, as these stand-alone technology-focused offerings differ substantially from general music courses. Gall et al. (2007) explained:

It is clear that purposeful sampling is not designed to achieve population validity. The intent is to achieve an in-depth understanding of selected individuals, not to select a sample that will represent accurately a defined population (p. 179).

Stake (1995) asserted that the foremost intent of case study research should be to expand what can be learned from each case.

Although I contacted participants directly through the APME database, in some cases it was necessary to obtain additional permission from school or district administrators. When making initial contact with these gatekeepers, I submitted a lay summary that introduced the study, what would be done with the results, and how long

the study would last (Glesne, 2016). It was imperative that, as the researcher, I assured the appropriate gatekeepers of my intentions and quelled any possible concerns. “Of special concern to administrators is whether the research results will negatively reflect on their institutions,” (Gall et al., 2007, p. 88). Because of this, I made sure to maintain confidentiality and anonymity in order to protect the participants and their institutions (Yin, 2018). Similar ethical precautions were taken by Wise (2016), who ensured confidentiality when exploring teachers’ use of digital tools for composition instruction in secondary classrooms.

Once permission and access were secured, I followed the protocols outlined by the Institutional Review Board (IRB) at Boston University. I sent a letter of introduction to each participant informing them of what would occur during the study and what would be done with the research data (Gall et al., 2007). Through this introductory letter, I also informed participants about the conditions of their participation and their right to withdraw from the study at any time (Gall et al., 2007). Appendices D and E include copies of the initial letters of introduction, participation, and consent. These letters comply with the Boston University IRB protocol and I included them in the IRB application paperwork (Appendix F).

The participants in this study were practicing high school music technology educators from varying demographics within the continental United States. All participants were selected with the goal in mind to collect data that provided a rich detail of their perceptions regarding how self-directed technology learning impacted their teaching practice. This approach mirrors the participant selection rationale used by

Villani (2014) and Berry (2019), who both aimed to capture diverse teaching experiences related to digital integration, accounting for variables like career phase, prior training, and technological proficiency. Pseudonyms were given to all participants and their schools in order to maintain anonymity. I also removed any district or demographic citations from the narrative report for confidentiality. Participants were selected based on their similarities and differences including career stage, years of experience, gender, racial background, and training. This afforded me a more concrete picture of the multiplicity of perspectives that exist within the current lens of self-directed technology learning and teaching practice.

Data Collection

Data collection took place over a six-week period in the summer of 2024. I collected data through individual Zoom interviews and a focus group discussion with all five participants. The focus group occurred only after I had conducted all individual interviews to promote a discussion uninfluenced by participants' prior responses. I collected data and transcribed interviews in a timely manner to maintain accurate records and notes regarding the nuances of each conversation. Due to the fast-changing nature of technology, I conducted a brief follow-up interview with each participant with questions regarding their use of artificial intelligence (AI) in their instruction and their perceptions of this newer technological advancement. This information was imperative to the study as AI is becoming more popular within the field of education. As bell et al. (2025) suggested:

As soon as you start working with technology, the pace of change is so quick that the closer your intellectual product is to the details of technology, the shorter the

shelf life is of the research (p. 4).

This aligns with Cremata's (2010) methodological urgency, in which data collection and analysis were completed swiftly to ensure accuracy and relevance in rapidly evolving digital education environments.

Following the completion of individual and focus group interviews, I conducted brief follow-up interviews with each participant via email to gather additional data specifically related to their perceptions and use of artificial intelligence (AI) in instructional contexts. This additional round of correspondence was necessary due to the increasing prevalence and rapid integration of generative AI tools in educational technology; an area not initially explored during the first interviews. Email was chosen as the method for follow-up in order to reduce scheduling demands and offer participants time for reflection. This approach aligns with practices used in Cremata (2010) and Prendergast and May (2020), who conducted supplemental participant communication through email to expand and refine interview data.

To facilitate data collection, I conducted individual Zoom interviews, a collective focus group discussion, followed by a short follow-up email interview with questions specific to AI (Appendix C). I used semi-structured interviews allowing for a more conversational approach while also maintaining a systematic collection of data across all participants (Gall et al., 2007). Yin (2018) stated, "case study interviews will resemble guided conversations rather than structured queries" (p. 118). This type of interviewing requires the interviewer to follow their line of questioning while also ensuring inquiries are presented in an unbiased manner (Yin, 2018). This technique was employed by

Gaines (2018), Prendergast and May (2020), and Wise (2016), all of whom used semi-structured interviews to probe specific teaching experiences and support in technology-enhanced instruction. I designed the interview questions to align with the research purpose, which was to explore self-directed technology learning habits, understand participant perspectives, and develop a more detailed portrait of each individual. This helped to account for individual participants' unique perspectives and afforded me the flexibility to dive further into specific lines of questioning based on participants' responses. The semi-structured interview guide can be found in appendix A.

I conducted and recorded each interview using the video conferencing software Zoom. There are several benefits to utilizing online video conferencing for data collection. Zoom is a cost-effective way to reach participants from geographically diverse locations without the expense of travel (Gray et al., 2020). Zoom does not require participants to create an account, download, or purchase their software as a live, password-protected link can be provided by the researcher (Gray et al., 2020). Gall et al. (2007) noted the importance of not only paying attention to the respondent's words, but also their nonverbal communication. Online video conferencing affords the interviewer the ability to note nonverbal cues such as facial expression and body language (Farooq & de Villiers, 2017). Villani (2014) noted similar advantages using Skype for interviews, citing the importance of observing participant gestures, posture, and expressions to contextualize verbal statements. Zoom stores recorded sessions onto the host's computer in two convenient files: audio only and audio-video which assists with secure data generation and storage (Gray et al., 2020). By storing the records on my password-

protected computer, I was able to keep participant data secured. Video conferencing also allows for participants to choose a convenient location and time for the interview which allows for flexibility in scheduling and length (Gray et al., 2020).

Each interview was approximately one hour in length. Glesne (2016) asserted, “an hour of steady talking is generally a suitable length before diminishing returns set in for both parties” (p. 110). Yin (2018) also recommended interviews be focused to about an hour in length as to not put undue burden on the participants’ and researcher’s schedules. Cremata (2010) and Berry (2019) conducted interviews ranging from 45–60 minutes, suggesting that this length is optimal for depth without fatigue, especially when dealing with professional educators with demanding schedules. Other researchers have suggested time allocated for interviews is up to the discretion of the interviewer (Farooq & de Villiers, 2017). I was careful to spend enough time interviewing participants in order to obtain data saturation while also being mindful of the participants’ schedules, professional, and other duties as to not cause any undue stress to them. This also allowed me to maintain a neutral position as to not develop too close a relationship with participants which may have biased the findings (Creswell, 2007).

Bias is an inherent concern in case study research because the researcher plays such an active role in collecting and interpreting data (Yin, 2018). Yin emphasized that the reliability of case study depends on minimizing error and bias through clear, systematic procedures. The author recommended making research processes explicit and approaching data collection as though another researcher were observing each step, ensuring transparency and consistency. Similar to Yin’s procedural focus, Stake (1995)

argued that the researcher's interpretations are inevitably shaped by personal experience and perspective, making reflexivity essential to case study research. Both authors highlighted that addressing bias in case study research requires both methodological precision and continued self-awareness on the part of the researcher (Stake, 1995; Yin, 2018).

Once individual interviews were conducted, I organized a focus group with all participants. Gundumogula (2020) suggested that the purpose of the focus group discussion is to bring about an in-depth conversation and to elicit interaction among participants. Gundumogula stated that "this type and range of data generated through the social interaction of the group are often deeper and richer than those obtained from one-to-one interviews" (p. 301). This type of interviewing required me to take on the role of conversation facilitator (Yin, 2018). As suggested by Gundumogula (2020), I utilized opening remarks and a questioning sequence to maintain structure of the focus group conversation. As discussion facilitator, I assist the group in discerning a set of ground rules in order to maintain a respectful environment where participants' voices could be heard (Glesne, 2007).

I conducted and recorded the focus group using Zoom (Appendix B). This was the platform that was familiar to each participant from individual interviews. I also selected Zoom for the purpose of continuity and researcher familiarity. Gundumogula (2020) asserted, "the venue for the focus group session should be accessible and convenient to all participants and it should be decided beforehand" (p. 299). The focus group interview lasted one hour for the same reasons as the individual interviews, including consideration

of the participants' schedules and undue burden on both participants and researcher. The advantages of using Internet technology to conduct focus group interviews include reaching geographical boundaries, convenience, and the ability to easily record and document the session (Gundumogula, 2020). This is consistent with the format used by Biasutti et al. (2019), who conducted 45-minute online focus groups with teachers to evaluate a long-term professional development program.

Data Analysis

During each stage of data collection, I stored all notes, transcripts, audio, and video files in password-protected storage on my personal laptop. I organized the file database in such a way so that an audit trail of all data was easily accessible (Yin, 2018). Although this study accounted for multiple cases, the data collection process yielded an organizational structure of information and topics covered.

To account for data triangulation, I sought confirming and disconfirming examples and experiences through each participant interview, the follow-up interviews, and the focus group discussion. Triangulated data sources such as these are commended in collective case studies of music technology integration as they provide a more comprehensive narrative of each participant's pedagogical context (Glesne, 2007). I also sought triangulation through multiple sources, including the five participants' individual experiences as well as the multiple perspectives brought about during the focus group interview (Glesne, 2016). The transcripts of each interview and the focus group yielded a substantial amount of data, which were analyzed within the parameters defined by the scope of the study (Stake, 1995). I obtained data saturation when sufficient consistencies

in coding categories among participants emerged (Gall et al., 2007).

After the conclusion of each interview, I cleaned up verbatim transcription for accuracy using the video file generated from the interview session using Zoom's transcription feature. Glesne (2016) suggested that transcription should occur as soon as possible after the conclusion of the interview. I used this process again directly after the focus group interview. Once I had completed the transcription, I sent an emailed copy to each participant for a member check, which allowed participants the opportunity to check for accuracy, further clarify, and expound upon their statements (Glesne, 2016). This practice was mirrored by Cremata (2010), Wise (2016), and Gaines (2018), who each emphasized member checking to validate interview context and reduce interpretive bias.

The follow-up email interviews provided a written audit trail of participant reflections and allowed for more deliberate articulation of their evolving relationships with AI in their classrooms. As Cremata (2010) emphasized, collecting and reporting data in a timely manner is critical when studying educational technologies with rapidly shifting applications and implications. Given that AI was not a prevalent theme in the initial interviews, the follow-up responses added depth to the thematic analysis of the study and ensured data remained current with ongoing developments within the field. Participants' emailed responses were reviewed, coded alongside their earlier interviews in NVIVO, and incorporated into the cross-case analysis to support emergent themes and confirm patterns across data sources. This additional step strengthened data triangulation and contributed to the rigor and relevancy of the findings.

I analyzed all collected data with NVivo, a qualitative data analysis software. I used coding to identify emergent thematic material within the data. I sought examples confirming and disconfirming information relevant to each code in order to provide rich, thick description within my report (Phelps et al., 2005; Glesne, 2016). While NVivo assisted in illuminating emergent themes, I interpreted the data descriptively to construct a narrative of the participants' experiences (Yin, 2018). Both Glesne (2016) and Yin (2018) asserted the belief that qualitative data analysis software are helpful tools, but the decision-making and interpreting is the job of the researcher. This analytic method aligns with Gaines (2018), who used NVivo to identify themes and word frequency patterns in interviews with music technology faculty, and Berry (2019), who used it to uncover emergent themes related to TPACK development across a cohort of online instructors. The coding process was fluid and continued to evolve over the course of data collection to ensure that I was thorough in reporting cross-case findings.

Trustworthiness

I created an audit trail with each piece of collected data and stored and organized data in a database (Yin, 2018). This provided a record of the research process (Glesne, 2016), that was preserved for methodological transparency, but remains confidential in accordance with IRB guidelines. The database also contained the coding schemes and reports run using the NVivo software for replication purposes. I secured data in a password-protected database on my personal computer.

I also utilized member checking as a form of reliability. After each interview, I provided participants with a copy of the transcription and asked each participant to review

and to clarify statements as necessary (Stake, 1995). Additionally, I sent the final narrative research report to each participant to obtain their feedback (Glesne, 2016). By confirming my reports with participants, I sought to corroborate my findings and build credibility.

I employed peer review as another form of trustworthiness to assist with scrutinizing the study findings (Glesne, 2016). I consulted with colleagues in the Boston University doctoral program who were familiar with my topic in order to establish trustworthiness of the data interpretation. My dissertation supervisor, an experienced researcher, served as an external auditor throughout the research process. This assisted with verifying consideration of various perspectives and interpretations.

Throughout the data collection and reporting processes, I had to account for my own personal biases (Glesne, 2016). I accounted for personal biases through my notes during and after each interview and focus group. I continued to reflect on how my own personal biases could affect how I was interpreting situations and data. This, coupled with the other techniques used to seek reliability, helped me to establish a reasonable degree of confidence in the results and final narrative of the study (Phelps et al., 2005).

Preparation and Qualification of Researcher

In preparation to conduct this study, I completed graduate-level coursework and training in qualitative research design. I also completed required training on research participants, ethics, and compliance through the Collaborative Institutional Training Initiative (CITI) program. I am a professional music educator who currently teaches high school music technology with an understanding of teaching practice and terminology related to the field. In addition, I am a doctoral student in music education at a leading

global research institution with a focus on interdisciplinary research. I remain aware of the limitations of research pertaining to music technology and sought to reveal, through narrative analysis, the need for further research.

