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Improvise: Research-Creation of a Framework and Software Prototype for Creative Music Learning with Technology

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Improvise: Research-Creation of a Framework and Software Prototype for Creative Music Learning with Technology

ABSTRACT

If music education is to respond to the skills and needs of 21st-century music learners, innovative learning paradigms must be explored. This dissertation reports a research-creation approach for the development of a framework for Creative Music Learning with Technology (CMLT), which emphasizes a process of learning to interact creatively with music. Theoretical analysis of improvisation pedagogy and technology for learning to improvise provide the foundation for creative experimentation. An examination of existing technologies reveals a lack of available tools for cultivating a creative disposition to musicianship. As a result, a prototype application was built for iPad and iPhone based on the principles of the CMLT framework. The software is at once a tool for developing musical understanding and for exploring creative freedom in music. A two-phased study of middle school instrumentalists and expert teachers examined the effectiveness of the prototype. In the first phase, seven expert music teachers and eight middle school instrumental students participated in user testing, revealing that the prototype effectively engaged users in learning many key objectives of improvisation pedagogy. In the second phase, six middle school students reported increased confidence after using the prototype for four weeks. Results suggest there is a strong potential for the framework for CMLT to positively enhance creative music learning.

Improviser : Recherche-création d'un cadre d'applications et d'un prototype logiciel pour l'apprentissage de la musique créative avec la technologie

RESUME

Des paradigmes d'apprentissages novateurs se doivent d'être explorés afin que l'éducation musicale réponde aux aptitudes et aux exigences de l'apprenant au 21e siècle. Cette dissertation décrit une approche en recherche-création pour le développement d'un cadre d'applications pour le logiciel Apprentissage de la Musique Créative avec la Technologie (AMCT), qui met l'accent sur un processus d'apprentissage pour interagir de manière créative avec la musique. Une analyse théorique de l'improvisation dans l'enseignement ainsi que de la technologie pour apprendre à improviser fournissent une base pour l'expérimentation créative. Un examen des technologies existantes révèle un manque d'outils disponibles favorisant l'exploration de la musicalité de façon créative. Par conséquent, un prototype d'application a été créé pour iPad et iPhone incorporant les fonctionnalités du cadre d'applications pour l'AMCT. Le logiciel est à la fois un outil qui permet de développer la compréhension musicale et d'explorer une liberté créative en musique. L'efficacité du logiciel a été testée à l'aide d'une étude réalisée en deux phases sur des élève-instrumentistes au collège et sur des enseignants expérimentés. Lors de la première phase, sept enseignants de musique et huit élève-instrumentistes ont participé au test utilisateur. Il a été constaté que le prototype incitait favorablement les utilisateurs à apprendre de nombreux objectifs clés liés à l'enseignement de l'improvisation. Dans la seconde phase, six élèves de niveau collégial ont rapporté une confiance en eux plus élevée après avoir utilisé le prototype pendant quatre semaines. Les résultats démontrent le potentiel du cadre d'applications pour l'AMCT afin d'améliorer positivement l'apprentissage de la musique créative.

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DEDICATION

This work is dedicated to Pauline Oliveros (1932-2016), the pioneer of deep listening, and the many beautiful souls that departed this earth in 2016.

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CHAPTER 1: INTRODUCTION

The 21st-century music learner is unlike any before her. At her disposal there exists a plethora of instruments and tools for creating, remixing, and sharing her music. She has the ability to hear most any song or sound in existence, at any time, at the tip of her fingers. She listens to music constantly in tiny earbuds nestled in her ears. The value to her musical life of learning to perform polished replications of classical music is less than it may have been had she been born a half century ago. She spends her hours of music making immersed in her laptop—recording her instrument, recording her voice, making loops, mixing and remixing with the music in her life. This young person craves an ability to interact with music creatively and immediately, to expand and explore, and to discover herself in the music. She values impermanence, as evidenced by her love of Snapchat, where her posts survive for no more than 24 hours. She shares what she is proud of immediately with her community, supporting them with her creative contributions to the world. So, how can we best support her?

If music education is to respond to the skills and needs of 21st-century music learners, innovative learning paradigms must be explored. This document presents a process of theoretical work and creative experimentation with improvisation pedagogy and technology that led to the development of the framework for Creative Music Learning with Technology (CMLT). Within this framework, learning improvisation is contextualized in aural training through interactive listening sessions and playing an instrument. A prototype application was built for iPad and iPhone that incorporates the five principles of CMLT. The software is at once a tool for musical understanding and for exploring creative freedom in music.

The framework for CMLT and the software prototype were conceived of and built through a process of research-creation. They are inspired by the application of the learning theory of constructionism as an alternative disposition for musical learning, where students' creative processes of "making" and "inventing" within the language of music are considered essential. Inquiries into improvisation pedagogy, and improvisation-learning-technology

constitute the theoretical analysis and research that inform a process of creative development. A further component of the project is a two-phased study that examines user testing of 21 participants, including six long-term users. The degree of user confidence improvising after using the software for an extended time is assessed.

Rationale

Education in the 21st century calls for the cultivation of a new set of skills for students including digital literacy, inventive thinking, critical thinking, problem solving, communication and creativity (Partnership for 21st Century Skills, 2008). While other subjects are working towards an alignment with these skills, music education has often been resistant to change as music teachers continue to focus on repertoire and playing in large ensembles (Kratus, 2007). Many students are not being provided with the appropriate training to be creative musical participants in a multicultural and digital age. Educational objectives in music institutions and with teachers are often divorced from the realities of students' relationships with music and as a result, student motivation for pursuing school music is declining (Harland, 2005). Cuts in funding and declining enrollment in both the US and Canada speak to a field increasingly out of touch with young musicians and pupils (Kratus, 2007). As the prevailing models of music education are being questioned (Campbell et al., 2014; Hargreaves, Marshall & North, 2003) it is imperative that we begin to imagine new ways of presenting music learning.

Situating improvisation as a core objective in music learning may be one effective strategy, since an improvisatory musical process challenges students to be active listeners and prepares them to make complex decisions in the moment. When students improvise, they more deeply integrate the fundamentals of music into their own vocabularies and therefore develop a more comprehensive musicianship (Bradshaw, 1980; Whitener, 1983). Once they have this

faculty, they gain the ability to interact with other musical genres and cultures, something of increasing importance in our multi-cultural, mobile, technologically-enabled society (Fischlin & Heble, 2004; Solis & Nettl, 2009). Improvisatory music practices provide students with the agency that comes from developing fluency, defined here as the ability to interact creatively with the language of music, while simultaneously challenging them to invent, experiment, and move beyond that which has existed before them. By cultivating a musical disposition of spontaneity and the facility to interact with canonic and non-canonic musical forms, we grant students the possibility to participate in a wider variety of musical contexts. This expansion of skills and creative flexibility invite a more democratic form of artistic musical participation. Furthermore, due to the intrinsic nature of improvisation as a meaningful artistic experience that fosters an exploration of self, we invite music students to participate in a more embodied form of music making than that entailed in repertoire performance. The sense of risk and individual autonomy that are characteristic of improvisation can serve as catalysts for growth, innovation, creativity and critical thinking.

A contemporary music education practice should resonate more appropriately with today's climate—musically, multiculturally, artistically, and democratically. In North America, movements in music education have struggled to situate improvisation and creative musicianship at the forefront of music learning and teaching for some time. In the 1960s, movements such as the *Contemporary Music Project* (CMP) (Willoughby, 1971), and the *Tanglewood Symposium* (Choate, 1968) attempted to reshape music teaching and learning. The *Manhattanville Music Curriculum Project* (MMCP) (Thomas, 1970) and the *Hawaii Music Curriculum Program* (Burton, 1990), were both examples of the *Comprehensive Musicianship* methodology (Standifer, 1990), a wide-scale movement aimed at reforming music education into a more

holistic and creative process. An excerpt from a report sponsored by the CMP elucidates the values at the core of these movements:

> Our plea is for a kind of instruction that will release the imagination of the student, that will help him to find fulfillment in the music, that will awaken or stimulate his own creative and innovative capacities, that will make him a responsible, and responsive citizen of the world of music. (Mitchel, 1967, p. xii)

These projects may not have been as successful as they intended, however, their influence has been felt and amplified in more recent decades. One clear manifestation of this influence was enacted by the *Music Educators National Convention* (MENC) in the United States, who designated "improvising melodies, variations, and accompaniments" as the third of nine national standards for music education (1994). Research has shown that this pronouncement was similarly only marginally successful at changing the music education landscape (Bell, 2003; Byo, 1999; Orman, 2002; Whitcomb, 2005). This document was recently updated with a new publication of standards by the newly named *National Association for Music Education* (NAFME) in conjunction with the *National Coalition for Core Arts Standards* (2014). The new publication emphasizes three principle standards: creating, performing, and responding. Creating is defined as a student's need for experience in creating for success as musicians, and as 21st-century citizens. ("Standards - NAfME," 2014). While not a specific call for improvisation, it implies an overarching emphasis on the creative processes of music, implying a structural conception of, and fluency with, the language of music. As creativity takes a more prominent place in curricula across the arts and other subjects, the imperative of improvisation and composition in music learning becomes more pronounced.

The specific argument that improvisation holds a more essential placement within music teaching and learning is one held by a growing number of leading educators in the field (Azzara, 2002; Campbell, 2009; Elliot, 2005; Gordon, 2003; Grunow, 2005; Hickey, 2015; Kratus, 1995;

McPherson, 1993; Reimer, 2009; Sawyer, 2000; Small, 1998; Wright & Kanellopoulos, 2010). As the movement towards increased inclusion of improvisation gains traction, publications are increasingly emerging that expound the benefits of learning to improvise (Gagne, 2014; Kratus, 1995; Mazzola, Park, & Thalmann, 2011; Pignato, 2010; Ross, 2010; Sarath, 1996; Shane, 2013; Shevock, 2015; Solis & Nettl, 2009; Stringham, 2010). Many of these authors are directly involved in university music programs whose role in supporting a transformation in the field of music education is paramount. In these programs, there is often a compartmentalization of improvisation strictly within the domains of jazz and organ performance while, according to Swanson and Campbell, most music students outside of these departments graduate with "little to no experience in the essential creative processes of improvisation and composition" (2016, pp. 203–204). Campbell also suggests that the cycle of improvisational illiteracy stems in part from teachers' admitted inability to teach improvisation themselves, as attested in this teacher's words: "Teach improvisation? Not when I've never improvised myself" (Campbell, 2009, p. 137).

The recent manifesto published by the *Task Force on the Undergraduate Music Major* (TFUMM) stands to affect change in university music programs and subsequently beyond. The organization was created in 2013 in the United States with a mandate to advance the undergraduate preparation of students in music, specifically with regards to graduates' "potential for successful participation and leadership in contemporary and evolving musical cultures" as well as "the role of musicians in public life and the ways in which the curriculum might better reflect relevant needs, qualities, knowledge, and skills" (Campbell et al., 2014, p. 1). The published manifesto marks a culminating moment in the movement towards the reform of a canonic music practice. The work is organized by three pillars: creativity, diversity, and

integration. The first position described in the executive summary reveals the importance of improvisation in their vision:

> TFUMM takes the position that improvisation and composition provide a stronger basis for educating musicians today than the prevailing model of training performers in the interpretation of older works. This position does not suggest that there is no longer a place for interpretive performance in the emergent vision, but that when this important practice is reintegrated within a foundation of systematic improvisation and composition, new levels of vitality and excellence are possible in the interpretive performance domain. Such an approach will inevitably engage students more fully with the world in which they live and will work professionally. (Campbell et al., 2014, pp. 2–3)

Campbell and her associates thus envision a future where musicians have the flexibility to move within diverse contexts and respond to artistic and cultural challenges. The reintegration of interpretation "within a foundation of systemic improvisation" implies a fundamental reshaping of the way music is presented to students. In such a context, students would learn a dialogic fluency with the language of music so that they may interact with music both on and off the page. The broadening contexts of musical performance in the 21st century demand this level of fluency with the language of music in order to successfully transfer musical skills within various genres. By teaching improvisation, we can provide students with an active form of engaging within diverse musical environments.

Music education is not evolving independently from rest of the world. As dynamic, living things, both music and education are necessarily adapting to the current society and the culture in which they exist (Jorgensen, 2003). The changes taking place are part of a larger movement happening in education in general. Borgo (2007) argues that the dominant educational philosophies of the West have "notoriously under-appreciated the physical, psychological and social dimensions of the learning experience" (p. 61). He acknowledges that there is currently a small revolution taking place in numerous disciplines, involving a move away from knowledge

as “stored artifact” to knowledge as “constructed capability-in-action.” As the field of education changes to better reflect societal needs and undergoes widespread curricular reform, so too must music education become more inclusive of alternatives to the traditional methods of teaching music. We are already seeing an increased introduction of popular, jazz, rock, and other musical styles from around the world into music curricula in schools. Informal learning pedagogies are likewise becoming acknowledged as beneficial strategies for students (Green, 2009; O’Neill, 2012; Wright & Kanellopoulos, 2010). There is a widening of scope currently underway, one that stands to change our musical interactions and practices in education.

Purpose

Following extensive theoretical work into improvisation pedagogy and technology for autonomous music learning, this dissertation proposes a framework for Creative Music Learning with Technology. Existing theories, models, and pedagogies of improvisation are foundational to the development of CMLT. Theoretical work examines improvisation as a more democratic and embodied form of collaborative music making, and the application of the learning theory of constructionism for teaching music improvisation with technology. Also integral to the creative design process was a history of media for improvisation pedagogy and an evaluative survey of iOS applications for learning to improvise, two components in Chapter 4.

This framework may serve as a model for creating novel systems of music learning, and one such system is proposed in which students are taught to improvise music through interactive listening and creative play. The prototype was produced through a creative design process and a study invited input from 21 user testers—seven expert teachers and 14 middle school instrumentalists. This two-phased study sought opinions and evaluations, as well as examining student confidence improvising following extended use of the software. Improvisation and

creative work interfused the project, and the process itself presents an alternative research design, one that opens up possibilities for advancement and creative contribution to the community—research-creation.

Research-Creation

A methodological approach of research-creation was chosen so as to acknowledge the inherently personal process of creative research projects. Research-creation presents the potential for intervention by generating new forms of knowledge and tools. This work expands upon existing forms of research-creation, as it is not focused on an artistic work, but rather, the development of new technology and a system for creative music learning. As a type of intervention, at once multi-faceted and heterogeneous, the development of the CMLT framework and the prototype seek to produce an outcome of innovation.

Preliminary Research

Before this project began, numerous independent research projects were undertaken that were influential in the present work. It was from within these experiences that the nascent spark of this work was conceived. Each represents an independent project, and they will not be thoroughly explained, but a brief description may be helpful in order to understand the foundation of the subsequent research-creation in the present work.

One semester as a research-observer of a jazz improvisation course for classical musicians at McGill University exposed the complexity and difficulty of learning the jazz language for students studying in a different style (Khoury, 2017, *Jazz in the Classical Academy: A language barrier*). A ten-day ethnographic study of a community music program provided insight through observation of the inclusive teaching of improvisation to at-risk and inner-city youth (Khoury, 2017b, *Living Music in the Community of Houston*; Khoury & Dove, 2014,

Nameless Sound: The music is the pedagogy). This experience demonstrated the importance of a safe space for allowing one's most vulnerable sounds to be heard. An innovative method of music learning through improvisation was studied in Salamanca, Spain during a week-long summer course held by the *Instituto de Educacion Musicale*[1] (IEM) (Khoury, 2015, *Improvisation as a Pedagogical System: An analysis of the methodology of the Instituto de Educacion Musicale*). This pedagogical approach to teaching music through improvisation is gaining ground in a traditionally conservative system of music education in Spain.

Music technology was used to teach Renaissance counterpoint through improvisation at McGill University, where a research role allowed for observation of the substantial benefits of improvisation for learning modal counterpoint, as well as potential of technology to aid in this process (Guido & Khoury, 2017, *Improvisation and technology in the counterpoint classroom*). In this study, the computer software *SmartMusic* was employed as a tool for students to practice and record improvisations.

In the fall of 2014, a unique opportunity presented itself to study partimento with a renowned visiting Italian scholar, Giorgio Sanguinetti at McGill University. This resulted in the publication of *Partimento as Improvisation Pedagogy: Renewing a Lost Art* (Khoury, 2015), which draws similarities between partimento and jazz improvisation.

All of these projects were undertaken in tandem with active teaching that included private guitar lessons, performance groups, improvisation ensembles, and undergraduate courses at McGill University. Within these teaching environments, many pedagogical approaches to improvisation were implemented and explored from a personal perspective and practice.

[1] See Chapter 3, Emilio Molina, for a description of this system

Likewise, work as a graduate research assistant with the *Improvisation, Community, and Social Practice*[2] (ICASP) project provided opportunities to interact with leaders in the field of critical improvisation studies. Through ICASP, there occurred bi-monthly reading groups to stimulate thought, performances of improvising musicians, conferences for sharing and discovering research and ideas, and an online journal[3] that served as a catalyst for many discussions. Through my relationship with this organization grew an appreciation for free improvisation, and the creative freedom of this music.

Free Improvisation

Many music educators and theorists champion free improvisation, or non-stylistic improvisation, as a tool for musical creativity and expression (Bailey, 1993; Heble & Laver, 2016; Hickey, 2009; Kanellopoulos, 2011; Lewis, 1996; Steinbeck, 2011). There is a growing body of methods and applications of free improvisation to music learning (Hall, 2009; Niknafs, 2013; Rose & MacDonald, 2016; Schafer, 1986; Stevens, Doyle, & Crooke, 2007; Wallace, 2012), examples of free improvisation being used for social equity and creative agency (Dove, 2016; Fischlin, Heble, & Lipsitz, 2013; Willox, Heble, Jackson, Walker, & Waterman, 2011), as well as recent research that examines the possibilities of free improvisation for music education (Burrows, 2004; Hickey, 2009; Hickey, Ankney, Healy, & Gallo, 2016). The body of work in free improvisation has a significant role to play in reimaging music education in the 21st century.

The proposed system of improvisation in this dissertation upholds the creative and exploratory disposition of free improvisation, however, the principle pedagogical objectives are not concerned directly with this practice. Rather, CMLT is concerned with a more basic function,

[2] Now called the International Institute for Critical Studies in Improvisation (IICSI). See www.improvisationinstitute.ca
[3] www.criticalimprov.com

propelled by the belief that musicians deserve the ability to interact with all music they are playing in a dialogic and creative manner. Because of a typical students' involvement in diatonic, stylistic music such as pop, rock, hip hop, classical, etc., learning to improvise within these styles may provide a relevant and meaningful form of musical experience. By building a creative disposition and a strong musical foundation, it is hoped that students may gain the freedom to interact with any music or musician, from a creative place of knowing.