Summary

In this chapter, I outlined the approach used to investigate the research questions, beginning with a clear restatement of the research questions guiding the study. I detailed a description of the research design and the overall strategy, study context, and participant selection processes. I discussed data collection methods, including instruments and procedures used to gather information as well as the data analysis techniques employed to interpret the findings. I reported the trustworthiness of the study through strategies used for ensuring reliability and validity, while highlighting the preparation and qualifications of the researcher to ensure credibility and ethical rigor. Together, through these sections, I provided a comprehensive overview of how the study was conducted to address the research questions effectively. In the following chapter, I provide a detailed narrative exploration of the findings.

CHAPTER FOUR: FINDINGS

Introduction

In this chapter, I provide detailed information pertaining to each participant and their respective music technology programs. I also discuss the career trajectory of each participant so the reader can gain valuable insight into the backgrounds of each of the music technology educators. A comprehensive look at each district and student demographics assists the reader in understanding the cultural and social environment in which these participants teach. I also provide brief descriptions of the course offerings and programs of each participant's teaching context as to paint a fuller portrait of the course of study. Through these portraits, I aimed to contribute to a further understanding of the perspectives of the five study participants.

The high school music technology educators in this study have varying backgrounds, career stages, and come from differing geographical regions. Despite their differences, several overarching themes emerged through the interview and focus group data. Themes of confidence and comfort with technology, technology professional development, and learning resources were among the major topics of discussion for each participant. Following a detailed description of each participant, I present a narrative exploration of the study findings in relation to the two guiding research questions. Participant perceptions and experiences remain at the forefront of this exploration, highlighting the nuanced ways in which individual and collective experiences shaped their engagement with music technology. By centering participants' voices in this chapter, I aimed to uncover insights into the challenges and opportunities faced by music

technology educators, providing a foundation for future research and practical applications in the field which I present in the following chapter.

Portrait of Ari

Ari is a female music technology educator in New Jersey. She has been teaching music technology for five years and is in the early to mid-stage of her career. Ari teaches in a public school district which serves approximately 15,000 students across 17 elementary and secondary schools. The district has a diverse student population with a majority of students from Hispanic/Latino descent, many of whom are limited-English proficient. The school district summary reported that 72.2 percent of students qualified for free lunch. The district is classified by local government agencies as an area of low socioeconomic standing with many students facing poverty (citation removed to protect anonymity).

Ari studied music education as an undergraduate. She received instruction in one music technology course which she described as a brief exposure to GarageBand and Finale. Ari began her teaching career as a general music and ensemble teacher at the elementary level. She has taught band, chorus, and orchestra at various stages throughout her career. She holds a Master's degree in Music Education. During her graduate career, Ari expressed she had no exposure to music technology courses.

Ari began teaching music technology courses during the 2019–2020 school year. Her district applied for and received Career and Technical Education (CTE) funding and thus, a music technology program was created. Ari expressed that one of the reasons she was chosen to teach the new music technology program was because of her Master's

degree, a condition and requirement of CTE programs. She was initially hesitant to leave her previous position as she really enjoyed her job and students. However, Ari expressed that the music technology course was created for students not drawn to traditional music education, a sentiment she related to as a non-traditional music student herself. She stated:

For whatever reason, the traditional music band programs or ensemble programs are not reaching [students]. And I was that student, um, when I was in the same school district...and so, my music life outside of school was so rich and so fulfilling, and it was so relevant to my culture and my life that [traditional music education] didn't really reach me.

Ari claimed the music technology program currently served 110 students with a vast majority being non-traditional music students.

Portrait of Ari's Music Technology Program

Ari teaches in an iMac lab with 27 stations. Each station is equipped with MIDI controllers and headphones along with other audio interfaces. She designed the current curriculum with the support and assistance of her district supervisor. The music technology course is a four-year program with years one through three required and year four optional. First-year students learn a basic overview of digital audio. Students use Audacity and GarageBand in a project-based curriculum. First-year students are focused on loop-based and multimedia compositions. Second-year students receive a basic overview of the business aspects of the music industry and receive further exposure to topics covered in year one. Students in year two learn about DJing, contracts, copyright, intellectual property, and legal and ethical issues surrounding the music industry. Both first- and second-year students build basic music theory and keyboarding skills as well as

focus on cultivating and maintaining student work portfolios. In the third year, students continue to build on skills and topics from previous years, while also mastering Pro Tools through Avid courses. Ari is a certified Pro Tools instructor. By the end of their third year, students take level 100 of the Pro Tools exam and receive certification. Students who opt to take the fourth-year continuation of the program begin internships and work-based learning through in-school and out-of-school partnerships. Students receive opportunities to build their industry-related work skills through mentorships with industry professionals.

Portrait of Rick

Rick is a male music technology educator residing in Ohio. He has been teaching music technology for 12 years and is in the mid-stage of his career. Rick teaches in a large urban school district serving a diverse population of approximately 50,000 students across a wide range of socio-economic standings with nine percent of students identified as vulnerable youth, which includes students who may be homeless, in foster care, or in temporary living situation according to the district website (citation removed to protect participant anonymity).

Rick took an interest in band from a young age. He stated, “so when I was a kid, I saw the high school band at a basketball game where my sister was a cheerleader, and I thought it was the coolest thing.” He joined his middle school band program and began taking trumpet lessons with a collegiate instructor. Rick studied music education as an undergraduate and has always enjoyed being a peer teacher and mentor to friends. He initially struggled to find a position in education after graduation in 2001. He held odd

jobs and was a substitute teacher until he found a position as a middle school band director. Rick supplemented income for his first teaching job with after-school lessons for a time. He has also marketed and taught band to homeschoolers. Due to the closing of the middle school where he worked, Rick applied to be the band director of a larger high school program within the district. While the job was given to another candidate, he was offered a teaching position as the music production and recording instructor. With no prior expertise in music technology, Rick accepted the position.

Rick expressed that he had no prior knowledge of recording arts or music technology hardware/software, but was willing to learn. He also affirmed that he had very little exposure to music technology during his undergraduate and graduate career. He had isolated experiences with music technology, but these instances lacked practical application for his teaching context as a band director. Rick spent the summer learning about music production. He shared:

I would say I studied probably ten hours a day, seven days a week the entire summer. I read *Modern Recording Techniques*, a big book. It's like 700 pages. I read that cover to cover. Learned how to record. I watched a bunch of DVD tutorials back before YouTube had all the tutorials online. I watched DVDs on how to use Pro Tools.

He also spent time taking apart the school's recording studio to gain knowledge of the technology he would be using within his daily teaching duties.

Portrait of Rick's Music Technology Program

Rick teaches in a career center, which offers CTE certifications to students from 25 different high schools. The music technology program is funded through CTE grants. Students in the music technology program receive instruction daily for two and a half

hours. Students in grades 11 and 12 receive a rigorous two-year course that covers topics and skills related to music production, recording, editing, mixing, mastering, post-production, live sound, beat making, and songwriting. There are no prerequisites to take the music technology course as the state of Ohio deemed prerequisites inequitable. Students are now admitted to the program through a random lottery; however, most students have a stated goal of going into the music or entertainment industry after high school.

Rick wrote the curriculum for the music technology program. The district developed relationships with various software companies which afforded access to students from low socioeconomic standings. Rick created a majority of the materials used for his courses. He stated, “I find it very, very difficult to use anything off the shelf from somebody else because almost every curriculum that’s designed by some, you know, hot shot, is designed for suburban kids.” He currently has a self-created music theory course with videos based in a MIDI editor rather than Western five-line music staff. He has also created various tutorial videos and online courses for his students. Rick’s students are afforded the ability to gravitate towards their interests and are given ample time to pursue these avenues. Rick has used his knowledge of the industry to design education opportunities that address necessary job skills.

Rick is a certified Pro Tools instructor and runs 100- and 200-level certifications in Pro Tools for students as part of the program. Students also receive experience in audio engineering, learning in depth about microphones, mixing, EQ, and live sound recording. Students receive simulated work experiences through the on-campus theater, learning

about sound systems and digital mixers. Rick teaches in an iMac lab with 30 student stations equipped with MIDI keyboard controllers, Ableton Push 2s, audio interfaces, and headphones. Students use Pro Tools, Native Instruments, Screen Flow, DaVinci Resolve, coding software, and video game software for a variety of projects. Students also have access to a recording studio, outfitted with amps, instruments, mics, and mixing boards.

Portrait of Bill

Bill is a male music educator in his tenth year of teaching music technology. He is in his 22nd year of teaching and is in the mid-stage of his career. Bill teaches in a diverse public district in New York serving approximately 5,000 students across 200 square miles according to the district summary. Students come from a variety of living situations, from very rural to urban city centers. Approximately 40 percent of students within the district are identified as economically disadvantaged with a large population of immigrants from China and India (citation removed to protect participant anonymity).

Bill has always been involved in band, starting on trumpet and eventually moving to euphonium. Both his father and brother played instruments. He studied music education in his undergraduate career and wanted to be a band director. He affirmed that he had no exposure to music technology in his collegiate career. Bill took his first job in a very small district teaching seventh through twelfth grade instrumental music. He then moved to Maryland and for three years taught band, orchestra, and general music. During his time in Maryland, he began using the program SmartMusic which sparked his initial interest in music technology. Bill moved back to New York and began teaching middle school general music and high school music theory part-time. He continued to

incorporate music technology in his general music classes. Bill then took a full-time position in his current district teaching sixth through eighth grade instrumental music from 2008 to 2013. During his Master's studies, Bill took a course in GarageBand which opened an interest in the possibilities of education through music technology. With this new-found interest, he redesigned the middle school general curriculum to be music technology focused. He was able to secure funding for an iMac lab and continued to build the program through student interest and enrollment. Bill applied for and received the Ableton Push grant, securing more opportunities for students within the middle school program. The grant provided the district with free Ableton Push units for the classroom and access to Ableton's online community for educators. In 2018, Bill moved to his current high school position within the same district teaching music technology.

Portrait of Bill's Music Technology Program

Bill teaches Electronic Music 1, Electronic Music 2, Music Production, guitar, and adaptive music. Electronic Music 1 and 2 are semester courses that run sequentially in the fall and spring respectively. Music Production is a full year course catered to upperclassmen; however, there is no prerequisite for the course. Classes meet for 43 minutes daily. Bill teaches in a 25-station iMac lab. Student stations include MIDI controllers, audio interfaces, Push 2 launch pads, condenser microphones, and headphones. Students use Logic Pro, Ableton Live, Pro Tools, and have access to a recording studio.

Both Electronic Music and Music Production are project-based courses. Electronic Music 1 and 2 have a structured and sequential curriculum that exposes

students to industry tools and skills. Music Production is a deeper and more rigorous dive into topics covered in Electronic Music 1 and 2. Bill shared that students in Music Production have a bit more curricular flexibility which panders to their individual interests. He is a certified Pro Tool instructor and students in Music Production receive their Pro tools Artists certification. Students in Music Production also receive industry exposure through various educational field trips.

Funding for the current equipment was secured ten years ago during the merging of two district schools. Bill described his district as supportive of the program and plans to rebuild a state-of-the-art recording studio were in motion for the 2025–2026 school year.

Portrait of Alice

Alice is a female, 25-year teaching veteran in her second year of teaching music technology in Massachusetts. She taught other subjects before going back to receive certification in music education. She is in her 20th year teaching music. Alice has taught a variety of subjects in K–12 music education and has always had an interest in music technology. She took a music technology course in high school as well as a course in her undergraduate studies. She stated that the courses had little to no practical application of technology integration and were more history-based. Alice also affirmed that the technology course was an elective and not required for graduation.

Alice teaches in a public school district of 18 schools serving approximately 10,000 students across grades K–12. The high school is fed by five middle schools and the district contains a diverse population of students. According to the district website,

approximately 80 percent of the district's students are identified as coming from low-income situations and approximately 20 percent of students are considered multi-language learners (citation removed to protect anonymity). Alice began teaching in her current district six years ago and was initially employed at one of the district middle schools. Due to the COVID-19 pandemic, the students in the district receive district issued laptops. Alice began using music technology during this time as it was readily available. She began integrating music technology into her sixth through eighth grade lessons and wrote a curricular unit for eighth graders in preparation for the music technology program offered at the high school. She utilized BandLab for Education with her eighth-grade students. Due to a retirement, Alice was offered the high school audio and music production position, where she teaches today.

Portrait of Alice's Music Technology Program

Alice teaches two levels of audio and music production. The entrance level is a college preparatory (CP) course and the second level is an advanced placement (AP) course. In her first year of teaching the CP course, Alice petitioned for the inclusion of the AP level. Both courses are semester courses, running daily for 53-minute class periods. While there is no prerequisite for the CP level course, students must maintain an average no less than a B in the CP level to be accepted into the AP level. The AP level required moderately more responsibility and depth of knowledge and skill. The AP level course also affords students further exploration into individual interests and more curricular freedom than the CP level.

The music production lab and equipment were purchased three years ago by the

district with the creation of the new high school. Alice stated that purchasing new equipment could sometimes be a hurdle and may need to be done piecemeal over time, rather than all at once as she relied heavily on the district budget because the program is not funded through CTE.

Alice teaches in a 16-station iMac lab. Each student station is equipped with Akai 249 MIDI keyboard controllers and Ableton Push controllers. The district currently has a contract with Soundtrap and Alice is a certified Soundtrap instructor. Students also use GarageBand and Logic Pro. Alice makes use of demonstration-based instruction and she described the course as project-based. Students learn a variety of skills including loop-based composition and EQing. Students also produce a digital portfolio of work which can follow them past graduation from the program.

Portrait of Theo

Theo is a male music technology educator in his seventh year of teaching the subject. He began teaching in 2011 and is in the early to mid-stage of his career. Theo teaches in a large public school district in New Jersey. The district served over 38,000 students throughout 60-plus schools. Approximately 90 percent of the students are Black or Hispanic, with just over 24 percent considered multi-language learners (citation removed to protect participant anonymity). According to the district summary, 81 percent of the student population receives free or reduced lunch. Students come from a diverse variety of socioeconomic family situations.