Stylistic Improvisation

Borrowing from Azzara's definition (1992), for the purposes of the present work, improvisation is considered the manifestation of musical thought based on an internalized musical vocabulary and an ability to understand and to express musical ideas spontaneously. It is differentiated from composition primarily based on a notion of temporality. Nachmanovitch (1990) discusses this in his book *Free Play: The Power of Improvisation in Life and the Arts*:

> In improvisation there is only one time… the time of inspiration, the time of technically structuring and realizing the music, the time of playing it, and the time of communicating with the audience, as well as ordinary clock time, are all one. Memory and intention (which postulate past and future) and intuition (which indicates the eternal presence) are fused. (1990, p. 18)

In order to participate in this time of inspiration, structuring, realizing, playing and communicating, a student must have developed an improvisatory disposition to music, and a depth of musical understanding. It is the process of learning to interact creatively with music that is the focus of the proposed system of CMLT.

Chapter Outline

Following this introduction, Chapter 2 presents the methodological design of the theoretical and creative phases of this work, as well as the presentation of the six research questions that guide it. Chapter 3 is a theoretical analysis of improvisation pedagogy, beginning

with a discussion of improvisation as a more democratic and embodied form of music making. The chapter then traces a history of improvisation pedagogy within Western traditions, discussing some key educators and theorists. The chapter also examines pertinent research and publications from this field.

Chapter 4 begins with a discussion of constructionism and constructivism as productive means of cultivating improvisational skills through technology. Tools for autonomous music learning are examined before focusing specifically on the history of media for learning improvisation. Recent advancements in mobile technology and touchscreen interaction present new avenues for music education that are ripe for innovation. In order to examine the existing tools available on these devices, an evaluative survey of iOS applications for learning improvisation is presented.

Chapter 5 presents the framework for Creative Music Learning with Technology, including an elaboration of the framework specifically for the context of learning improvisation. The prototype development (Chapter 6) and a two-phased study (Chapter 7) are in support of this framework, providing an opportunity to test the validity of the claims. Chapter 8 summarizes findings and presents ideas for future research.

CHAPTER 2: A RESEARCH-CREATION METHODOLOGY FOR CREATIVE MUSIC LEARNING WITH TECHNOLOGY

This work maintains a fundamental purpose of situating music learning within a dialogic and improvisatory musical process. A creative, multifaceted research design was essential in order to contribute to the advancement of music learning in the 21st century. A theoretical exploration of existing work and the analysis of other scholarly material provide the groundwork for discovery in this project. However, it is also important for this research to be open to creative exploration of new and not yet imagined solutions. Theoretical analysis alone cannot provide sufficient room for innovation, nor would other traditional methodological designs or experiments. Improvising is inherently creative, therefore logically, a successful teaching strategy will likewise require a creative approach. Thus, a "research-creation" methodology is applied, where contributions and innovations are iteratively developed within a balance of creative and theoretical work. When a systematic inquiry process is interactive, creative, and critical it has the most potential to produce new knowledge (Sullivan, 2006).

The Principle Research Question

This work is driven by the following research question: How can the literature, methodologies, and experiments conducted within the field of improvisation pedagogy inform the creation of a technology-assisted teaching framework that provides instrumental music students with creative agency through a dialogic approach to learning repertoire and improvising? In response to this question, the following trajectory was formulated.

Overview of Components

Driven by a commitment to critical thinking and creative innovation, six research questions, described in detail below, charted the following methodological trajectory:

- *An initial theoretical inquest into pedagogies of improvisation*
- *An examination of technology for autonomous music learning*
- *A history of media for learning improvisation*
- *An evaluative survey of existing technology for improvisation*
- *The creation of a framework for Creative Music Learning with Technology*
- *The design of a software application using the given framework*
- *Testing of the plausibility of the tool by building a prototype*
- *Testing the usability of the prototype by engaging 21 user testers*
- *Testing seven middle school students over a period of 4 weeks using the software*
- *Testing self-reported confidence of students improvising after using the prototype*

A methodological approach that welcomes creative dialogue stands in stark contrast to prevailing methodologies commonly found within the domain of music education research. A comparison may be drawn between the prescriptive method of music learning and the prevailing research methodologies championed and utilized by most researchers in music education. Methodological designs have in many ways remained relatively unchanged for decades. The body of knowledge and research that have been produced is of substantial importance and significance, ushering in new understanding of many aspects of music learning. However, as we move forward in the 21st century, we are poised to witness a new era of music learning, one in which creativity and individuality may prevail over absolute structures. As this change occurs, the field of music education research must likewise incorporate innovative, critical, and creative models of research design.

Research-Creation

An experimental approach to methodological design can provide the greatest potential for discovering innovative and impactful results. Research-creation is perhaps the closest example of

an existing methodology that features experimental design in this capacity. It stands in "overt resistance to strict, potentially reductive, and object-centric understandings of research", appealing to researchers "whose work requires self-reflexivity and experimentation for analysis" (Hogan, 2012, p. 94). Manning and Massumi describe research-creation as an "experimental practice" that "embodies technique toward catalyzing an event of emergence" (2014, p. 89). This event, they contend, is one that evades prediction or cannot be determined in advance. It is precisely this inability to foresee the outcome that warrants and invites new forms of research methodologies. In this way, this work departs from a tradition of finite studies that focus on one small aspect of music learning, instead allowing a breadth of study to produce new forms of imagining musical understanding. Because the scope of this project was substantial and multi-phased, other methodologies are also employed throughout the research. However, it is the creative and exploratory nature of research-creation that drives the work into new territories.

The process itself is thus an important outcome of the dissertation, providing a framework for other researchers endeavoring in the creation of new teaching methods. Similar to practice-based research (Candlin, 2000; Frayling, 1997) and arts-based research (Cahnmann-Taylor & Siegesmund, 2013; Eisner, 1993), research-creation is an innovative form of design research that allows for the integration of the creative process of design into the investigation. Often associated with new media experimentation, research-creation has emerged within the social sciences and digital humanities, and pursues theoretical, technical, and creative processes in tandem (Chapman & Sawchuk, 2012). Interdisciplinary scholarship and research, as well as the creation of hybrid forms are becoming increasingly prevalent in doctoral dissertations (Shanken, 2005). This hybrid dissertation can be considered a research-creation project that engages in a mixed methods study with an expansion intent, aiming for scope and breadth

through the use of multiple components (Clark & Creswell, 2008; Greene, Caracelli, & Graham, 1989; Madey, 1982).

In a recent manifesto on research-creation, Natalie Loveless explains the importance of research-creation to help in the process that "re(con)figures our approach to disciplinarity" (2015b, p.53):

> Attention to disciplinary inheritance is crucial. However, in asking us to unhook ourselves from a primary alliance to disciplinary identity, the critical discourse of research-creation wedges open inherited forms of legibility and value that configure our daily activities as academic practitioners… I argue for research-creation as crucial to the development of new academic literacies that challenge traditional modes of knowledge in the university. Research-creation is a particularly potent way of speaking across and *with* disciplinary, political, ideological, methodological, and affective (diffractive) differences in the academy today. Research-creation invites us to reassess our inherited modes of publication and pedagogy in ways more attuned to the modes of creativity needed to face ecological and economic crisis that are actively remaking how we might conceive of the work of university today. (Loveless, 2015b, pp. 53-54)

The present discord between the state of music education and the needs of music learners in the 21st century represents a crisis worthy of the kind of critical discourse that research-creation so appropriately undertakes. While it is most often encountered within the domains of art and media, there have been research-creation projects in music (Beghin, 2015; Ferguson & Wanderley, 2010; Fujinaga, Vigliensoni, & Knox, 2015). Within music education, it has been scarcely employed, with the exception of a French project that utilized research-creation to examine and expound upon the complex and understudied process of artistic creation within the field of music education. Recognizing the tendency in French music education towards an interpretive rather than creative approach to teaching music, the project took a creative methodological approach in order to both investigate and innovate:

> The objectives of this research project focused on analyzing the creative process and determining methodology in the field of research-creation, transposing and designing

> models for teaching artistic creation, exploring the motivational and cognitive aspects of artistic creation, and investigating the impact of artistic creation on academic learning. (Giacco & Coquillon, 2016, p. 2)

The nature of creative interaction with models of teaching made research-creation an effective methodological framework for the French project, providing opportunity for advancement in the field, in addition to the in-depth analysis and investigation.

In the present work, research-creation also serves to provide room for investigation and innovation, guided by the following series of six questions.

Theoretical Analysis and Synthesis

Research question one:

How can the literature, methodologies, and experiments conducted within the field of improvisation pedagogy inform the creation of a technology-assisted teaching framework for providing instrumental music students with creative agency through a dialogic approach to learning repertoire and improvising?

With an intended result of developing a framework that expands current methods and models of teaching music improvisation, the present work begins with investigation. Theoretical work that examines improvisation as a democratic and embodied form of music-making precedes an examination of existing literature and the work of key scholars in the field of improvisation pedagogy. A review of research studies that examine the teaching of improvisation provide further understanding of effective means of cultivating improvisational skills.

Due to the difficulty of instituting change within existing frameworks of firmly established music education (Bowman, 2007), a focus on the individual learner in the development of musicianship presents a favorable strategy, one adopted in this work. The agency

of the individual learner may be facilitated by a focus on internalization. The Vygotskyan concept of internalization insists that the mind creates mental models of artifacts as tools (in this instance, for creative thinking) by intervening in and interacting with them. This internalization then enables the possibility of consequent change within the culture (Burnard, 2007).

A focus on the agency of the individual learner and the creation of a tool for creative musicianship with a broad reach may be the most potent form of intervention within a musical culture based on interpretation. Bypassing institutional change and addressing students through accessible and ubiquitous technological tools may be an effective strategy. In this way, we may circumvent structures that may be difficult to penetrate, and instead focus on new forms of learning in the 21st century. Pamela Burnard presents an alternative approach to music learning, embracing the potential of technology to address creative opportunities:

> Imagine multiple forms of music pedagogy, where creativity (like inspiration) comes from outside in *and* inside out as a process inseparable from technology, playing into and recruiting different forms of pedagogy. Where a gradual but perceptible process of pedagogical evolution takes place, with music educators developing new strategies that go beyond making new tools 'fit in' to current ways of working. Instead, the 'deeper' object of *musical learning* arises inseparably from creativity and technology as interrelated tools. Both teachers and learners use these tools to manage their own learning, creating opportunities for the making, creating, receiving and producing of music. (Burnard, 2007, pp. 37–38)

An exploration of technology for autonomous music learning provides further foundation for the development of a framework. This exploration includes a history of media for improvisation that concludes with the most recent development of mobile devices. The effect that recent mobile technologies have had on our lives is undeniable (Goggin, 2012; Walsh, White, & Young, 2010). Previously impossible learning contexts are now made possible on these small and powerful devices (Martin & Ertzberger, 2013; Wu et al., 2012). Never before has there existed such capabilities in sound manipulation and interaction. Music pedagogies stand to

change significantly as new paradigms of learning become possible. The combination of touchscreen interaction with high-quality music listening presents a new context of music learning. An exploration of this context is paramount for addressing the needs of 21st-century learners. Therefore, following a focus on improvisation pedagogy, the second question brings in technology.

Technology Surveys

Research question two:

What technological tools exist to aid students in the acquisition of musical improvisation skills?

In order to answer this question, three research areas were addressed in Chapter 4. The first involves the use of technology for autonomous student learning, the second, a history of media for learning improvisation, and finally, an evaluative survey of existing mobile software to learn improvisation. These three studies reveal a lack of efficient tools that take full advantage of technological affordances in order to teach improvisation outside of specific contexts such as jazz or particular instruments. Synthesis of the research from improvisation and technology has led to the conclusion that one potential solution to the first research question could be the development of a learning system that fuses rich pedagogical traditions and approaches in improvisation pedagogy with the recent innovations in mobile technology.

Mobile devices specifically introduce learning features previously not possible: real-time feedback, coupled with touchscreen interaction, autonomous and student-led progression through scaffolded learning structures, and the portability and convenience of the mobile device. This work argues that the advancement of music pedagogy in the 21st century must embrace the overarching movement towards creativity in learning, which leads to the third research question.

Creating a Prototype

Research question three:

How might we incorporate the body of work in improvisation pedagogy with recent technological advancements, specifically with regards to mobile devices, in order to support deep and creative learning of music?

In response to this question, a framework for Creative Music Learning with Technology (Chapter 5) was developed. This framework consists of an integration of music learning principles with new advances in technology and represents a form of music learning that has not previously been encountered. The chapter draws on existing research in music learning, improvisation, and motivational gameplay. The framework has the potential to be applicable in a variety of music learning scenarios and to guide the design of new technologies. In order to address the specific context of developing creative agency, comprehensive musicianship, and fluency with the language of music, one potential iteration is presented for teaching music improvisation.

Building a Prototype

Research question four:

How might the framework for Creative Music Learning with Technology be used to design and build a software application for teaching improvisation to a broad population?

With the goal of constructing an interactive software application for learning music improvisation, a prototype was subsequently built in collaboration with a software developer.

Chapter 6 presents the design and describes the various components of the software, with supporting diagrams and screenshots.

In order to test the validity of the CMLT, 21 user testers participated in the subsequent testing phases. The final two questions are posed with regards to this testing process. The methodology for these studies is elaborated in full at the outset of Chapter 7.

Qualitative Research

Research question five:

Is the prototype successful at engaging students in improvisation? Does it have potential for application in the lives of students? How is their experience using the software? What are its strengths and weaknesses, specifically with regards to the principles laid out in the framework for CMLT?

The qualitative research from these studies provides a number of important findings about the framework, about creative music learning with technology, and learning music in a 21st-century context[4]. Undoubtedly, the most exciting part of creating a new system for creative music learning is observing it in an authentic context of student learning. A qualitative approach to research can be the preferred method when the researcher is "interested in understanding how participants make meaning of a situation" and "seek(s) to discover and understand a phenomenon, a process, or the perspectives and worldviews of the people involved" (Merriam, 1998, p. 11). Therefore, the principle methodology for examining the effectiveness of the prototype takes the form of qualitative research. It was important to allow for a variety of

[4] This research was conducted with the approval of the McGill Research Ethics Board, Certificate # 336-0116

viewpoints and values to be expressed and considered in the design of an effective tool. The sensitivity and adaptability to the "many mutually shaping influences and value pattern" make qualitative methods especially relevant for this study (Bresler, 1995, p. 2). Furthermore, adaptability to the students is crucial for understanding their viewpoints and impressions about the prototype and incorporating these into the design. Thus user testing of eight students and seven expert teachers constitutes one portion of Chapter 7. A subset of two research questions guided this portion of the study:

Expert teachers: Research question #1: What impressions, opinions, and evaluative responses do professional music teachers have about the prototype and the potential application for their private music studios?

Middle school instrumentalists: Research question #2: What impressions, opinions, and evaluative responses do middle school instrumental students have about the prototype and the adoption of such a tool into their musical lives?

This research does not attempt to establish that this learning framework, or the software, is more effective than other methods of learning improvisation. Instead, this work examines the capacity of CMLT to engage and foster creative freedom in music, as one component of musical growth. Research reveals a variety of improvisation learning tools and pedagogies at our disposal, and yet improvisation has not become a foundational skill in musicianship. This research is therefore focused on the possibility of a new form of technology to enhance the learning of creative musicianship.

Chapter 7 also includes a second phase of research involving the case studies of six students who interacted with the software prototype for four weeks. A final question concerning

these six students called for an examination of their self-rated confidence improvising after using the prototype.

Examining Perceived Self-Efficacy

Research question six:

Do students using the software over an extended period of time find that it helps them to become more confident improvising?

For this component of the study, the six long-term users were asked on three occasions to improvise and then immediately complete a questionnaire concerning their confidence improvising. The results from this study are reported at the end of Chapter 7.

CHAPTER 3: IMPROVISATION: URGENCY, THEORIES, AND PEDAGOGY

Improvisation as a Democratic and Embodied Form of Music Making

To improvise is to participate in an innately meaningful, creative, and embodied form of music-making, to intentionally bring into existence a spontaneous musical thought. This is made possible by an intricate process of internalizing a musical vocabulary to such an extent that this language becomes accessible for personal expression. Improvisation is a form of active music-making that supports notions of democratic music education, requires an increased incorporation of risk, and provides a deeper sense of performing in one's body. Music students of today require the creative agency inherent in improvisation, in order to interact in the ever-changing musical culture of the 21st century. Restructuring the values and objectives of music education, such that improvisation is situated in a central role, represents an urgent task facing music educators.

This chapter begins with theoretical and empirical work that identifies improvisation as a more democratic and embodied form of music making, deserving placement at the core of music learning. The remainder of the chapter is concerned with investigating improvisation pedagogy. This is first undertaken from a historical perspective of Western classical music as well as an exploration of improvisation pedagogy in jazz. These historical accounts are followed by a collection of eight pedagogical treatments of improvisation outside of jazz, as presented by important educators in the field. Three distinct classification systems of improvisation pedagogy from the fields of music education, cognitive science, and phenomenology precede a final section that discusses important and relevant research and new publications within the domain.

Democratic Music Education

> Government, business, art, religion, all social institutions have a meaning, a purpose. That purpose is to set free and to develop the capacities of human individuals without respect to race, sex, class, or economic status. And this is all one with saying that the test of their value is the extent to which they educate every individual into the full stature of his possibility. (Dewey, 1948, p. 107)

Education in the 21st century, especially in the arts, has a duty to respect and support students of any age, race, sex, sexual orientation, and social class. In a moment in which political and social values are being challenged, education in the arts must support the values of freedom, equality, and democracy. Performing pre-composed works in the Western classical tradition is only one facet of music education, and to exclude improvisation is to neglect students' self-determination and autonomy as individual artists. As university music programs begin to address the ideological discord between classical and contemporary musical practices and values, they must also address the range of musical skills they are training students to master. Drawing on the philosophy of Castoriadis (1997), Kanellopoulos (2012) argues the following:

> Improvisation and composition might be seen as ways of positing the issue of political autonomy in musical terms… emphasis[ing] the role of improvisation and composition as a mode of potentially transformative educational practice that may foster the development of critical consciousness, linking music education to a larger project of re-discovering and at the same time re-defining democracy. (p. 153)

A democratic music education is one in which value is not predetermined and is instead dependent upon the individuals implicated in the act of education. Such a practice requires respect for the individual. Composition and improvisation, as active processes of creativity that cultivate autonomy, allow us to interrogate hierarchies, musical values, as well as the relationship that we have to historical dimensions and values in music (Kanellopoulos, 2012). Castoriadis (1997) defines autonomy as "the capacity, of a society or of an individual, to act deliberately or explicitly in order to modify its law—that is to say, its form" (p. 340). Kanellopoulos (2012)

further argues that it is through the political autonomy afforded through creative musical activities that we can transform the educational paradigm by questioning long-held ideological values.