Theo stated that his interest in music technology began in high school when he pirated a copy of FL Studio. In his undergraduate education he studied guitar, graduating

with a Bachelor's in Music Education. He took two music technology courses during his undergraduate career, the first at a community college and the second at a four-year university. He stated that the community college course was music theory-based and the university course had very little practical application to teaching contexts.

Theo took his first teaching job in 2011 in his current district and always had the goal of creating a music technology program. He and a colleague began building the program during extended learning time after school using a free online digital audio workstation (DAW). Student interest continued to grow and Theo continued to advocate for the creation of a music technology pathway. Theo received a grant from the GRAMMY Foundation to secure student iPads. The district's visual and performing arts director was approached by the Save the Music Foundation and she applied for and was awarded the Save the Music J. Dilla Music Technology Grant. The grant not only provided brand new equipment valued at approximately \$75,000, but also included master classes and professional development for the educator moving into the role. This generated significant interest in the music technology program and student enrollment grew. Theo expressed that he worried about program sustainability due to district funding. Despite being awarded a significant grant, eventually equipment would need to be replaced. The district eventually moved towards CTE funding and the music technology pathway is now a fully approved CTE program of study.

Portrait of Theo's Music Technology Program

As previously stated, Theo teaches a fully approved CTE program of study which means his students receive dual credit from a local community college. Students in his

program take the Avid Pro Tools Artist User certification exam. Theo primarily teaches audio engineering. He wrote the course curriculum for the CTE pathway.

Students begin in sophomore year with Music Technology 1. Each course is sequential and a prerequisite for the following level. In their junior year, students take Music Technology 2 and as seniors, Music Technology 3. All courses are a full year in length and there are currently 150 students in the program.

Theo teaches in an iMac lab. The school currently houses three iMac labs, each complete with 25 student stations. In the music technology lab, each station is outfitted with MIDI keyboard controllers and headphones. Students also have access to a recording booth equipped with microphones, outboarding gear, compressors, and channel strips. Students have access to laptops, various synthesizers, monitors, sound systems, mixers, electric guitars, electric basses, an electric drum set, and DJ equipment. Students in Theo's program use Pro Tools, GarageBand, and Ableton Live as well as Serato for DJing and FL Studio in the recording room. The courses are project-based with task-based sequential learning. Students receive simulated work experience and can job shadow within the school through various performing arts programs the school also offers.

Findings Addressing Research Question One

In order to present the research findings, the following sections pertain to each guiding research question and the overarching themes that emerged through data analysis. A narrative exploration of each theme and sub-topic is used to keep the participants' voices at the forefront of the discussion (Phelps et al., 2005, Yin, 2018). Research

question one was how has self-directed technology learning contributed to music technology educators' development of the technological domains within the TPACK framework? Overarching themes that emerged for this research question included self-directed technology learning, resources, pedagogical change, and growth.

Self-Directed Technology Learning

The journey of self-directed technology learning is a dynamic process that encourages individuals to uncover their potential and adapt to ever-changing circumstances. The educators in this study used several strategies to continue to build their technological knowledge base. Each participant expressed a strong desire to consistently seek out ways to learn about the hardware and software they utilized each day within their teaching practice. Under the overall theme of self-directed technology learning, several sub-themes or related topics emerged through the data. These included educator self-reliance, trial and error learning, necessity for a broad range of technological knowledge, the changing technology landscape, and technology funding and sustainability.

Self-Reliance

A common sub-theme present within each individual interview was the idea of self-reliance to gain knowledge about new software and hardware. Bill spoke of his strategies early in his career, when many online resources were not yet in existence, "...when I started doing this, as much as there exists now for technology, it wasn't there then." Rick echoed similar circumstances stating that he used DVD tutorials to learn about programs before YouTube had tutorials online. Several participants claimed that

they were self-motivated and dedicated a significant amount of time to the continual learning process. Theo stated, “I mainly got my experiences individually, you know? Learning for myself and then recording with bands. That’s how I got my experience, not through formal education.” This sentiment was similarly shared as Bill expressed, “I spent hours after school trying to figure stuff out. I spent hours at home trying to figure stuff out.” Likewise, Alice commented on her knowledge base, “It’s all independent. I do it on my own.”

Trial and Error Learning

A large part of the learning for the participants in this study revolved around learning through doing and then adapting. In speaking about learning how to J in order to teach her students, Ari stated:

I didn’t know anything about DJing. I had to learn. Luckily, I have a cousin who’s a professional DJ, really successful...I would call her and say, “Hey, can you come here and give my students a lesson?” And while she’s giving the lesson, I’m zeroed in on everything she’s doing.

Alice shared that upon beginning her music technology career it was a “touch and go” situation and that she would adapt and tackle technology issues as they arose. She said, “I will, in the middle of a lecture, if a kid asks me a question, I’ll say, ‘I don’t know. Let’s figure it out.’” Bill spoke specifically to being comfortable with making mistakes which was also echoed by each of the participants during the focus group discussion. Ari and Rick managed learning and teaching new technologies by simply staying just a few steps ahead of their students during projects.

Need for Broad Range of Technology Knowledge

A common thread across much of the individual interviews and focus group discussion was the expressed necessity for a broad range of technology knowledge. The educators in this study interacted with a myriad of hardware and software programs, recording equipment, and instruments. They must be well-versed in each to properly teach and demonstrate for their students. Theo stated, “I, just personally, think that if you’re going to teach it, you should at least be very...extremely comfortable with multiple DAW software programs and how to use it in different situations.” This broad range of knowledge has allowed the participants to make informed decisions regarding which tools to use for particular projects and learning goals.

Of equal importance to the participants was the motivation for continual learning and not becoming complacent or stuck. “I don’t ever want to be at a point where I feel like I know everything” stated Theo. He added, “and that’s been a big part of the reason why I’ve been able to teach for ten years is just because it’s this idea of technology self-exploration and I wanted to learn more.” Similarly, Ari expressed that despite feeling intimidated at times, as long as she was challenging herself to learn new programs without overwhelming herself, she was able to learn in digestible chunks.

Changing Technology Landscape

The topic of broad knowledge was brought up concurrently with the topic of the constancy of change within the technology landscape. Interestingly, participants felt that despite the changes, the skills they have acquired through self-directed learning are transferable to new technology. During the focus group discussion, both Rick and Alice

spoke of the new AI tools and how they have been able to use them in lessons. However, Rick cautioned in his interview:

So, I don't jump on every new technology bandwagon as soon as it comes around because when you teach a skill like mixing, mixing is mixing. Will it be automated later? Probably, but there's always going to be a need for humans to interpret and understand what technology is doing.

Bill was in the process of learning a new DJing program to add into his current curriculum for the upcoming school year. Likewise, Ari, Rick, and Alice were in the process of learning new programs for implementation with students.

Technology Funding and Sustainability

Because the technology landscape is constantly evolving, participants also mentioned technology sustainability and the range of situations that can arise from district budgetary constraints and technology adoption policies. In speaking about the current equipment in her classroom Alice stated, "those keyboards are three-ish years old. And the teacher station, the A440 [key], she's a no go! So, we're going to need to start thinking forward." She also shared that it would take about four years to replace the keyboards in the entire lab which would be done piecemeal. Bill reflected, "a lot of the equipment that was purchased for the recording studio came from when the school merged back in 2014." However, he claimed that most of the equipment is still in satisfactory working order, despite being ten years old. Theo worried about program sustainability especially in a district with very little funding.

It was clear from participant responses that technology adoption and budgets varied significantly from district to district. Alice stated, "we are lucky in that we are

working on year three of a brand-new high school. So, they budgeted for a complete Mac lab with the keyboards and this and that.” She added that her predecessor was very technology savvy and set her up for success with equipment purchased. Likewise, Bill claimed his district was very supportive, which he understood as a luxury. Rick had a similar experience:

...because I’m the only teacher that teaches this in our school district and nobody else understands it at all, they sort of trust me to do whatever. There’s only like a dozen people that teach audio in the state, so there’s very little oversight.

The participants also discussed the purchasing process for their respective districts. For instance, Bill noted a vague process for adopting new technology. In his district there is a technology committee which meets once a month and will discuss requests. Bill, however, works around this process by communicating with the district data protection officer, but noted if the request requires payment, then the process is quite lengthy. Ari shared a similar complaint:

If it’s something we have to pay for, then it’s a longer process. If it’s a subscription-based program or something you have to purchase a package for, I have to get a quote for the item, sometimes write a rationale, submit it to my administration, and then with the funding we receive from the state, it’ll get approved. Then I won’t get the program until the following academic year, so I always have to plan a year ahead.

Alice concurred, “if it’s huge ticket hardware, hope for the best!” Likewise, Rick claimed that submitted requests through his district’s purchasing department were not a guarantee.

Another barrier identified by several participants was their districts’ IT departments. Rick, Bill, and Alice claimed their IT department staff were not trained in Mac. Bill stated, “I will say that our IT department hates Macs with a passion!” Rick shared similar experiences claiming that often, the IT department will not respond to his

requests because of the lack of training. He also shared that if things need to be installed within the Mac lab, it can be quite difficult to get the IT department to comply.

Interestingly, both Bill and Alice have administrative credentials as a means of working around the lack of IT department support. Contrastingly, Ari claimed the IT department in her district was a significant support. “We’re so lucky, because in my school, I think only two classrooms have iMacs, so he’s available to us all the time.” Both Rick and Alice noted that their IT departments were not solely to blame as they are overworked and understaffed.

Resources

I asked each participant which resources they found most beneficial to their teaching and learning. Many different types of resources have been used by the participants including their colleagues, networking, technology manufacturers, web resources, YouTube, social media sites, and even their own students. In the following sections I discuss specific resources in further detail to shed light on the resourcefulness of each participant and their differences in learning styles.

Colleague as Resource

Several participants are singletons within their teaching contexts; however, they have been able to rely on colleagues who may teach similar subjects with similar hardware. Alice relies on a technology specialist from the TV production studio within her school to assist with Mac related questions. Bill relies on coworkers who also teach in Mac labs within the building to help each other through hardware and software issues. He stated, “sometimes we just talk to each other. We just ping ideas off of each other and

issues.” Others have colleagues within district, but not within the same school building. Their communication has been essential to maintaining cohesion in instruction across the district. Alice works often with the middle school teachers within her district that are teaching the curricula she wrote.

Networking as Resource

Because music technology education is a relatively niche community, networking with others in similar roles has been beneficial for several participants. Music technology educators may be singletons within their districts and having a network of individuals within the field has been key to expanding learning and teaching practice. Ari explained:

...so usually, word of mouth. I look at those sessions in the New Jersey teacher conference thing and I see the people, their names and emails are usually there, so, I'll reach out and say, "Hey, I missed your presentation, I would love to chat more." Sometimes they'll respond because our community, music teachers, we're so nice. We give and give and give.

Ari also spoke of her relationships with professors in higher education who she has reached out to for support. Both Rick and Bill named Will Kuhn, a professor, author, and music technology educator as an important resource.

Social Media as Resource

Social media sites have helped several participants stay connected to the music technology community despite physical distance. Rick, Alice, and Theo named Reddit as a resource. Theo stated, "Reddit, in particular, is incredibly useful for troubleshooting things. And I don't even ask anything, I just search for what other people ask and then find the answer in there." Bill claimed the "I Teach Music Technology" Facebook group

had also been immensely helpful. Rick is part of an online community of producers and developers that he has found beneficial not just for learning, but for generating curricular ideas as well. Interestingly, Ari is the only study participant that does not maintain membership to any social media sites.

Manufacturer as Resource

Several of the study participants found assistance through reaching out directly to manufacturers. Alice stated, “if I’m just looking for a question that’s Soundtrap related, I’m going directly to Soundtrap.” She claimed that she will either email her account manager or utilize the technology chatbot available on their website. Rick utilized a direct approach reaching out to developers to request demos of programs. Theo used manufacturers’ websites and manuals for issues. He shared, “my compressor from Empirical Labs broke last year, so I reached out to the manufacturer. He gave me the specific thing I needed to fix it.”

Website Resources and YouTube

The study participants discussed using simple web searches to quickly find answers to issues that arose. The participants also identified specific sites that have assisted them in troubleshooting and learning about specific technology. Alice uses shedthemusic.net which provides courses and curricula based in music technology. She has also attended professional development offered by the website developer. Bill subscribed to the Mac Pro Video website. He also uses midnightmusic.com, a website created by Katie Argyle, geared toward music technology educators. The site offers

teaching resources and professional development. Rick used edmpod.com which offers one-on-one coaching and courses for music technology educators. Rick was also a particular proponent of Berklee online stating, "...Berklee Online is probably the gold standard for music tech instruction. I've taken a bunch of their courses and it's truly enhanced my knowledge base and what I'm able to do."

Each participant used YouTube for a variety of purposes when attempting to troubleshoot and learn new hardware and software. In speaking about her most used resource, Alice exclaimed, "bottom line: YouTube!" Theo expanded:

I mean, I watch a lot of videos on YouTube. So, if I want to learn something, or if there's something new coming out, I'll watch a tutorial video on it. I just got this mixer and I thought I knew how to use it really well, but they'll show me something I didn't know. But I'll watch a whole tutorial about it, how to use all these different things. So, I learned everything myself, primarily with YouTube.

Rick added that YouTube has served as his primary source of professional development.

Student as Resource

A few study participants highlighted the importance of using their students as a learning resource. Bill claimed, "I have students who come into my program who know so much more than me, and I'm happy to allow them to help me." He also spoke about the ability to learn hardware and software in tandem with students. Rick has used student knowledge about specific software for curricular additions. At the time of his interview, Rick was in the process of installing DaVinci Resolve on the computers upon a student's suggestion. He shared, "I will often learn from the students about the new stuff. If I see them using it for a cool, interesting purpose, then I'm more likely to adopt it." Alice and Theo have been able to utilize students for troubleshooting issues within the classroom.