Lucy Green (2002) problematizes the ideological discord between the teaching of classical music versus that of popular, jazz and world music. Principally, this ideology is manifested in the belief that classical music is the most valuable type of music (Green, 2002). Though the focus on classical music remains prevalent in music education, it does not always "correspond to the musical tastes, values and experiences" of a majority of those involved (Green, 2002, p. 17). Values such as universality and eternality that were developed in the nineteenth and twentieth centuries carry implications that do not necessarily transfer to music outside of the classical tradition. The processes of reification and legitimization have perpetuated the ideological construction of values and social relations in the classical music tradition. Though these values and relations may seem natural, they clearly work towards the advantage of some and the disadvantage of others (Green, 2003).

Improvisation is a musical activity that is open to anyone. Kanellopoulos (2012) explains, "Improvising and composing become active processes of positing new legitimacies, and of creating a music-making context that searches for its own foundations" (p. 151). It is an activity that is self-directed, reliant upon one's own musical histories. George Lewis (2009) describes the complexities of improvisation:

> We actualize or realize our desire, our intentions, our responses, in a real-time analysis, generation, manipulation and transformation of meaning, mediated by (among other factors) the body, history, temporality, space, memory, intention, material culture, and diverse methodologies. (p. 4)

The diverse factors that are at play during improvisation are a substantial departure from those evoked during performance of pre-composed music. John Paynter (2000) acknowledges

the personal process in composition, also relevant in improvisation, as complex, and built upon personal musical histories:

> There are bound to have been influences—all the music the pupils have ever heard, and their musical preferences: what they think of as 'music'—but even if it is derivative, what they produce is what they have made, and to do that they had to take decisions. (p. 8)

Distinction is apparent between the focus on musical product and musical process. In improvisation, the central aim, the primary value, and arguably the derived pleasure of the music resides in the process of improvisation. While an improvised product becomes the end result of an improvised performance, the process involved requires a different level of agency and choice than playing fixed repertoire (Lewis, 1996). According to Lewis, it is precisely this appreciation of process and narrative that can make improvisation difficult to appreciate within the ideological values of classical music (1996). However, far from implying that the meaning or value of improvisation is of less significance than classical music, it simply implies that the values are different.

Alperson (1984) affirms the essential aesthetic value of improvisational activity, as distinguished from a musical work. To improvise is to simultaneously enact the two primary praxis of music-making—composition and performance. Alperson suggests that the technical and expressive elements are shared between improvisation, composition, and performance, but to improvise, one undertakes a significantly higher risk, composing musical material in the moment. This sense of risk and individual autonomy are defining characteristics of the musical process of improvisation. To invite these values into our musical understanding is to challenge notions of music aesthetics that place value on the end musical product as opposed to the process.

For example, Hanslick's quote from the 1950s brings into perspective the vast trajectory

of musical experiences since that time, exemplifying the idolatry of a musical work: "It [improvisation] imposes on music an irrelevant and distracting wash of emotion and it results in a musical product typically devoid of beauty" (as cited in Alperson, 1984, p. 17). Neglecting the long history of improvisation in Western classical music, Hanslick considers the process of music-making and individual expression to be of little value. The absolutist view that musical meaning is within the work itself has been challenged repeatedly (Born, 2005; Elliott, 1995; Goehr, 1992; Green, 2009) and holds less relevance in today's multi-cultural musical landscape.

Changing the values and structure of music education in a way that supports the learning of improvisation demands a shift of perspective, and a re-examination of the values that we impart on students. It demands questioning the way we conceptualize music and how this information is conveyed to students. As Derek Bailey explains:

> One reason why the standard Western instrumental training produces non-improvisors (and it doesn't just produce violinists, pianists, cellists, etcetera: it produces specifically non-improvisors, musicians rendered incapable of attempting improvisation) is that not only does it teach how to play an instrument, it teaches that the creation of music is a separate activity from playing that instrument. (Bailey, 1993, p. 98)

To improvise is to act with an awareness of the many possibilities that are available, choosing in each moment the future of the next. This may demand a level of comfort with one's personal self and the capability to express a personal narrative (Lewis, 1996). For this to be possible, an embodied disposition towards musical creativity music be nurtured in music learners, one which unites music creation and playing an instrument. The following discussion examines improvisation as a more embodied level of musical performance than the interpretation of repertoire.

Improvisation as Embodied Performance

When we imagine the place of body in a discussion about musical experience, notions of

space and time become relevant. We may look to the tradition and teaching of improvisation in theatre to explore ideas of embodiment as related to space and time. Perry (2013), in her work on theatre improvisation in the classroom makes a distinction between striated space, which is regulated by specific rules and limitations, and smooth space that has no predetermined order and therefore creates new possibilities of composition. A striated space is comparable to the performance of predefined musical works, in which the physical experience can be imagined even before performance. In a smooth space, akin to musical improvisation, Perry suggests, "[t]he sensation of corporeal interaction affects experiences of performers and the progress of the action" (p. 100). Improvisation, as opposed to scripted and rehearsed action, emerges simultaneously as a "space and time of inquiry" (Perry, 2013, p. 100).

In the striated space of a scripted environment, actors may have an internal map of body movement and an understanding of scene structure within physical terms. In contrast, in the smooth space of improvisation, the spontaneous actions of the body are a motivational force. The actor is at once choosing her course of action with her body and mind. The body is more involved in smooth, or improvised spaces, than the body in a striated performance of fixed material.

The difficulty of teaching improvisation comes in part from the disconnection we have with such embodied forms of action. Dramatist Keith Johnstone discusses pedagogical strategies in teaching theatre improvisation that work to undo this disconnection:

> Humans are too skilled in suppressing action. All the improvisation teacher has to do is to reverse this skill and he creates very gifted improvisers. Bad improvisers block action, often with a high degree of skill. Good improvisers develop action. (as cited in Borgo, 2007, pp. 82-83)

By over-intellectualizing music, the Western classical tradition may have deviated from the physical embodiment once inherent in the musical processes of human beings. In musical

improvisation, the player, undistracted by the score, interacts more fully through his body and kinesthetic sense. Jeff Pressing (1988), a cognitive scientist who worked extensively on improvisation, examined this notion of physicality in improvisation. He found that physicality was more encoded in the process of improvisation than when performing from a score due to the improvisors'[5] need to "feed off all the resources of the moment to create" (p.23). According to Pressing (1988), the need to rely directly on manipulation of motor programs in unforeseen as opposed to foreseen ways requires a greater sense of risk.

Pressing defines the manner in which music is represented in kinesthetic movement and in our physical perception of musical emotions. He describes the muscular connection to tension and release that are applied to the performance of harmonic progressions and the trajectories of melodic lines within a gravitational field (Pressing, 2002). These sorts of physical enactments of music have been observed in musical practices around the world and seem to originate from human beings' unique characteristic of being innately *musical* beings. Pressing (2002) describes the dynamic system invoked through a physical experience of music, stating:

> The mind, body, and environment are not separated by hard boundaries, but are roughly demarcated parts of an interacting dynamical system. It is clear that full physical involvement aids learning, and that the subjective body experience is central to primal rhythmic elements of music like tempo, accelerando, syncopation, and ostinato improvisation. (p. 24)

Music, especially rhythm, is felt in the body (Mithen et al., 2006). Pressing's use of the word primal to describe one's physical experience resonates with our understanding of music's origin, which was certainly an improvised form of music-making. While it may seem divorced from musical practices in the West, the notion that physicality, as opposed to intellectuality,

[5] The spelling of the word "improvisor" has been chosen for use in this work, however, "improviser" appears in quotations and titles, to respect original spelling.

could support music learning and specifically improvisation, logically corresponds to our history of music making over tens of thousands of years. All music has evolved from primal music-making, and, in some ways, making music through improvisation deeply felt within the body must connect to our roots of musical practice. Consider the relatively new concept of the "work" and musical score as related to the historical music-making of human beings (Goehr, 1992). We cannot be precisely sure how long human beings have been making music, but archeology provides some indications. A bone flute was found in Slovenia that dates back to between 43,000 and 82,000 years old (Huron, 2001) and it is safe to assume that humans have been playing music since at least that time. If we imagine 43,000 years as the first music of man, our practice of reading from score is a strikingly new phenomenon, as seen in Figure 3.1.

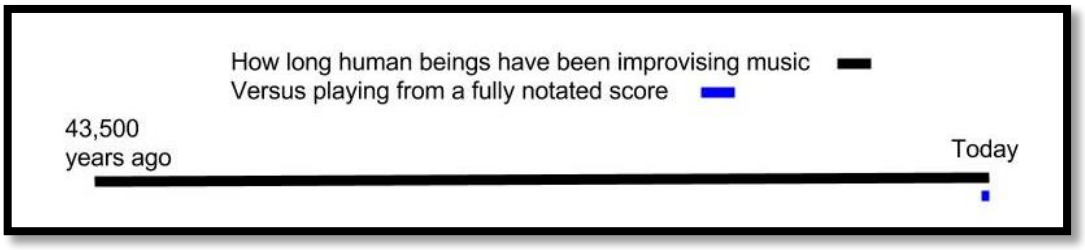

Figure 3-1: Time human beings have improvised versus played from a notated score

In her defining work on the body in musical performance, Eleanor Stubley (1998) describes an imaginative experience of two contrasting performances—one of a string quartet playing Beethoven and the other, an African drumming ensemble. While the string quartet is both "bound by the score" and "searching for something that lies beyond," the African drummers exist "as if they are joined to their drums and are making music with their whole bodies… It is as if the movement motivates and sustains the music making… the movements seem to define their total sense of being or self-awareness" (Stubley, 1998, p. 94). Drawing from Merleau-Ponty's phenomenology of perception, Stubley describes how the musicians carve out a space in which the music takes on a bodily presence.

> This tuning seems to unfold through the music making and appears to be driven by a movement of mind that enables the musicians to reach through their bodily actions and experience the outer edge of the sounds being shaped and articulated, not as actions already taken, but as possibilities that might be. It is as if each moment has a spatial dimension that extends between "the here and now," a spatial dimension that gives the musicians a bodily presence in the sounds themselves. (Stubley, 1998, p. 95)

The possibilities represented in improvised music have implications for the individual as well as for the ensemble. This open-ended quality is not only within the sound but also drives the musical identities within the ensemble. The power of each musician's "musical voice" discovered within the ensemble "seems to be particularly potent, however, where the ongoing music making widens or goes against the grain of the field through an experience of otherness that requires immediate accommodation or that creates...an opportunity for individual musical identities to be asserted" (Stubley, 1998, p. 96). Here, Stubley is describing the improvisatory aspect of music-making as particularly potent. She also observes that the ritual enables embodiment through play that is grounded in the present: "While the musicians have their own individual spaces, the boundaries distinguishing those spaces appear to be blurred by an awareness of the activity of the ensemble as a whole" (Stubley, 1998, p. 95).

The collaborative nature of group improvisation is based on the synergy between players as Stubley has described. In improvisation, unbound by the score, this synergy is experienced by listening and responding from an embodied place.

While many of the pedagogical treatments of improvisation discussed below focus on autonomous learning of skills for attaining musical fluency, a primary objective of attaining this ability is in an increased ability to become a creative and collaborative participant in music making. The collaborative nature of group improvisation provides both a setting for asserting one's individual voice, and for discovering the musical possibilities that arise in tandem with others. Having determined improvisation to be a more democratic, embodied and collaborative

form of music making, we now examine some of the body of literature concerning improvisation pedagogy.

Improvisation Pedagogy

The second half of this chapter addresses improvisation pedagogy, focusing on forms of stylistic improvisation that are prevalent today in Western culture. For a broader and more complete look at pedagogies of improvisation, Pressing's *Improvisation: Methods and Models* provides a thorough investigation. For the purposes of this work, some popular methods and approaches will be discussed, as well as some classification systems and models, an examination of pertinent research, and some recent publications from the field of critical studies in improvisation. While this chapter aims to document a variety of approaches and theories, it unfortunately cannot address all of the different methodologies and recent contributions to the field.

Pedagogy can be defined as the art and practice of teaching, specifically with regards to one particular domain or body of knowledge. Pedagogy typically extends from knowledgeable teachers who pass down skills and concepts to students through explanation and examples. When we refer to a pedagogy of music improvisation, we refer broadly to the methods and practices that are or have been used to teach improvisation and therefore cultivate musical fluency among music instrumentalists and vocalists.

The world is rich with pedagogical treatments of improvisation. The Hindustani *rägs* of North Indian classical music (Jairazbhoy, 1995; Slawek, 1998), the Carnatic music of South India (Morris, 2001), the Persian *radif* (Nettl, 2009), West African music (Locke, 1980), the Javanese Gamelan (Hood, 1964; Sutton, 1998), and Balinese Gamelan (Gray, 2010), the Arabic *Taqāsīm* (Ayari & McAdams, 2003; Racy, 1998, 2000) all contain developed processes of

improvisation pedagogy. In all of these stylistic forms of improvisation, as in Western classical and jazz, we encounter a language and structure unique to the individual practice. The manners of applying these linguistic rules and structures form one aspect of the process of learning to improvise.

Equally vital however, is the uniquely personal process of artistic expression and the cultivation of one's own voice (McMillan, 1997). Sometimes this aspect of improvisation pedagogy is less addressed in formalized methods. Regardless, if democracy and embodiment are to be cultivated, the respect for individual expression bears importance in the teaching of improvisation. As explained by Jacques-Dalcroze "[i]mprovisation is the study of direct relations between cerebral commands and muscular interpretations in order to express one's own musical feelings" (Abramson, 1980, p. 64). There is a necessity to support students' assertion of creative agency in a way that is not as crucial when teaching strict performance of existing music. Despite the fact that this aspect of the pedagogy is almost unmentioned in most treatments, it must be understood as a crucial ethos for properly cultivating the imagination and expressivity of individual artists.

Maud Hickey (2009) in her provocative work that argues for a balance between musical control and musical freedom in improvisation instruction in the schools, argues that in fact "*[t]rue* improvisation cannot be taught—it is a disposition to be enabled and nurtured" (2009, p. 286, emphasis in original). This notion of "enabling a disposition" is paramount, as any pedagogy of improvisation should facilitate the cultivation of spontaneity and creativity. While the remainder of this chapter addresses many approaches to improvisation pedagogy that entail functional learning concepts, in order to properly teach improvisation, the individual expressiveness of the learner must be considered essential.

Western Classical Music

Historically, within the culture of Western classical music, pedagogies of improvisation were most often passed down in master-apprentice relationships. Because of this, little documentation has survived from the 16th and 17th centuries that provides a window into the way musicians learned to improvise. We know that improvisation was a widespread practice among musicians at the time and that for most Western musicians in the 16th and 17th centuries, an ability to spontaneously create music was a fundamental musical skill. For example, in the Baroque period, improvisation was constantly present, integrated within "the harmonic and melodic fabric of the music" (Bailey, 1993, p. 21).

Historians have uncovered details about an instructional tool that was utilized for learning improvisation on the keyboard during this period—partimento (Khoury, 2014a; Sanguinetti, 2012). By analyzing partimenti, we are able to glean some information about how musicians of this period learned to improvise. The technique reveals dominant pedagogical strategies used for training students in improvisation during the late 17th and early 18th centuries, based in great part on the tradition of figured bass. Giorgio Sanguinetti has been integral in uncovering many lost artifacts and manuscripts that reveal the secrets of partimenti in greater depth. He defines partimento as "a sketch, written on a single staff, whose main purpose is to be a guide of improvisation of a composition at the keyboard" (Sanguinetti, 2012, p. 12). While partimenti resembled figured bass, they were more akin to a musical problem, to be solved by the performer/improvisor. A set of *regole* (rules), along with a knowledge of the *schemata* (learned musical exemplars), guided students in the practice and performance of partimenti.

As the number of amateur musicians began to increase in the 18th and 19th centuries, publications that aimed to teach improvisation became available in the form of improvisation

treatises written by well-known performers and teachers such as C.P.E. Bach and Carl Czerny. Amateur improvisation treatises brought the art form into the hands of anyone who could purchase the manuscript. These documents have survived and provide historians and educators with examples of how the art of improvisation was approached in the Western classical music tradition. One example is the work of Carl Czerny, a student of Beethoven. In 1836 he published *Systematic Introduction to Improvisation on the Pianoforte*, one of many treatises published around this time. Czerny's work was a systematic treatment of the art of improvisation, covering the structural harmonic formulas as well as the idiomatic use of melody and musical surface, or diminution (Berkowitz, 2010).

In Berkowitz's (2010) recent book that examines keyboard treatises of the 18th and 19th centuries, he includes a letter written by Czerny to a pupil. Czerny describes a myriad of aspects surrounding improvisation and the proper course of action to acquire the skill. The letter provides an interesting glimpse into the practice of teaching improvisation at the time. Czerny asks the student to begin practicing, both alone and in front of her teacher, "to connect together easy chords, short melodies, passages, scales, arpeggioed chords; or, which is much better, leave it to your fingers, to effect this connection, according to their will and pleasure" (Berkowitz, 2010, p. 16). Czerny then spells out the requirements for improvisation:

> Great and highly cultivated facility and rapidity of finger, as well as perfect command of all the keys and of every mechanical difficulty. For you may easily imagine, Miss, that the happiest talent avails nothing, when the fingers are incapable of following and obeying its dictates. Besides this, it also requires intimate acquaintance with the compositions of all the great composers;… a thorough practical knowledge of harmony; and lastly...our own indefatigable and rationally applied industry. (Berkowitz, 2010, p. 16)

Based on the words of Czerny, the 19th-century student of improvisation would have been required to: understand the body of work, have practical knowledge of harmony, command

technical prowess, and work hard. When one examines these historical pedagogies of improvisation from the Western classical tradition and compares them with a sampling of methods presently used to teach stylistic improvisation across musical cultures of today, we see more similarities than differences. In effect, all of these pedagogical approaches aim to teach students how to speak the language of music within the particular genre or style in question. This requires training students to have an understanding of the grammar and syntax of the musical style, while cultivating nimble agility with notes and rhythms. Students are made to understand the direct relation of melody to harmonic structure. They are made to cultivate the ability to move melodically based on and between harmonic motion of the music. The majority of pedagogies instruct students to repeat and internalize musical figures and work to have students understand chord/scale theories. When sufficient skills have been developed, students are also taught to recognize and make stylistic inflections. They might be given practice drills such as responding to musical questions with musical answers or copying and transcribing previous compositions or improvisations.