Theo spoke specifically about how a student assisted him in resolving an issue with a streaming platform on the spot.

Pedagogical Change and Growth

Throughout individual interviews and the focus group discussion, it became clear that each participant consistently reflected on their teaching practice and curricular choices to best suit the needs of their students. Their motivation to learn about new technological tools and how they might utilize each within their teaching contexts helped to shape the courses they are currently teaching. I found several sub-themes within the data including curricular design, technology teaching pedagogy, and ideas for program growth.

Reflecting on Curricular Design and Teaching Practice

Reflecting on teaching practice is an essential part of building the teacher toolbox to best suit the needs of students and learning outcomes. Several participants spoke about their reflection on past practices and how it has shaped their curricular decisions moving forward. Ari stated:

Year three, I'm changing this year because I used to start music theory and keyboard skills for the digital musician in year three, their junior year. I found that this was too late...So, I feel like they need time, they need some years to really get it. So, I'm bringing this over to year one and just breaking it up between years one, two, and three to have a steady thing.

Ari also affirmed that she believed she should not become complacent by continuing to teach the same things as this would not reflect the changes within the industry. Alice also spoke about the struggles of teaching theoretical music knowledge to non-traditional music students:

They're not necessarily readers. Some of them are music readers, but others of them, I'm like, "Hey, these squares, it's a grid. Remember math?" And I'm like, "These are fractions." I can't go into the ta's and ti-ti's world, I'll lose them. So, there's sometimes a learning loss challenge, if you will, when I get juniors and seniors in the course.

Rick has remedied this very issue through the creation of his own materials:

I'm prepping a new music theory course right now. I've got about 30 videos so far and it's just music theory based on a MIDI editor instead of the Western staff. And so, I try to have a very wide breadth.

Both Bill and Theo are also making curricular changes from their reflections. Bill claimed that he was moving away from Pro Tools to Logic Pro this school year based on his students' preferences and the appropriateness for the level he teaches. Likewise, in evaluating new technology for student use, Theo stated, "Dolby Atmos. It's been out for a few years. I am still unclear how to implement that effectively inside the classroom."

Another sub-theme that emerged through discussions pertained to the consistent reflection by participants on their teaching practices. For the participants in this study, demonstration-based teaching and project-based facilitation are used to deliver content. Ari used the demonstration method with her students which she claimed could take up considerable time, but was necessary to assist students with step-by-step skills. Likewise, Alice used a similar process. She shared, "the first term is a lot of teaching the technology." Similarly, Theo expressed:

I find I need to spend a lot of time with kids teaching them how to just use a computer. Like, this is how you open up...this is what a browser is, this is how you type in a URL, you know, those types of things, because the kids are so used to cell phones and tablets that using a computer is a foreign thing to them.

Rick and Bill used a similar system with a short five- to ten-minute tutorial lesson and then time for students to practice the skills addressed. Theo made use of project sheets

when he introduced a new concept. He then uploaded an exemplar into Google Classroom along with giving a full class demonstration.

Creating Resources

It should be noted that each study participant either created or had a hand in the creation of their respective curricula. This fact speaks to the newness of their respective programs. Ari was assisted by her district supervisor, “so, we came up with a syllabus because we had to for the state. And so, the syllabus had a whole bunch of project ideas.” Alice was in charge of creating the middle school music technology curriculum that is still in use within her district. She affirmed that this has set her incoming high school students up for success within her classes by having familiarity with certain concepts and programs. Likewise, Bill rewrote his middle school general music curriculum to be music technology based. Rick not only wrote the curricula for his courses, but for all of the high school music technology courses within his district. Theo was in charge of writing the music technology for his district as well.

For several participants the need for curricular flexibility has been key to successes. Bill stated:

I don't want to say there's not a curriculum, but it's very loose, you know what I mean? And that's the beauty of music technology is the fact that you can meet the students where they are and develop...go from there.

Rick shared similar sentiments, “there's no template. It's the wild west. It's uncharted territory and it's up to each teacher's personal integrity and skill set to make something of it and I like that aspect.” This aspect of curricular flexibility afforded Alice's students more autonomy. Alice allowed students to choose which programs they use to complete

tasks. She stated, “the pathway to your end result is not my concern, really. It’s the end result and the amount of skills that you’re demonstrating.”

Participants also claimed that they had created materials for their courses. Ari, upon first starting out, broke down her projects into the skills needed and created materials from there. Theo comparably stated, “it’s kind of like breaking it down into the simple, simple steps and the exact things that they need to do. I find myself doing a whole lot, making these projects.” Rick, in particular, during his interview shared the importance of tailoring his instruction for his student demographic. He claimed that he had always created his own materials because the one-size-fits-all curricula that he had encountered did not properly serve his student population or utilize the equipment he had available.

Student Opportunities and Growth

At the forefront of each participant’s teaching practice was a focus on their students and how best to continue to create opportunities for their growth. Ari referred certain interested students to take classes held through an online platform. She stated, “it gives them something else other than what we’re doing in class because I have to keep moving.” Alice has entered former students into her state’s Contemporary Creators festival for further opportunities. Bill has taken students to tour music studios and partnered with his local community college which has an audio production program. Likewise, Theo has offered students job shadowing opportunities at a local studio. He was also looking at ways to expand opportunities for students. He shared:

I’m trying to get an internship with Universal Music group started so that the

students can, you know...they have a six-week program that they go in twice a week, into the city and they learn about primarily music business, but they also, there's a component that goes into their studio. So, a variety of things, trying to get more internships started.

As stated in the participant portraits, several of the programs offer job shadowing, school enterprise, apprenticeship learning models, and simulated work experiences to best prepare students for careers in the industry.

Findings Addressing Research Question Two

The following sections pertain to themes and sub-themes related to guiding research question two. Again, I used a narrative exploration of each topic to keep participants' experiences and perceptions at the forefront of the information presented. Research question two: In what ways has self-directed technology learning influenced music technology educators' perceptions of their preparedness and willingness to integrate technology into their teaching practice? Emergent themes included perceptions of confidence, music technology professional development, and current practices and perceptions regarding GenAI.

Perceptions of Confidence

Each participant was explicitly asked about their confidence levels upon first starting in their music technology teaching positions and their perceived levels at the time of our interviews. Several sub-themes emerged within the collected data including confidence from doing, confidence in troubleshooting, and comfort admitting the unknown. Each sub-theme adds to the participants' overall feelings of confidence with technology and their willingness to implement within their teaching practices. As a reminder, each participant started out teaching elsewhere before migrating into music

technology.

Confidence from Doing

Participants spoke to how self-directed learning over time had assisted in their overall confidence with technology. For instance, Rick stated, “when I was newer at this and just starting to teach music technology, I was terrified all the time.” Likewise, Bill shared, “yeah, when I first started, I was terrified. I was completely underprepared.” However, both Rick and Bill shared that they felt much more confident now. Bill claimed, “in the past 12 years I’ve been teaching music technology, it’s just crazy how much knowledge and stuff I’ve picked up just by doing it.” Contrastingly, Theo shared that initially he had some levels of comfort with certain software:

I mean, I’ve always been comfortable with the compositional part of the DAW software. You know, like connecting the keyboard and writing music and everything, but over the years since I’ve started the program, I’ve learned a lot of engineering-type stuff, mixing-type stuff, and mastering.

Alice shared that through teaching, she is more confident to branch out and talk more about topics she initially was nervous about in her first semester. Ari claimed that she still finds the number of opportunities for new technology somewhat overwhelming. Alice also shared that sometimes she will stick with a particular technology because she is familiar with it. Sharing similar sentiments, Ari stated, “I’ve come a very long way. I will say that. And I’m very confident with what I’ve done in the past.”

Comfort Admitting the Unknown

Of equal importance to participants was the ability to be comfortable with the unknown aspects of technology. Bill shared that despite his ten years teaching music

technology, he still considered himself a novice because of the sheer mass of technology now available. He elaborated, “so, you know, I don’t know if I’m ever comfortable with what I’m learning, and rightly so.” He also shared that he has made plenty of mistakes. Several participants expressed that due to their personalities, they were more apt to dive in and ask questions later. Alice said, “I’ve always been a jump right in the pool kind of person and then cry later.” She also expressed that because of her ability to be comfortable with the unknown, her students adopt similar practices. She expanded:

I use my own, pardon the term, but I use my ignorance as a strength because it’s teaching them to persevere through finding answers to a question and you’re not always going to have an instant answer.

Similarly, Rick explained, “so, I’m sort of a feet first, diving in kind of guy. I don’t mind taking risks.”

Participants have also found that learning from and with students has been an asset in their overall comfort. Alice expressed comfort in admitting when she does not have the answer to a student’s question, seeing it as an opportunity to show humanity. Bill emphasized the importance of humility, acknowledging that students may sometimes know more about technology than the educator. He further explained:

Barb Freedman¹ had this quote and I heard it when I went to see her and, you know, I think I still go by it every day. It’s like, “Teach music, technology will follow.” And that’s the thing, I have to humble myself to know that I’m not going to know everything there is about every single program as much as I want to, you know?

¹ Barbara Freedman is a music technology and audio engineering educator, author, and professional development presenter. For more information see <https://musicedtech.com/about/barbara/>

Both participants highlighted the value of humility and mutual learning in fostering an environment where they feel comfortable and confident to try new approaches.

Confidence in Troubleshooting

One of the essential skills highlighted by the educators was technology troubleshooting, a topic they were specifically asked about during their interviews. Rick expressed confidence in his troubleshooting abilities stating, “there is very little I can’t troubleshoot and I’m very comfortable with that” adding that with experience, he felt freer to experiment when encountering unknown technology issues with students. Ari acknowledged the frequent challenges technology can present, describing it as “the most stressful moment” but explained that she learned to troubleshoot by persevering through the process, making phone calls, and documenting steps along the way. Alice emphasized a more hands-on approach, often checking for updates or refreshing systems and noted that students’ tech-savviness is an asset. In contrast, Bill shared his initial discomfort with troubleshooting, recalling that when he first started it was a lengthy process. These varied experiences illustrate the different ways these educators approached and adapted to the ongoing challenges of the complex technologies they utilized within their classrooms.

Music Technology Professional Development

The participants’ perceptions of the formal professional development workshops they had encountered was critical in shaping an understanding of how the educators continued to develop their pedagogy. As the field of music technology evolved, the educators faced the dual challenge of keeping up with rapidly advancing tools and methods while also nurturing their own pedagogical expertise. While each participant

expressed the importance of formal professional development, they noted the availability and effectiveness of such offerings greatly varied. This influenced the participants' necessity for self-directed technology learning. Understanding these perceptions helped to identify gaps in support and how the educators adapted to fit their growing professional needs.

Perceptions of Formal Music Technology Professional Development Offerings

Professional development (PD) opportunities in music technology were often described as inadequate by the study participants. During the focus group discussion, Rick highlighted the challenge of finding quality PD and noted that much of his PD was self-directed. Similarly, Theo shared frustration with the lack of beneficial PD and remarked, "there is not a lot of really good PD specifically for music tech." Ari shared that from her experiences, music technology PD had been entirely too broad. She stated, "it can cover live audio. I can cover engineering. We need so many different subtopics under the umbrella of music technology." Despite this, Ari claimed that the most beneficial PD she had experienced came directly from representatives from music software companies. Contrastingly, Theo found that PD offered at his state conferences had been too narrow, focusing on only one program or concept.

Ari also emphasized the need for effective pedagogues who can translate complex concepts into accessible lessons. Likewise, Theo shared, "there isn't a standard way to teach this..." While some PD experiences like the Pro Tools instructor certification had been useful to Bill and Theo, many other opportunities fell short. Theo criticized his state music educator annual convention and called the music technology sessions,

“...unspectacular and lame.” Similarly, Rick pointed to a significant “unfulfilled need for professional development for music and theater teachers surrounding technology.” He elaborated further by claiming most teachers in these roles do not possess the knowledge of how to simply set up and run a sound system for their performances. The overwhelming sentiment was that PD in music technology was underdeveloped, with few resources.

Professional Development Funding

Some of the participants turned to self-funded or independent professional development to enhance their skills. Rick shared that he, personally, funded his PD through Berklee Online. He had taken 18 courses and found them “incredibly rigorous and well-designed.” However, Rick claimed he had spent roughly \$18,000.00 for his Berklee Online training. Alice also funded her PD independently and highlighted the value of courses offered through sources like Bob Habersat². Likewise, Rick self-funded his subscription to the Mac Pro Video website which he found beneficial for his independent PD needs. Theo’s program began with the Save the Music grant and he was offered PD as part of that package. However, he noted that his experience afforded him access to PD that most other educators did not possess. Despite these self-funded efforts, time constraints made it difficult for participants to engage in formal PD. Alice mentioned the difficulty of attending weekend PD as she often had conflicting commitments. Ari echoed this sentiment and stated that weekend workshops often

² For more information on Bob Habersat’s resources, see <https://www.shedthemusic.net>

conflicted with her schedule as a professional musician. Both Ari and Alice expressed that the lack of time often meant that PD opportunities during the school day were also difficult to attend. Overall, participants commonly funded their own PD and they faced significant barriers related to time, accessibility, and the need for specialized resources.

Delivering Professional Development

Because of the perceived issues and concerns with PD offerings they had encountered, several of the participants in this study took to delivering PD and becoming a resource to others. Rick is a member of Technology Instruction in Music Education (TI:ME), an organization dedicated to delivering professional development to music technology educators. He has delivered PD opportunities at state conferences through his membership. In bartering for her district to fund her PD opportunities, Alice shared, “I’ll come back to the district and teach it for you...I will bring back my knowledge.” Alice also explained that she felt, as the high school teacher who wrote the curriculum, a sense of responsibility to assist her colleagues at the lower secondary level within the district. In terms of district PD relevancy, Alice claimed she delivered PD because otherwise her department would, “...sit and talk about curriculum development and things that don’t necessarily relate to us.”