The prevalence of improvisation in Western classical music came to an end in the mid-19th century. At this time, the spontaneous composition of music and the sense of risk-taking involved were laid aside in favor of a strict adherence to notated music. Classical music pedagogy became organized in a logical and linear progression (Small, 1996), which left little room for personal exploration. There are numerous theories that account for the demise of improvisation (Moore, 1992; Sancho-Velazquez, 2001; Shane, 2013; Todea, 2014; Woosley, 2012), and it was probably a confluence of forces that are responsible. Composers were increasingly disillusioned with the way other musicians failed to interpret their music to their liking (Sanguinetti, personal communication, March 17, 2011). They began notating parts of the

music that were once improvised. Beethoven's final piano concerto has been singled out as the definitive change in the practice of fully notating cadenzas. No doubt also influential in this shift, during the Romantic period, the composer was increasingly viewed as an "authoritative and solitary hero" (Gould & Keaton, 2000, p.144). Gould and Keaton (2000) likewise cite an increase in complexity of the music as an explanation, as well as the need for performers to sustain the classical canon while simultaneously playing within the current romantic style. The spontaneous practices of music were traded in, and performers became increasingly technical and relied more heavily on the score. Sanguinetti believes that the shift occurred in great part as keyboard compositions began to be published with all of the fingering markings written into the score, diminishing the exploratory aspect of learning music (Sanguinetti, personal communication, March 17, 2011).

This change in performance practice occurred at the same time that the field of music teaching was being professionalized, one of many effects of the industrialization of society occurring in the 18th and 19th centuries in Europe and North America (Mark & Gary, 2007). Mass production, mechanization, and factors such as speed, efficiency, and measurability became idealized. As these factors influenced music education, what was once a comprehensive, interconnected field of study became increasingly compartmentalized. Likewise, at this time work and play became dichotomized, and "music as work" may have similarly led to the de-emphasizing of improvisatory musical practices within formal education. The technical study of instruments became the focus of musical instruction as the Protestant work ethic gradually took over all aspects of life (Weber, 2002). Classical compositions demanded strict reproduction, regardless of the particular geographical settings or social and performative contexts, and training in many ways began to relate more to athletic training than to artistic training (de

Bezenac & Swindells, 2009). Despite the fact that some composers such as Stockhausen, Lutoslawski, Kagel, Xenakis, Ives, and Messiaen incorporated improvisation into their compositions in the 20th century, this did not prompt a return to a study of improvisation in music pedagogy.

Presently, improvisation is emerging within early music departments (Schubert & Guido, 2016) as a renewal of the art of extemporizing and a way of achieving authentic performance within specific styles. It also remains prevalent in organ studies, as improvisation continues to be an important part of church music as a way to accompany the fluctuating length of musical performances within a service. Music methods courses for those pursuing music education typically contain a component of music improvisation, and some universities provide ensemble opportunities (Khoury, 2014b).

While classical music departments in universities are only recently beginning to make improvisation a mandatory part of students' musical training, this has not been the case in the jazz departments of North American universities. These programs have a foundation in improvisation and students are expected to attain fluency within the stylistic language of jazz. The pedagogies in these institutions are not representative of the original oral pedagogical traditions of jazz, a fact lamentable by some. However, one benefit to come from the formalization of jazz in the academy is the now large and accessible body of work in improvisation pedagogy: methodologies, cognitive studies, pedagogical approaches, and research.

Jazz Improvisation Pedagogy

Jazz is, first and foremost, an improvised music; jazz players communicate through improvisation, co-creating art in moments of unified exploration and openness. Because

improvisation has always stood at the heart of this musical tradition, the largest existing body of literature, methodologies, and research into musical improvisation concern jazz. A discussion of the original oral tradition precedes an examination of jazz in universities, and the vast assortment of method books.

An oral tradition

From jam sessions at clubs to informal practice sessions in the homes of musicians, or in clubs during the day, there was a sense of camaraderie and of sharing musical secrets in the original tradition of jazz improvisation. Berliner offers a thorough glimpse into these rich educational scenarios in his seminal book *Thinking in Jazz* (1994). In the book, anecdotal learning strategies are reported by jazz musicians that include learning by ear, learning patterns, transcribing and listening, singing, learning licks, learning to "play changes", studying classical music, playing something in all twelve keys, and many other strategies. Walter Bishop Jr. summarizes a typical trajectory for learning jazz:

> It all goes from imitation to assimilation to innovation. You move from the imitation stage to the assimilation stage when you take little bits of things from different people and weld them into an identifiable style—creating your own style. Once you've created your own sound and you have a good sense of the history of the music, then you think of where the music hasn't gone and where it can go—and that's innovation. (Berliner, 1994, p. 120)

Using source material from many of the most important jazz improvisors, Berliner discusses pedagogical approaches to improvisation taken by many jazz educators and provides numerous examples and models. He also elaborates on values considered important in jazz improvisation:[6] rhythmic substance; melodic substance; harmonic content; originality and taste; emotional substance; instrumental virtuosity and technical features of ideas; storytelling ability;

the spontaneity, in relation to the uniqueness, of invention; evolving a unique voice within the jazz tradition; and accommodating musical change as the tradition progresses.

As an oral tradition, imitation and copying played a major part of the dissemination of jazz improvisation techniques. Jazz musician and educator David Baker describes the autodidactic nature of learning improvisation and the tendency to downplay instruction:

> I imagine if you asked Charlie Parker how he did something, or Miles [Davis] how he did something they'd probably tell you "Listen to what I'm doing…." If I asked Wes Montgomery "What is that Wes," he'd say, "You'll hear it," because basically people were not trained to articulate that. (Prouty, 2006, p. 315)

As an oral tradition, the origins of jazz point to people playing music that was full of personal meaning and narrative, using a combination of memory and preference, greatly affected by the context of performance and the group of musicians playing. The tradition of learning orally and primarily through imitation did not maintain prevalence as jazz shifted into the academic setting in North America.

Jazz in universities

In the late 1940s, the first jazz education programs were established at North Texas State University and Berklee School of Music (Prouty, 2005). In the 1960s and 1970s, jazz was adopted more widely into the formal music settings of university music programs. These developments began a considerable shift in the way jazz music was imparted to students. Jazz improvisation pedagogy was profoundly influenced by the subsequent teachers and students that built and came through this new system. Formalization began, and at this time, books for learning improvisation became popularized. Chord scale theory in the bebop style became the dominant teaching vehicle for jazz improvisation in the universities (Prouty, 2005). Eventually,

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[6] Chapter 10, pages 243-285

hundreds of method books became mainstream material, covering numerous styles and approaches.

Jazz method books

Many successful jazz educators developed their own pedagogies and subsequently published their own books that utilized their specific "method" for teaching improvisation. The use of these books and other media[7] for learning jazz improvisation is a prevalent supplement to the study of jazz improvisation. Used autonomously, as a source of study with a teacher, or within jazz programs, there are thousands of publications that aim to teach students the art of jazz improvisation. A great number of surveys and analyses of pedagogical material and approaches to jazz improvisation exist (Bash, 1986; Benward & Wildman, 1984; Bergmann, 2012; Berliner, 1994; Bowman, 1988; Cosmo & Cosmo, 2002; Dunscomb & Hill, 2002; Hart, 2011; Jones & others, 1997; Kuzmich, 1975, 1990; Leavell, 1996; Madura, 1996; Maksymkow, 2003; May, 2003; Palmer, 2013; Paulson, 1985; Prouty, 2006, 2008; Re, 2004; Watson, 2010; Witmer & Robbins, 1988).

Witmer and Robbins' (1988) survey provides critical analysis of many methods available at the time of publication. They refer to "the big three"–Aebersold, Coker, and Baker as the most prolific publishers of jazz material (p.15). These methods focus on the acquisition of scales, arpeggios, and patterns (Aebersold, 2000; Baker, 1988, 1989, Coker, 1987, 1997). Witmer and Robbins observe that "beyond the 'meat and potatoes' of chord/scale relations and basic progressions, there may be found the occasional 'condiment' of the author's insight" (1988, p. 23). Coker, for instance, suggests "Playing along with records to develop 'tone quality, phrasing,

[7] Chapter 4 has an extensive discussion of media for improvisation.

time feel, etc.'", although these elements that are not further explained in the text (Coker, 1975, p. 12; Witmer & Robbins, 1988, p. 11).