Several participants spoke of the relatively small community of current music technology educators and how this somewhat forced them to become a resource, whether in district or to the larger community. Theo said of the niche community, “...there’s not a lot of music educators that know about music technology. Most music educators are classically trained or jazz trained. They don’t know anything about any technology.” Ari

shared of her district colleagues, "...because you teach a technology class, even though it's music technology, they think you're the tech guru." Rick expressed similar sentiments in that he believed most colleagues would consider him an expert and that he usually took on the role of problem solver for others. Because of the relatively small community, Alice stated, "...we all keep showing up to each other's workshops." It should be noted that through the focus group, the participants were extremely willing to share resources with one another. For instance, Rick gave the other participants access to an entire unlisted YouTube channel with self-created videos addressing how to teach music theory for non-traditional music students. It is evident that the educators in this study were passionate about continued learning and sharing their resources with others.

GenAI Integration: Current Perceptions and Practices

In this section, I explore the multifaceted ways the educators in this study are engaging with emerging AI technologies in their teaching practice. Through the findings, I report a spectrum of experiences that range from creative integration and planning support to ethical skepticism and concerns about overreliance. The educators expressed their perceptions on the changing landscape where AI was viewed as both a tool for innovation and a source of critical debate. Their feelings were shaped by their individual values, teaching contexts, and comfort levels with the emerging technology. While there is crossover between the themes and sub-themes addressed by the initial research findings, this supplemental section adds important perspectives about a new and increasingly present tool within the field of music education.

GenAI as a Planning and Efficiency Tool

AI has several functions within education including use for creative ideas in lesson planning and assistance with clerical teaching tasks such as creating handouts and even graphics. Several participants in the study expressed that they used AI primarily for behind-the-scenes tasks such as generating rubrics, lesson planning, and assessment creation, rather than for direct instruction. For instance, Ari has used AI to generate grading rubrics for students. She expressed:

This has been really helpful because I find rubric creation time-consuming and challenging, particularly when it comes to articulating performance levels with clarity precisions in a way that students understand. AI has helped me overcome that barrier by providing well-structured language and criteria that I can then adapt to fit my specific goals.

Theo used a similar approach, using AI for test and quiz creation which is a process he deemed tedious. Bill used AI as a creative assistant, finding inspiration from the outputs for lesson planning and differentiating for students with varying experience levels.

Cautious Optimism Toward GenAI in Music Education

GenAI's inclusion in educational contexts has become a topic of debate among educators, ranging in feelings from optimism to reluctance. Several participants expressed a cautious optimism toward the use of GenAI in their music technologies classrooms. Ari, Bill, and Alice expressed an openness to AI as a helpful tool, but remained aware of its limitations and risks. Alice described AI as a viable tool, seeing it as an engaging and inspirational way for student creativity, but admitted to not be able to keep up with all the new AI tools due to rapid evolution. Ari also noted the value of AI in supporting students' creativity, but expressed hesitation in students losing touch with

foundational music creation skills. Similarly, Bill shared, “AI is a powerful tool, when used appropriately.” However, Bill also worried about new teachers entering the field might become too reliant on AI, which would cause them to miss out on learning through experience.

AI Used to Support Creativity

GenAI can be used as a creative assistant, often as a catalyst to drive innovative ideas. Participants used AI in creative ways to spark their own creativity, as well as student creativity. For example, Bill used an GenAI voice creation application to assist in the creation of a narrated scene in a musical. He found that he could not quite get the sound of his own voice to fit what was needed, so he used AI to circumvent the issue. Bill’s musical team enjoyed the voice so much, they even utilized the same application and voice to create the opening welcome message to be played prior to each performance.

At the time of the follow up interviews, only Alice had programed AI for student use. Alice described a song-writing project in which she had students use Suno.ai to generate lyrics. Students used Suno.ai as a creative partner and then were instructed to edit the lyrics to their liking and create a song using the lyrics as inspiration. This approach positioned GenAI not as a replacement for student creativity, but as a springboard for expression, allowing students to personalize the output.

Ethical Concerns and Criticism of GenAI in Education

There is notable skepticism among participants as they navigated the challenges GenAI presented within their classrooms. Participants shared concerns regarding student

privacy, ethical implications, and overreliance on GenAI in music education. Rick was strongly critical of GenAI. He had suspicions regarding where the information from personal input was going. Rick stated:

If I wanted to use it [GenAI] for teacher tasks we would have to integrate our student information system, which would be a direct violation of privacy because then we're feeding all this personal demographic and student data into these AI models, and we really have no idea where the information is going.

Rick also strongly questioned the motives behind universities' rapid adoption of GenAI. He mused that this heavy adoption by universities might be in relation to big tech companies supplying money to higher education institutions and, in turn, profiting from university students and using the applications.

Ari had concerns regarding an overreliance on GenAI in her teaching practice. She shared, "I'm cautious about allowing it [GenAI] to replace my own critical thinking or creativity." While Bill did not explicitly state he worried about overuse in his own practice, he did, however, worry about the next generation of educators using GenAI to bypass experiential learning. Both participants emphasized the importance of maintaining a balance between GenAI assistance and human-centered teaching practices.

Limited or Skeptical Adoption

Due to the relative newness of GenAI technologies, participants have taken different stances on their use of GenAI in their teaching practices. Some participants were either skeptical of the capabilities of GenAI or used it only minimally and not yet with students. Rick described GenAI as over-hyped and over-sold. He shared that he had experimented with it to assist in building content for his course on Canvas, but ultimately

found the outputs underwhelming and not significantly more efficient than traditional methods. His experience reflects the broader hesitation among the educators who are also still evaluating whether GenAI offers meaningful value to instructional practices. Theo used GenAI strictly for generating tests and quizzes and noted, “I’m stuck in my ways to some extent!” This points to a sense of comfort with his established practices. Theo and Alice both claimed they had not yet explored the full potential of GenAI, indicating that their limited use was not necessarily a rejection of the new technology, but rather a reflection of time constraints and competing priorities. For the educators in this study, GenAI remained a tool in the periphery.

GenAI as Support for Accessibility

One of the benefits expressed by the participants regarding GenAI usage was the ability for differentiation and accessibility. The participants saw GenAI as a way to better meet diverse student needs by providing tailored support or differentiated resources. Several participants made use of project sheets in their instruction, breaking tasks down into smaller digestible pieces for students to follow. Ari had begun using GenAI to assist with generating these project sheets and shared that GenAI made the tedious task of differentiating the written instructions for differing levels of understanding a much simpler task. Similarly, Bill had used GenAI to plan lessons that differentiate how material is presented for students who may not know a lot about traditional Western music theory and those with more experience. Both educators were using GenAI to support independent student learning and tailored lesson content specifically for their students’ needs. These examples reflect how the participants are beginning to integrate

GenAI as a practical tool for enhancing differentiation, making instructional materials more accessible, and supporting a wider range of learners with greater ease.

Learning Through Informal or District Provided Methods

Participants approached learning about GenAI tools in much the same way they had previously engaged with music technologies. Participants reported using hands-on exploration and a gradual integration into their teaching practices. The participants had not had formal training in GenAI and much of what they had learned thus far was through self-directed learning. Alice shared, “as far as going about learning new AI tools, I tend to let the kids experiment.” In Alice’s district, she has access to a program called MagicSchool AI in which students and teachers can use the platform for administrative and personalized learning experiences with an emphasis on built-in safeguards and privacy measures for monitoring student activity. Bill expressed that his approach to learning about GenAI tools has been simple web searches. Theo stated he had learned more about GenAI tools through district provided professional development; however, Theo also shared that he did not explore GenAI tools independently. Interestingly, this was a different approach than what participants had expressed in regard to the music technology professional development they had encountered. This contrast suggests that while participants were generally self-motivated in exploring music technologies, their engagement with GenAI tools was more varied, influenced by access, support, and individual comfort levels with the emerging technology.

Similarities in Initial Study Findings

There were several areas of cross-over between the initial findings from the individual interviews and focus group to the follow up questions regarding GenAI. Similar to the initial findings on self-directed technology learning, most participants learned about GenAI through hands-on exploration and simple Internet searches. This shows a consistent learning approach across music technology and GenAI tools and reinforces informal learning preferences across both contexts. Regarding pedagogical change and growth, the initial study findings highlighted the participants adapting their teaching practices through self-directed means of learning. The participants built their knowledge base which in turn affected their adoption and use of music technology with students. Likewise, one participant used GenAI to support new pedagogical approaches, while others were considering the ways in which to utilize GenAI in future practice. This emphasizes that both learning about music technology and GenAI contributed to the educators' ongoing pedagogical evolution.

As well, in the initial findings, educators expressed that they had created their own resources when they perceived a deficit or a need. The participants shared that they had used GenAI to assist in the creation of rubrics, tests, quizzes, lesson plans, and project sheets. GenAI was used as yet another tool in the creation of resources; however, it was appreciated for increased speed for tedious tasks. The participants initially spoke about the ability for music technology courses to engage non-traditional music students, making music creation more accessible. Likewise, the participants claimed that GenAI had assisted in the creation of differentiated content and student-tailored learning

materials. Finally, participants discussed their perceptions on formal music technology professional development, claiming the options to be limited, inconsistent, and too broad to effect pedagogical change. While Theo expressed he had received district PD on GenAI, most participants still opted for a more informal approach to explore GenAI.

Differences in Initial Study Findings

In this section I focus on the differences in the findings from the follow up questions regarding GenAI adoption and the initial findings from the individual interviews and focus group discussion. The first difference stems from Theo's experience with GenAI professional development offered within his district. From the initial findings, participants favored a more informal approach, stating that music technology pedagogy often was too broad, or lacked relevance to the participants' specific teaching contexts. Theo, however, shared that he had been solely learning about GenAI tools through district offered professional development sessions. This could reflect a possible shift in institutional focus toward supporting emerging GenAI tools for educational usage. Another difference was found in the ways in which the educators were engaging with GenAI tools versus music technology tools. Participants expressed using GenAI for repetitive or administrative tasks, whereas this topic was not emphasized in the initial findings where resources were self-created by the participants using other means.

The educators had either opted for limited student use of GenAI tools or none at all. This was in contrast to the heavy music technology adoption for student use in their courses suggesting a slower integration possibly due to the newness of GenAI tools, uncertainty, ethical hesitation, and lack of clarity in how to implement the technology in

their teaching practices. The educators also shared that their engagement with GenAI varied based on comfort levels and individual perceptions about the tools. As well, there was an increased skepticism of GenAI tools due to ethical concerns. The educators expressed a stronger caution around privacy, loss of critical thinking, loss of creativity, and ethical implications surrounding GenAI usage with students. This is a departure from the initial findings where skepticism was not a central tenet of discussions. These differences reflect a shift in participants' perceptions of formal GenAI PD, practical use for efficiency, slower student integration, and greater ethical concerns compared to earlier, more informal and student-centered music technology adoption. In the next chapter I will discuss these findings in relation to the existing literature and propose implications for future research studies within the field.

Summary

In the first section of this chapter, I summarized the career journeys, backgrounds, and music technology program offerings of each participant. The purpose of this section was to establish background information and teaching contexts including participant undergraduate and graduate music technology experiences, district and student demographics, courses offered within each program of study, hardware and software available to the students, and program funding. These portraits enable the reader to have a more informed foundation for the themes and sub-themes presented from participant perspectives in the rest of the chapter sections.

In the second section, I addressed all data pertaining to research question one as told through a narrative exploration of each topic and sub-topic. Analysis revealed that

self-directed technology learning was reflected in the sub-themes of self-reliance, trial and error learning, broad range of knowledge, and the changing technology landscape. These themes were further expanded upon through specific discussion of the participants' use of resources including colleagues, networking, social media, websites, YouTube, and even their own students. I then addressed the pedagogical change and growth each participant expressed through their discussions of curricular design and teaching practices, the creation of resources, opportunities for their students', and program growth.

In the third section, I addressed research question two. Again, I utilized a narrative exploration of each topic and sub-topic in order to keep participants' perspectives at the forefront of the data presentation. I discussed themes pertaining to participants perceptions related to confidence from doing, comfort admitting the unknown, and confidence in troubleshooting technology issues. Additionally, I addressed themes relating to professional development via the lenses of formal professional development offerings, self-funded and independent professional development, and delivering professional development.

In the final section of this chapter, I discussed the findings from the follow up questions with participants regarding GenAI perceptions. The participants expressed similarities in their approaches to learning about GenAI tools through informal means like Internet searches; however, notable differences from the initial interview and discussion group findings suggested a slower integration of GenAI tools with regard to student use, possibly due to the newness of these technologies and the participants' skepticism and ethical concerns.

In the next chapter, I expand upon themes presented with a more in-depth analysis addressing the existing literature. Below, I summarize the study findings and provide conclusions supported by the data. I further expound upon a discussion of the data presented, the implications for the field of music education, and suggestions for future research.

CHAPTER FIVE: DISCUSSION

Restatement of Purpose and Research Questions

The purpose of this collective-case study was to examine how five music technology educators engaged in self-directed learning, focusing on their perceptions of professional development and their confidence in integrating technology into their teaching. This study was guided by two central research questions, both of which I designed to explore the role of self-directed technology learning in professional growth and instructional practices among music technology educators. These questions remained the focal point throughout the study and informed the design, data collection, and analysis processes. First, I sought to examine the ways in which self-directed technology learning contributed to the development of TPACK among high school music technology educators. With this question, I aimed to uncover whether and how the educators' independent exploration of technology informed their integration of pedagogical strategies, technological tools, and subject context in meaningful and effective ways. Second, I sought to investigate how self-directed technology learning influenced the participants' perceptions of their own preparedness and willingness to incorporate new technologies into their teaching. Throughout the line of inquiry, I aimed to better understand how informal learning experiences shaped confidence levels and openness to innovation within the classroom environment. Together, these questions offered guidance through which I was able to examine the nuanced and personal journeys educators take when adapting to the evolving demands of music technology education.

In this chapter, I present a discussion of the key findings of the study, which focused on participants' self-directed technology learning habits, TPACK development, comfort and confidence levels with technology, perceptions of music technology professional development offerings, and their perceptions and engagement with GenAI. Through the findings, I offer insights into how the individual participants engaged with resources and professional development within their teaching context and how these factors influenced their pedagogical growth. I use the discussion to interpret the findings in relation to existing literature and theories, providing suggestions for professional development and resources. Finally, I provide a synthesis of key insights, along with an examination of the study limitations and recommendations for future research and practice in supporting music educators' technological growth and development.

Interpretation of Findings

I interpret the findings of this current study in relation to the existing literature across several key areas, beginning with the role of self-directed technology learning. Previous researchers have highlighted the value of informal, self-directed learning in fostering teacher agency and adaptability in technology integration (Bauer, 2013; Lieberman & Pointer Mace, 2010; Macià & García, 2016; Pellegrino et al., 2014). Through the current study, I build on these points by examining how much technology educators used self-directed learning as a pathway to develop their instructional practices. I consider these findings alongside studies that emphasize experiential learning and reflective practice as essential components of professional growth in technology-rich teaching environments (Bauer et al., 2003; Tseng & Kuo, 2014).

Additionally, I situate the findings within the growing body of literature on music technology professional development by reinforcing the need for context-specific, flexible learning opportunities (Bauer, 2007; Bauer, 2010; Bond, 2015). Whereas many professional development models remain generic or technology-centered without addressing pedagogy (McCusker, 2017), these findings support prior claims that educators benefit from training that is customizable and allows space for educator reflection (Bauer, 2010; Latham, 2020; Leong, 2016). I also present themes of comfort and confidence in relation to existing literature on teacher self-efficacy (Doherty, 2021; Gudek, 2019; Joo et al., 2018) and, more particularly, how this affected the participants' willingness to adopt new tools and strategies in the classroom.

I then connect the findings regarding TPACK development to existing frameworks (Bauer, 2013; Koehler & Mishra, 2005; Macrides & Angeli, 2018a; 2018b) that underscore the complex, iterative nature of building technological, pedagogical, and content knowledge. In doing so, I highlight how self-directed learning and reflective professional development experiences contribute to more holistic and sustained TPACK growth among music technology educators. Finally, I discuss the findings related to the follow up interview questions regarding participants' perceptions and engagement with GenAI tools. I situate these findings not only in similarity and difference from the initial study findings, but also within the existing literature. This chapter concludes with implications for the field of music education and future research, as well as the limitations of this study.

Self-Directed Technology Learning

The five study participants shared similarities in their approaches to expanding their technological knowledge and skills. It became evident through individual interviews that each participant possessed a motivation to continuously build their knowledge repertoire of the technological tools available. Bauer (2020) claimed, “the constantly changing nature of technology results in this being a challenging dimension, making an individual’s disposition to continue to learn and adjust to new technologies important” (p. 11). The educators in this study expressed a desire to continuously grow their knowledge of technology, emphasizing the importance of avoiding complacency and maintaining a mindset open to ongoing learning. Rick shared, “I continue to learn stuff constantly and that’s kind of in my nature.” Likewise, Ari stated, “I would be a horrible, horrible teacher if I just stayed in the stone age because this landscape changes so much.” Participants expressed that self-directed technology learning was used most often to build their technological knowledge. Rick and Theo shared similar experiences to one another claiming that they were both adept at using a DAW for compositional means, but had to teach themselves the audio engineering and mixing side of music technology. This was echoed in Bauer’s (2013) findings that his participants’ largest means of building the technological domains of TPACK was through self-directed learning. This aligns with Diel (2021) and Doherty (2021), who observed that music teachers often develop technological expertise through independent, experiential learning outside of formal professional development.

Participants conveyed that tracking the continual changes within the industry

generally guided their self-directed learning pursuits. Ari stated, “I feel like I wanted to get as authentic as possible, as real as it gets, see what they’re doing in the real industry.” This was echoed in Ezell’s (2017) findings that teachers who engage in self-directed, technology-enhanced professional development are more likely to apply new strategies and remain responsive to changing educational technologies.

Participants in this study also expressed that continual changes and advances in the technological landscape could sometimes cause them to feel overwhelmed. Rick stated, “I am a tech-oriented person, I suppose, but this is a different level” as opposed to general music or ensemble uses of technology. Similarly, Alice expressed, “I will say, I found it, and I still find the amount of opportunities overwhelming,” regarding navigating technological tools available. Bill voiced similar opinions in that despite teaching music technology for ten years, he still considered himself a novice in the field. The overwhelming nature of the changing technology landscape has been echoed by participants in bell et al. (2019) who claimed a skillset in technology was necessary to their future teaching careers, yet it was seldom covered in their undergraduate experiences. House (2025) similarly noted that adjunct faculty with limited institutional training often relied on self-directed learning to adapt to rapidly changing technological contexts. Despite this, several of the current study participants also shared their strategies to combat these feelings, including researching products to determine their usefulness and adaptability to their specific teaching contexts.

Bauer (2013) asserted that teachers need to take several components, including cost constraints, into account in determining whether certain technologies are beneficial

for classroom use. Each participant named budgetary constraints as a means of narrowing their self-directed learning pursuits. Several researchers have found budgetary constraints to be a significant factor influencing teacher technology usage (Brudvik & Hebert, 2020; Dorfman, 2008; Powell, 2019). These district budgetary and approval limitations have also forced participants to find free online programs and work arounds, which also fueled their self-directing learning focuses. Theo shared that he needed to rely on the district IT department to simply install software, while Alice expressed that part of the reason she used Soundtrap was because of the contract the district held with the company. These limiting factors helped to narrow the educators' self-directed learning to include mastering tools available. Regarding budgetary approval, Rick spoke to his encounters of having to educate administrators on the costs of particular technological equipment and why certain equipment was essential to the success of the program.

The educators in this study reported using a wide array of resources to support their self-directed learning efforts in learning and integrating music technology. These included colleagues, professional networks, social media, web-based resources, technology manufacturers, YouTube, and their students. For example, Ari shared, "I think my experience has been...it's not scripted. It's kind of like, 'What do I need right now?' 'I need to learn how to do this.' 'Who can help me with this?'" As well, Bill expressed, "I learned a lot of this stuff right along with my students." The participants' collective approach reflected a strong can-do attitude and a shared willingness to learn through doing, even when faced with unfamiliar tools and concepts. Common themes of self-reliance, trial and error learning, and the cultivation of a broad technology

knowledge base emerged across participant narratives. This aligns with Bauer's (2020) assertion that music educators must remain open to new ideas and be willing to invest the necessary time and energy into mastering novel pedagogical and technological methods in order to continually refine their TPACK. Similarly, Diel (2021) found that music educators often possess interpersonal traits such as motivation, resilience, and passion for both their craft and their students. Likewise, Lan (2022) and Tzeng et al. (2022) highlighted that motivation, grit, and self-efficacy sustain teachers' long-term commitment to self-directed professional growth. These traits were clearly demonstrated by the participants in the present study. For instance, Rick and Alice expressed that they enjoyed learning new technology along with their students. Similarly, Ari stated, "...I have to implement new things. I have to try new programs. I have to think of better ways, different ways to teach the specific skills using different types of things."

In addition to motivation and collaboration, online communities of practice and participatory platforms played a crucial role in the participants' learning journeys. Multiple participants described using YouTube as a space for self-directed learning, echoed in Cayari's (2015) and Waldron's (2016) work, wherein the researchers describe YouTube as a participatory culture where educators can access user-generated content, share their work, and receive feedback. Several participants also referenced their involvement in broader online communities like Facebook and Reddit, aligning with Bernard et al. (2019), who noted the value of such spaces for accessing resources, planning support, and professional development. Tseng and Kuo (2014) further supported this idea, having found that online communities can strengthen both relationships and

pedagogical expertise. In Diel's (2021) study, participants actively sought out webinars, conferences, and self-paced learning opportunities which parallels the self-directed, resource-rich learning environments described by the participants in this study. Based on the findings, it appears that music technology educators not only rely on a wide network of informal learning resources, but also thrive through active participation in reflective learning communities which, in turn, shapes their teaching pedagogy and technological knowledge base.

Music Technology Professional Development

All participants in this study pursued professional development opportunities in an effort to expand their technological knowledge and better support their teaching practices. These opportunities included attendance at respective state conferences, conferences hosted by professional organizations, district-level training sessions, and online continuing education courses. However, participants also cited several challenges, including the need to self-fund many of these experiences and the difficulty in finding time to attend due to teaching schedules, district limitations, and personal obligations. These barriers highlight a systemic issue within music education: the availability and accessibility of meaningful professional development tailored specifically to music technology instruction. These findings also point to concerns about the broader structural and ideological dynamics in music technology education. While increasing the availability of professional development is important, access alone is insufficient if educators lack the financial resources or institutional support to participate. This suggests a potential funding gap and reflects a deeper trend in education that emphasizes

individual educator responsibility, self-reliance, and professional self-investment.

Many participants described the professional development content as either too general to be applicable, or too narrow to address the pedagogical demands of integrating music technology into teaching. In response, several participants created and led their own training sessions, either within district or at out-of-district conferences, demonstrating both leadership and a critical need for more targeted teacher-informed professional development. Rick expressed a desire to pitch a music technology skills course for in-service music and theater teachers at his local university to assist with the gap in relevant professional development offerings for that demographic. This aligns with the findings of Conway (2008), who noted that mid-career and veteran music educators often contribute to the professional development landscape by sharing their expertise through presentations and consulting roles.

The literature supports the participants' calls for more effective and relevant professional development. Merrick and Joseph (2022) emphasized the importance of training that integrates pedagogy, curriculum design, and technological tools rather than treating these elements as separate domains. Ari shared, "...it's really hard to find pedagogues...but we need pedagogues that can say, 'this is how you bring this down to a 14-year-old in your ninth-grade class.'" Garrison (2024) echoed this by asserting that professional development must be aligned with educators' needs, offering continuous updates to keep pace with technological advancements. Similarly, Bauer (2010) and Doherty (2021) both found that many music educators must learn new technologies independently due to the lack of structured support within professional development.

McCusker (2017) also reported that K–12 teachers are often left without sufficient job-embedded professional development, pushing them to design and implement technology-rich lessons largely on their own.

Several participants' experiences reflected the need for professional development to be both practical and teacher-centered. Theo expressed, "...the [state] convention is pretty worthless with music tech things. Like, somebody talking about how to use a launch pad for one project in a class doesn't give me anything at all, you know?" Bauer et al. (2003) stressed the importance of ongoing support and reflection in helping educators develop their TPACK. Latham (2020) also found that music educators favor sessions that are differentiated, hands-on, and focused on real classroom application. This was further supported by Leong (2016), who argued:

Teachers need professional development beyond initial teacher education that should include updating them with recent advances in their subject disciplines, development of new teaching approaches, learning outcomes, new circumstances and new educational research, enabling the application of these developments into curricula for more effective student learning and facilitating information exchange and expertise between key stakeholders. Effective professional development needs to be ongoing, include training, practice and feedback, and provide adequate time and follow-up support. (p. 333)

Taken together, the findings from this study support the broader literature in highlighting a clear need for music technology professional development that is flexible, relevant, and deeply connected to the instructional realities faced by today's educators.

Comfort and Confidence

The participants in this study consistently reflected on their evolving confidence and comfort with music technology, often describing a trajectory from initial uncertainty to practical competence. Most entered their roles without formal training in music

technology during their undergraduate programs and did not originally intend to become music technology educators. Bill stated, “it’s been a wild ride for sure. I never envisioned myself doing this and now I wouldn’t do any other thing.” This mirrors Dammers’ (2012) observation that individual teachers are often the driving force behind the creation and development of tech-based music classes, stepping into these roles by necessity or initiative rather than formal assignment. Theo initially pitched the idea to a supervisor, “I said to the director of visual and performing arts, ‘Wouldn’t it be awesome if we had a music technology program? I would love to start this program!’” The participants assumed their roles gradually and developed skills through lived classroom experiences. As they engaged more deeply with music technology, participants expressed that their confidence grew through a process of trial and error, learning by doing, and embracing early failures as part of the journey.

The self-directed learning approach fostered a sensible and resilient mindset among participants. Each reported feeling relatively confident with the tools and technologies used in their daily teaching. The educators also expressed comfort with the tools and technologies used in their daily teaching. The educators also expressed comfort with troubleshooting technical issues, often using online resources such as web searches, YouTube, Reddit, and consulting students or colleagues when problems arose. On troubleshooting, Ari shared, “I usually troubleshoot. Of course, I show my students so they can troubleshoot and then I send them to troubleshoot for me sometimes.” This flexible, on-the-go problem-solving approach reflects the findings in Diel (2021), who noted that educators often become more confident when they allow themselves room for

experimentation and develop adaptive teaching strategies in the face of technological challenges.

The participants' experiences also support research indicating that confidence and comfort with technology are less about formal qualifications and more about exposure, experiences, and self-motivation. Specifically, Rick stated, 'now, I would say that I've developed a confidence where any piece of software, any piece of hardware at all, nothing really intimidates me.' Similarly, Alice expressed, "the bottom line is I've grown in comfort." Holliman (2021) found that increased technology use led to greater comfort levels, independent of a teacher's years of service or degree level. Teachers who trained themselves reported more consistent growth in their comfort with technology. Likewise, Doherty (2021) noted that while many educators initially express concerns about their knowledge of specific technologies, confidence improved over time through hands-on engagement.

Several studies reinforce the idea that teacher self-efficacy and attitude toward technology are pivotal factors in successful integration. Gudek (2019) found a strong correlation between music teachers' computer self-efficacy and their attitudes toward digital tools. Sawyer (2017) reported that perceived skill and usefulness were predictive of a teacher's likelihood to integrate technology effectively. Welch (2013) also emphasized the importance of peer-based support systems, like the Instructional Technology Resource Teacher (ITRT) model, in improving teacher comfort and increasing the probability of using technology for instruction. This suggests that confidence is not innate, but built through experience, reflection, and support, which were

trends strongly echoed by the participants in this study. Music technology educators benefit from a learning culture that values risk-taking, ongoing exploration, and support networks. The participants' narratives illustrate the importance of individual motivation and a passion for students and learning outcomes.

Developing TPACK

Participants in this study demonstrated ongoing development of TPACK through a reflective and practice-based approach. They consistently evaluated technology for its relevance and usefulness in the classroom, adapting their curricula, instruction strategies, and tool selection based on student needs and evolving teaching goals. On evaluating new software, Theo shared:

...I need to have an idea where they can do something that is achievable for them. And it's kind of based on that. Can I use this to teach them something that is related to the curriculum I wrote? Will it eventually get them to further understand Pro Tools?

Rather than using technology for its own sake, participants made informed decisions grounded in pedagogical intent, aligning with Bauer's (2013) assertion that technology should serve as a tool to advance curricular goals, working in tandem with pedagogical and content knowledge.

A recurrent theme across participant narratives was the transition toward more student-centered, project-based learning environments, with teachers taking on the role of facilitator. Ari spoke explicitly about her thought process when first starting in her current role, "this is going to be a project-based situation. Okay. I'm not used to that. Let's see what kind of projects are out there." As the participants became more familiar with specific technologies, whether through self-directed learning or professional

development, they were better equipped to plan rigorous and meaningful instruction. This echoes Diel's (2021) findings where participants developed their TPACK by independently researching technologies, testing them before classroom implementation, and critically evaluating their impact on student learning. Likewise, Dorfman (2015) emphasized that both formal and informal learning experiences contribute to the development of technological skills and conceptual understandings that influence the instructional activities music educators design.

The reflective nature of the participants' practice echoes the professional challenges described by Merrick and Joseph (2022), who noted that keeping pace with technological change requires continual adjustments to pedagogy and knowledge frameworks. Ari shared:

I try to implement something else, something new because as you know, music technology is broad. There's a lot that fits under that umbrella and there's a lot that changes constantly. So, I kind of go by what my students show interest in or what I think they would like.

Adjustments such as these demand time, intentionality, and support. The educators in this study embraced that challenge, using the growing knowledge base to adapt and expand their programs in ways that best served their students. On his students' interests, Bill shared, "the beauty of the class is that I can take the students where they're at, what their interests are, and just lead them in a direction." Odajima (2019) similarly found that meaningful TPACK development is rooted not in technology itself, but in pedagogical understanding and the contextual relevance of professional development. Effective TPACK-based PD led to a shift toward more student-centered practices, a trend clearly visible in the experiences of the current study participants.

Despite these efforts, the development of TPACK in music technology remains undertheorized, in part due to the disconnect between traditional music education and emerging digital tools. As Walzer (2024) explained, the lag in theoretical scholarship around music technology pedagogy may stem from generational gaps among music educators and scholars, with those trained before the digital era lacking firsthand experience with modern tools. Rick mused, “I think that’s the reflection of the youth in the field, right? There’s no way to have done it before. If you’re talking about the engineering side, there was no ‘before’ whatever this is.” This disconnect reinforced the importance of teacher-led innovation, as participants in this study continued to build their technological, pedagogical, and content knowledge in real time, through experimentation, reflection, and active engagement with their professional communities and students.

Perceptions and Engagement with GenAI

The findings from the follow-up questions regarding participants’ perceptions and current practices involving GenAI reveal both alignment and friction between the current literature on GenAI in music education. While the potential of GenAI to support creativity, efficiency, and differentiated learning is reflected in both the literature (Cheng, 2025; Holster, 2024; Wang, 2025) and participant narratives, significant ethical skepticism, varying degrees of integration, and practical challenges remained. Participants expressed a complex scope of perceptions ranging from cautious interest, hesitation, and resistance, which offered a perspective on the pedagogical shift that GenAI integration introduced.

Much like Holster’s (2024) findings, participants in this study emphasized the

value of GenAI in supporting administrative and planning tasks. For several participants, GenAI was framed as a tool for efficiency. Ari, for example, saw value in how GenAI could support differentiated instruction in her courses:

In a subject like music technology, where students come in with varying levels of experience, AI could assist in generating tutorials or step-by-step written instructions that are tailored to different levels of understanding. This kind of support could help students work more independently, reinforce concepts outside of class time, and reduce the barriers that some learners face when engaging with new material or materials that are challenging at first sight.

This sentiment is reflected in ongoing discourse surrounding the capacity of GenAI to personalize learning (Cheng, 2025; Karataş & Aksu Ataç, 2025), especially in domains where students arrive with varied levels of prior experience. Bill expressed similar ideas to Ari sharing:

I use ChatGPT and Claude.ai to help me create some building blocks for different lessons and how to approach them from the perspective of a high school student who may not know a lot about music versus a high school student who has been doing music since fourth grade.

Participants in this study had begun to test out GenAI utility for clerical tasks, but had started to imagine more student-centered approaches to its usage.

Despite moments of creative exploration, the participants shared concerns about ethical use, overdependence, and the erosion of teaching and creative practices. The idea that GenAI might bypass critical thinking emerged repeatedly. Ari articulated this worry:

To be honest, I haven't actively sought out new AI tools yet. Part of that hesitation comes from a concern about becoming overly reliant on them. I worry that if I lean too heavily on AI, I might lose touch with some of the foundational skills I've developed...

This mirrors Cheng's (2025) concerns about creativity erosion through overuse, as well as O'Leary's (2025) warnings that educators may become detached from pedagogy as

they adopt GenAI for productivity. Unlike other music technology tools, participants previously explored through self-directed learning, GenAI tools appeared to evoke more internal questioning among participants surrounding what might be gained or lost pedagogically.

Rick took this ethical critique even further, positioning GenAI as more than just a pedagogical issue, questioning its legitimacy and motivations behind the strong institutional push. He claimed that he was unimpressed with the capabilities of GenAI thus far and stated, “I’m highly disappointed in AI beyond the novelty effect and I’m skeptical.” This aligns closely with bell’s (2025) and Treß’s (2025) warnings about corporate influence and the commercialization of AI in education, suggesting that educators may resist adoption not because of technophobia, but due to uncertainty about transparency in GenAI design. This was also echoed by Holster (2024) who brought attention to the opaque data practices and the ethical burdens placed upon teachers to make sense of the inner workings of GenAI.

Although, some literature points to increasing GenAI experimentation by educators (Celik, 2023; Xu et al., 2025), participants in this study conveyed a hesitant and uneven pattern of adoption. While some expressed curiosity, others had not yet used GenAI with students, citing either time constraints or lack of clarity around how to use the tools meaningfully. Theo, for example, noted that although he had used GenAI for generating assessments, he remained skeptical of its overall value. He shared, “I think it could be helpful when creating tedious things like questions for quizzes and tests, but I think it requires too much proofreading to be useful beyond that.” Similarly, Rick and

Bill had experimented with GenAI tools, but found them underwhelming or not yet ready for integration. Rick reflected his broader ambivalence, noting that while he had not ruled out future use, his hesitation stemmed from both skepticism and responsibility to ensure student privacy. He stated, “I will probably end up having to use AI in some capacity just so that students are aware of it so that they don’t get totally screwed over by an unknown entity.” Meanwhile, Alice articulated a tension between her sense of curiosity and overwhelm. She expressed, “...AI is faster than we are, so it’s almost an unconquerable market.” Her perspective reflects the rapidly evolving nature of GenAI tools, where teachers can feel overwhelmed by the endless possibilities of a changing technological landscape.

Much like the initial findings regarding music technology, participants reported informal and self-directed approaches to learning about GenAI tools. Bill described his process simply, “really, it’s just research. It’s just searching the web.” This echoes Hava and Babayiğit’s (2025) assertion that many educators explore GenAI tools independently, which can lead to both innovation and inconsistency in pedagogic knowledge. In contrast to the perceived irrelevance of formal PD reported in the initial findings, Theo noted that he had learned about GenAI through district-offered training. This suggests a possible institutional shift in PD priorities and a small, but notable divergence among participants.

The experiences of the educators in this study both mirror and complicate the existing literature on GenAI integration. While the educators valued the time-saving and adaptive features of GenAI tools for differentiated instruction, they remained wary of its influence on pedagogy, creativity, and ethics. The participants’ insights support calls for

critical AI literacy (bell, 2025; O’Leary, 2025; Treß, 2025), pedagogy-centered PD (Hava & Babayiğit, 2025; Xu et al., 2025), and greater institutional supports (Cheng, 2025; Karataş & Aksu Ataç, 2025;) to ensure GenAI is adopted thoughtfully and in alignment with pedagogical values.

Implications for Music Education

Through the discussion of findings from this study, I emphasized several needs within music teacher education, namely the modeling of technology as essential to teacher pedagogical practice. The study participants’ use of self-directed technology learning, informal learning opportunities, and social media communities stressed the lacking opportunities and depth of formal professional development. Teachers would benefit from preparation programs and professional development offerings that include flexible, teacher-centered programming in order to assist educators in developing the necessary tools to teach in technology-dense environments. The music educators in this study utilized experimentation, while reflecting on pedagogical successes and failures to develop TPACK. These types of experiences are not only valuable to educators in refining practice, but also set a precedent and model for students in a growing digital landscape to embrace risk-taking and self-directed learning to problem solve.

Increasingly, the educators were also experimenting with GenAI tools, often without structured guidance. This underscores the need for professional development specifically tailored to music education that addressed not just GenAI functionality, but also its ethical, creative, and pedagogical uses. Many of the participants expressed hesitation around over-reliance on such tools and concerns about their ethical opacity,

which highlights the importance of embedding critical AI literacy into music teacher education and professional development. Doing so could empower educators to make thoughtful, informed decisions about how to incorporate GenAI into their teaching practices.

Participants expressed inherent issues associated with one-size-fits-all professional development offerings. Participants repeatedly described how most available professional development lacked contextual and practical applicability. This led the educators to create their own learning pathways with some even leading professional development to fill the void. Educators may benefit from professional development focused on differentiated learning experiences that are customizable, dependent on educator needs. Professional organizations may benefit from prioritizing professional development offerings with ongoing, embedded supports to ensure music educators are capable of using technological tools successfully and are confident in their abilities to adapt tools for student needs. While one participant's district had begun offering training on GenAI, most of the educators relied on self-directed exploration. Institutions may benefit from providing ongoing and clear policy guidance aligned with the pedagogical values specific to the arts to ensure responsible and effective use of these tools.

Finally, the participants' experiences and perceptions emphasized the important role of self-motivation, adaptability, and reflective teacher practice in navigating technological landscapes. The study participants' comfort and confidence were built through classroom experiences, reflection, and a willingness to grow pedagogically. This has significant implications for how music educator programs assess teacher readiness

and support career-long learning. Teacher education programs and professional development initiatives can begin integrating opportunities for self-directed, collaborative technology learning, allowing music educators to build confidence and pedagogical fluency in authentic, supportive contexts. These approaches may also serve as a model for incorporating GenAI thoughtfully, ensuring that use enhances rather than diminishes creative and pedagogical intentions.

Implications for Future Research

Further research evaluating professional development offerings designed for music technology educators would be beneficial in assisting in the development of more effective training models. Research is warranted in assessing the effectiveness of customizable programs tailored for individual teaching contexts and needs, as opposed to the one-size-fits-all models. This research could be helpful in better structuring professional development offerings for music technology educators. There is also a need for research that investigates how time, reflection, and continued access to resources influences the success and sustainability of professional development programs. This information could be useful not only for professional development design, but also in assisting in creating more tailored opportunities for music technology educators. It may be beneficial for researchers to aim to identify best practices for fostering long-term professional growth in the rapidly evolving field of music technology education. Again, this could help to create better professional development opportunities tailored to different educational contexts.

As GenAI becomes more prominent in educational contexts, longitudinal studies

examining the evolving impact on music pedagogy are needed. Such studies could explore whether GenAI adoption follows similar patterns to the adoption of other technologies in music education, or if it introduces new challenges and opportunities unique to AI. Additionally, while this study focused on music technology educators, future research could examine how students perceive GenAI, particularly regarding its influence on creativity, feedback, and autonomy in music-making.

Furthermore, there is a need for research involving larger, more diverse populations of music technology educators to broaden the understanding of teachers' needs within the field. Expanding the participant pool in future studies could help to validate and refine the themes identified in this study, supporting the development of more targeted and effective teacher preparation and professional learning experiences. As well, research examining gender-based differences and the effect on comfort and confidence levels among music technology educators could yield insights into how identity-related factors influence professional development needs. Such findings could inform more inclusive support strategies within ongoing training programs. Likewise, studies on gender-based differences and their impact on overall career sustainability among music technology educators is warranted. This could help inform efforts to foster more equitable and supportive professional learning experiences.

Finally, several study participants questioned the corporate motivations behind GenAI and raised concerns about transparency and data use. Future research could explore how trust, data ethics, and institutional supports shape educators' willingness to adopt GenAI tools. Additionally, longitudinal studies that track music technology

educators from college through their careers are encouraged to evaluate the effectiveness of higher education training programs and how training shapes professional pathways over time. While such research may not directly influence institutional practices, it could contribute valuable understandings into how educators apply their training and help build a foundation for future studies focused on supporting educator growth and retention.

Study Limitations

This study includes several limitations that must be considered when interpreting the findings. First, the participant sample was not randomized. I selected participants via purposeful sampling to gain a more in-depth understanding of each participant. The sample size was limited to only five participants, all of whom were high school music technology educators, which also restricts the scope of the results. I intentionally kept the participant pool relatively small in order to present a more detailed and focused view of each participants' experiences and perceptions. As a result, the findings cannot be generalized to a broader population, particularly since experiences may differ for music technology educators teaching younger grade levels. Likewise, each participant taught at schools with established music technology programs and varying degrees of administrative support.

Additionally, the study participants resided in four states within a relatively close geographical range. This potentially could result in the similar professional development experiences across the group. Other limited factors included the length of the study. The study was conducted within a six-week period during the summer of 2024, with follow up questions in the summer of 2025 to cover the emergence of AI tools in education. This

was done in order to maintain relevancy of the collected data as the technological field is constantly changing (bell et al., 2025). As such, another limitation of this study is the relative newness and rapid evolution of GenAI tools, which may affect the longevity and generalizability of these findings as technologies, capabilities, and educational applications continue to develop. Despite producing significant data, more time and conversations could have yielded different topics and results. The study limitations emphasize a growing need for further research with a more diverse participant pool to better understand the experiences of the broader music technology educator community.

Conclusion

In this study, I examined the influence of self-directed technology learning habits on TPACK development, confidence, and comfort in technology-rich teaching environments for five high school music technology educators. The participants possessed an intrinsic motivation while utilizing self-directed learning, trial and error learning, and reflection to develop technological skills and pedagogy. The participants actively sought resources and adapted to an evolving technological landscape while taking on leadership roles within their classrooms and larger professional development communities.

The findings of this study indicate the value of individualized, context-specific professional development in shaping pedagogy. The participants' confidence, comfort, and skills grew through hands-on learning and student-centered teaching approaches. Formal professional development offerings did not meet the participants' needs which led to self-directed learning pursuits.

Through the findings, I expanded upon the existing literature regarding TPACK development, self-efficacy, and the evolving role of the teacher in technology-dense teaching environments. The music educators in this study demonstrated resiliency and creativity in adapting to the instructional demands within their classrooms. There is a need for professional development and further studies that prioritize the lived experiences and needs of music technology educators. Based on the findings of this study, I emphasized the urgent need to equip educators with the tools, confidence, and pedagogical strategies to lead in technology-dense educational environments.

APPENDIX A

Initial Interview Questions

1. Could you tell me about your journey and background toward becoming a music technology educator?
2. Could you tell me about your exposure to music technology during your undergraduate degree?
3. Could you tell me about the music technology program you currently teach? Who designed the curriculum? How are courses set up? Are there prerequisites?
4. What technology is available for student use in the classroom? How is the lab set up?
5. Could you tell me about your initial levels of confidence and comfortability with technology in your teaching practice? How do your levels of confidence and comfortability compare at present?
6. Could you tell me about your initial levels of confidence and comfortability with troubleshooting technological issues? How do your levels of confidence and comfortability with troubleshooting compare now?
7. Could you tell me about how you personally go about learning new technology? What sources have you used? What have you found most helpful?
8. Could you tell me about the process of implementing new technology into your teaching practice? How do you get approval in your district? How do you introduce the new technology to your students?
9. Is there anything else you would like to share about your music technology, pedagogy, or context knowledge that we have not covered so far?

APPENDIX B

Focus Group Discussion Guiding Questions

1. Could each of you tell me about the music technology professional development you have encountered? What have you found useful and why? Are there any music technology professional development offerings you have found not useful and why?
2. Have you had to fund professional development personally or does your district pay or assist in any way?
3. How long does it usually take each of you to go through the self-teaching process in regard to new technology? How long before you feel comfortable enough to teach it to your students and implement that technology in your teaching practice?

APPENDIX C

Follow up Interview Questions

1. Are you currently using AI in your instruction?
2. If so, in what capacities are you using AI?
3. What are your thoughts regarding AI in terms of using it within your courses?
4. Can you detail your process to learning about new AI tools?

APPENDIX D

Letter of Introduction

Alyssa Campanini
aversagg@bu.edu
[REDACTED]

RE: Participation in a research study

Dear (prospective participant name):

My name is Alyssa Campanini, I am a doctoral student in music education at Boston University, and I am conducting a study regarding music technology educators and their technology self-exploration habits. The purpose of this study is to discover the ways in which music technology educators learn about new technology and then implement them in their teaching practice.

I will be conducting a one hour Zoom interview with each participant separately and then conclude with a one hour Zoom focus group with all participants. Questions will only pertain to the study topics and you will have the freedom to expound on answers in any way you choose. I am looking to get the bulk of the interviews done during the summer as the school year is hectic for everyone, especially educators, and I do not wish to cause further stress with busy schedules once the school year commences.

If you are willing to participate, I will send over a document detailing more about the proposed study/agreement of your participation.

Looking forward to hearing from you!

Alyssa Campanini
DMA Candidate
Boston University

APPENDIX E

Letter of Participation and Consent Form



Protocol Title: TPACK Development through Self-Exploration: Music Technology Educators Perceptions and Experiences
Principal Investigator: Alyssa Campanini
Description of Study Population: Secondary Music Technology Educators
Version Date: July 8, 2024

Re: Informed Consent Form for Research Study

Invitation to Participate

You are being invited to participate in a research study that will be conducted as part of my doctoral studies in Music Education at Boston University. The purpose of my research study is to amplify the voices and illuminate the expressed technology self-exploration habits of those who teach music technology at the secondary level.

Participants who take part in this research study will be in this study for a maximum of 2-3 months. During this time, I will arrange to meet with each participant separately at their convenience as part of the interview process, lasting 45-60 minutes via Zoom. Finally, I will arrange to meet with all participants together for a focus group session, again lasting 45-60 minutes via Zoom. Additionally, participants taking part in this study will receive a transcript of their interview to review for accuracy and/or clarification of statements. Any further correspondence will be conducted through email or phone conversation.

There are no risks involved with taking part in this research study.

Introduction

Please read this form carefully. The purpose of this form is to provide you with important information about taking part in a research study. If you have any questions about the research or any portion of this form, please ask. Taking part in this research study is up to you. If you decide to take part in this research study and accept the conditions outlined, I will ask you to check the relevant boxes and sign page 3 of this form. I will give you a copy of the signed form.

What should I know about a research study?

Participation in research is voluntary, which means that it is something for which you volunteer. It is your choice to participate in the study, or not to participate. If you choose to participate now, you may change your mind and stop participating later. If you decide not to participate, that decision will not result in any penalty or loss of benefits to which you are otherwise entitled.

How long will I take part in this research study?

You will be in this research study for approximately two-three months. During this time, I will arrange to meet with you individually at your convenience via Zoom as part of the interview protocol, lasting 45-60 minutes. During the interview, we will discuss your particular teaching



context, your technology self-exploration habits and your comfortability with utilizing specific technologies in your teaching practice. Participants in the study will also engage in a focus group session with all participants present via Zoom. All interviews will be recorded and transcribed. If you do not wish to be recorded, notes will be taken by hand. Any further correspondence will occur by email or phone.

Loss of Confidentiality

I will protect your privacy by using pseudonyms (fake names) and your information will not be shared with a third party. Your information will be stored in a password-protected computer.

Will I get paid for taking part in this research study?

You will not be paid for taking part in this study.

What will it cost me to take part in this research study?

There are no costs to you for taking part in this research study.

Sincerely,

Alyssa Campanini





CONSENT FORM

I consent to the use of unidentified quotes obtained during the study in the dissemination of this research.

YES **NO**

I agree to participate in the following (check all that apply):

INTERVIEWS **FOCUS GROUP** **EMAIL CORRESPONDENCE** **NEITHER**

I agree to be:

Video-Recorded **Audio-Recorded** **NO Recordings**

Statement of Consent

I have read the information in this consent form and have had the nature of the study explained to me. I have been given the chance to ask questions, my questions have been answered to my satisfaction, and I agree to participate in the study.

SIGNATURE

Name of Study Participant

Signature of Study Participant

Date

I have explained the research to the research participant and answered all their questions. I will give a copy of the signed consent form to the participant.

Name of Person Obtaining Consent

Signature of Person Obtaining Consent

Date

APPENDIX F

IRB Application and Acceptance



Protocol #: IRB USE

RESEARCH WITH HUMAN SUBJECTS DETERMINATION FORM

Instructions: Please complete and submit this form via email to IRB@bu.edu along with any supporting documentation, such as a grant or contract supporting the project, data collection forms and other materials (e.g. assessments, questionnaires) to be used in the project.

Date: 2/21/2024**Project Title:** TPACK Development through Self-Exploration: Music Technology**Educator Perceptions and Experiences****Principal Investigator:** Alyssa Campanini**PI Email:** aversagg@bu.edu**PI Phone #:** [REDACTED]**Department/School:** College of Fine Arts**Project Funding Source:** N/A**Faculty Advisor, if applicable:** Dr. Brian W. Kellum

- 1. Please provide a brief description of the project:** *Please be sure to include how you will be collecting data, how many participants you will enroll, and the location of the research.*

This case study will attempt to understand the perceptions and experiences of current music technology educators involving technology self-exploration and technological, pedagogical and content knowledge (TPACK). A total of 5 participants will be selected from various locations within the continental United States. Data will be collected through individual participant interviews and a single focus group interview with all participants. The interviews and focus group will be conducted via the videoconferencing application Zoom with each session lasting approximately an hour in length.

- 2. The project is a systematic investigation** Yes No

Check if 'Yes'

<input checked="" type="checkbox"/>	The project will attempt to answer research questions (e.g. includes a hypothesis, research methods such as randomization, comparison of techniques/groups)
<input checked="" type="checkbox"/>	The project is methodologically driven (information collected is organized/consistent, guided by data, actual experiences or clinical results)
<input checked="" type="checkbox"/>	Conclusions will be drawn from the results

- 3. The project is designed to contribute to generalizable knowledge** Yes No

Check if 'Yes'

<input type="checkbox"/>	Results will contribute to a theoretical framework of established knowledge
<input type="checkbox"/>	Results are expected to be generalized to a larger population beyond the site of data collection and in some circumstances, the population being studied
<input type="checkbox"/>	Results are intended to be replicated in other settings

- 4. The project involves 'human subjects'** Yes No

Check if 'Yes'

<input checked="" type="checkbox"/>	The subjects of the research are currently alive
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Protocol #: IRB USE

<input checked="" type="checkbox"/>	The information to be collected is about the subjects (e.g. personal information about the individuals, not about products, organizations, systems, etc.)
<input checked="" type="checkbox"/>	Information/biospecimens will be collected by an intervention or interaction with the subjects AND the Investigator will use, study or analyze the info/biospecimens
<input checked="" type="checkbox"/>	The Investigator obtains, uses, studies, analyzes or generates identifiable private information or identifiable biospecimens.

If you have answered 'Yes' to all of the questions in 2, 3 & 4, you likely need IRB review/approval.

Principal Investigator Certification / Signatures

By signing below, you certify that the information contained in this Application is true, complete, and accurate.

Principal Investigator Signature:

Date: February 21, 2024

Faculty Advisor Signature (for student researchers):

Date: March 7, 2023

Submission: This form can be completed, signed, scanned and submitted to the IRB at irb@bu.edu.

IRB USE ONLY:

- Does not meet the definition of 'research' under 45 CFR 46.102(l)
 Does not meet the definition of 'human subjects' under 45 CFR 46.102(e)
 Requires more information to make a determination.
 If yes, describe here: [Click or tap here to enter text.](#)
 Requires IRB Review. Investigator should complete the following IRB Application:
 Exemption Application Expedited and Full Board Review Application

Analyst/Reviewer Signature:

Date of Determination:

3/18/2024

45 CFR 45.102(l)*

(l) *Research* means a systematic investigation, including research development, testing, and evaluation, designed to develop or contribute to generalizable knowledge. Activities that meet this definition constitute research for purposes of this policy, whether or not they are conducted or supported under a program that is considered research for other purposes. For example, some demonstration and service programs may include research activities. For purposes of this part, the following activities are deemed **not** to be research:

- (1) Scholarly and journalistic activities (e.g., oral history, journalism, biography, literary criticism, legal research, and historical scholarship), including the collection and use of information, that focus directly on the specific individuals about whom the information is collected.
- (2) Public health surveillance activities, including the collection and testing of information or biospecimens, conducted, supported, requested, ordered, required, or authorized by a public health authority. Such activities are limited to those necessary to allow a public health authority to identify, monitor, assess, or investigate potential public health signals, onsets of disease outbreaks, or conditions of public health importance (including trends, signals, risk factors, patterns in diseases, or increases in injuries from using consumer products). Such activities include those associated with providing timely situational awareness and priority setting during the course of an event or crisis that threatens public health (including natural or man-made disasters).
- (3) Collection and analysis of information, biospecimens, or records by or for a criminal justice agency for activities authorized by law or court order solely for criminal justice or criminal investigative purposes.
- (4) Authorized operational activities (as determined by each agency) in support of intelligence, homeland security, defense, or other national security missions.

45 CFR 46.102(e)**

(e)(1) *Human subject* means a living individual about whom an investigator (whether professional or student) conducting research:

- (i) Obtains information or biospecimens through intervention or interaction with the individual, and uses, studies, or analyzes the information or biospecimens;
or
- (ii) Obtains, uses, studies, analyzes, or generates identifiable private information or identifiable biospecimens.
- (2) *Intervention* includes both physical procedures by which information or biospecimens are gathered (e.g., venipuncture) and manipulations of the subject or the subject's environment that are performed for research purposes.
- (3) *Interaction* includes communication or interpersonal contact between investigator and subject.
- (4) *Private information* includes information about behavior that occurs in a context in which an individual can reasonably expect that no observation or recording is taking place, and information that has been provided for specific purposes by an individual and that the individual can reasonably expect will not be made public (e.g., a medical record).

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