Witmer and Robbins point to a shortfall of all of the standard published material: "the conspicuous and apparently deliberate separation of technique and music" (p.15). As an alternative, they discuss La Porta's *A Guide to Improvisation* (La Porta, 1968), a more "holistic approach" (p.17) with an emphasis on "making 'simple' things sound right" (Witmer & Robbins, 1988, p. 16). The exercises in La Porta's book are based on rhythmic patterns and call and response ear training. According to Witmer and Robbins, La Porta's approach holds the advantage that "the *sound* proceeds the *theory*" (Witmer & Robbins, 1988, p. 16, emphasis in original). Benward and Wildman (1984) are also cited as having an integrated approach. Exercises in the book are related to specific musical examples from the Smithsonian Collection of Classic Jazz, so that students can hear actual examples of the musical elements. Witmer and Robbins point out that the technique of guided listening to known recordings of music has an advantage over techniques that only employ the use of play-along tracks, like Jamey Aebersold collections. Listening to quality musical examples, as opposed to solely backing tracks, provides more information and demonstrates musical elements such as phrasing, expression, and time feel.

One important aspect of jazz improvisation relates to the manner in which the performances are guided by particular musical works. "Standards" as they are commonly called, are songs from the tradition learned by most jazz players. These musical works are the starting place for jazz performances and thus improvisations. In a typical jazz performance, a band will begin with someone playing the melody of the tune, and then the solos are passed around the

band. The interaction between the band members with regards to the musical material developed in the improvisations is one of the most characteristic and salient features of jazz music.

The Real Book and *Fake Books* provide lead sheets that form the core material for improvisational development. These lead sheets contain a skeleton of the music at hand—including the melody and the accompanying chords (written with chord symbols, not notation). These lead sheets become a form of musical puzzle, a problem to be solved. The interpretation of the work is left up to the improvisors/performers, using a combination of the material within the work and creative interplay. This creative interplay typically comes from study and practice of models, patterns, scales, and arpeggios.

As previously mentioned, there are similarities between jazz lead sheets and partimenti, as both represent a complex musical puzzle to be solved. Intense creativity can result in the solving of this puzzle, however, there is a preparation necessary to enable one to understand and react to the musical problems set forth.

Johnson-Laird (2002) has conceived of a principle of algorithmic demands in jazz improvisation:

> The cognitive problem for jazz musicians is to create a novel melody that fits the harmonic sequence and the metrical and rhythmic structure of the theme. The musicians must therefore be highly familiar with the chord sequence, use their working memory to keep track of where they are in that sequence and to register what other musicians are playing, and generate and execute sequences of notes in pleasing musical phrases. (p. 422)

Here, Johnson-Laird writes of the importance of understanding the harmonic construction of a musical work, in order to creatively produce melodic material that both corresponds to the chord sequence as well as to the music being played by other musicians. He later addresses the procedural knowledge that governs improvisation:

> Musicians also have in their heads a set of unconscious principles that control melodic improvisation. This procedural knowledge is acquired at the cost of considerable work. It embodies principles governing harmony, meter, rhythm, and contour. (see also Berliner, 1994) (Johnson-Laird, 2002, p. 439)

Learning to master jazz harmony and melodic orientation require intense immersion within the stylistic language in order to successfully improvise within this style. Music students who are not studying jazz may find it difficult to learn an entirely different musical language from that in which they are immersed. However, the wealth of pedagogical material and research studies from this domain stand as useful sources for improvising in other domains as well. Two educators discussed below, Christopher Azzara and Ed Sarath, have brought their experience as jazz improvisors and educators into a broader application of improvisation pedagogy.

Non-Jazz Pedagogies of Improvisation

While the term "non-jazz" seems pedantic and unnecessary, in a musical world in which improvisation is almost synonymous with jazz music, it functions to clarify an approach to improvisation that does not necessarily contain jazz rhythm, harmony, or style. The pedagogical resources and methodologies for improvisation outside of jazz are numerous and varied. A number of non-jazz pedagogical treatments of improvisation have made the process more accessible to a wide range of students.

The following list of method books have been published to provide guidance to students learning to improvise outside of jazz and may be useful to educators looking for ways to incorporate improvisation into their teaching. Many focus on only one instrument or context, but most provide valuable approaches to learning to improvise:

Improvisation Method Books for Non-Jazz Improvisation
• *Improvisation Games for Classical Musicians* (Agrell, 2008); • *From sight to sound: Improvisational games for classical musicians* (Brockmann, 2009); • *Improvisation at the piano: A systematic approach for the classically trained pianist* (Chung & Thurmond, 2007); • *Improvise!* (Harmon, 1995); • *Fun improvisation for violin: The philosophy and method of creative ability development* (Kanack, 1996); • *Beyond classical violin: An introduction to the world of improvisation* (Bisharat, 1998); • *Musical creativity: Strategies and tools in composition and improvisation* (Mazzola et al., 2011); • *Pattern play* (Kinney & Kinney, 2010); • *Developing musicianship through improvisation* (Azzara & Grunow, 2006); • *Music theory through improvisation: A new approach to musicianship training* (Sarath, 2013).

Important Educators of Improvisation (Non-Jazz)

While improvisation has not been widely taught throughout the last century, some influential music educators have considered improvisation to be an important component of music learning. The pedagogical treatments of improvisation by Émile Jacques-Dalcroze and Carl Orff have been particularly influential within elementary school music education in North America (Campbell, 2009). Edwin Gordon, Christopher Azzara, Patricia Shehan Campbell, and Ed Sarath are influential music educators in improvisation and are also discussed, as well as two important educators who are influential in Spain and Latin America, Emilio Molina and Violeta Hemsy de Gainza. Following a brief discussion of the work of these educators in improvisation

pedagogy, the writings of Jeff Pressing (1988), John Kratus (1995), and Patricia Nardone (1996) are presented, representing three distinct ways of modeling and classifying aspects of improvisation pedagogy.

Émile Jacques-Dalcroze

Improvisation is one of three branches in the pedagogy of Émile Jaques-Dalcroze (1865-1950), along with *eurythmics* (or the physical exploration of music) and rhythmic solfège (an aural training approach based in a fixed-do system). Dalcroze was concerned with unifying the mind and body in musical feeling and physical sensation. His improvisation method was based on providing constraints and musical problems to students, with the goal of achieving musical fluency; flexibility; and, above all, a personal creative voice. In the words of Dalcroze (1921), "[t]he art of improvisation rests on… a developed awareness of one's expressive individuality. This knowledge grows through interactive exercises with a teacher, whose function is not to present models for imitation, but to pose problems intended to provoke personal responses" (p. 52). Originally developed for more mature conservatory students, the improvisation pedagogy of the Dalcroze approach is complex and thorough, favoring the expressive and creative nature of students' experiences of improvising (Joseph, 1982). Dalcroze believed improvisation should allow students to "fearlessly and expressively experiment with musical concepts, techniques, experiences, understandings, and ideas of their own devising" (Mark, 1986, p. 102).

An embodied technique that focuses on movement and self-expression, the pedagogy of Jacques-Dalcroze can be seen as a counter-narrative to a disembodied epistemological approach that emphasizes notational reading and an analytical approach to music (Juntunen & Westerlund, 2011). Dalcroze believed that improvisation is a key component of music education and developed a pedagogy and series of exercises to facilitate creative improvisation among students.

According to Dalcroze, the teacher should regularly improvise, either to illustrate a concept, or to emphasize specific elements and musical concepts. (Jaques-Dalcroze, 1917; Palmquist, 1998).

A number of studies have been concerned with the application of the Dalcroze Method (Joseph, 1982; Nalbandian, 1994; Zachopoulou et al., 2003), and numerous music educators have published overviews and interpretations of his method and improvisational techniques (Abramson, 1980; Juntunen & Westerlund, 2011; Stone, 1985; Tucker, 2013). Many of the studies have produced positive results that implicate the relevance and benefits of using the Dalcroze approach to teaching music.

Carl Orff

Carl Orff (1895-1982) was a German composer who created a method of creative music education based on improvisation and movement. Orff-Shulwerk, now employed in over 30 countries, is most often taught primarily at the elementary school level, often with physically and mentally handicapped children (Shamrock, 1997). Concerned with "elemental rhythm" (referring to music of both early humans and to young children), this approach relies on a set of instruments (the *instrumentarium*) that encourage a tonally-centered sonority, beginning with the pentatonic scales. Carl Orff believed strongly in the importance of attaining improvisational fluency, and his method therefore has quite specific strategies for facilitating improvisation with young children. These include a series of prompts and the use of ostinato rhythm patterns as accompaniment (Shamrock, 1997). Use of the pentatonic scale helps to support an experience devoid of "wrong notes" and therefore favors creative exploration.

A number of studies have been published that examine Orff improvisation instruction in elementary and preschool settings (Beegle, 2001; Brophy, 2002; Flohr, 1981; Munsen, 1986; Warner, 1991; Zachopoulou et al., 2003). Contrastingly, there are no published studies that

examine secondary school application of the Orff-Shulwerk approach to improvisation.

Edwin Gordon

Edwin Gordon (1927-2015) created the Music Learning Theory (MLT) as a way to teach *audiation,* his term for the ability to think music with the mind. Gordon believed strongly in the correlation of music learning and language learning: "Audiation is to music what thought is to language" (1999, p. 14). He elaborates on this relationship: "just as we think with words, that is, patterns of letters not separate letters, in music we audiate patterns, both tonally and rhythmically, not individual time-value names or pitch letter names" (Gordon, 2009, p. 6). For Gordon, improvisation deserved a place at the core of music learning:

> My best recommendation to music teachers of the next century is to improvise, improvise, improvise! Get rid of notation. Learn from music learning theory to teach children to make music without the aid of notation or music theory. Follow religiously the process of the way we learn language. ("In Memoriam," 2015)

Gordon believed in the imperative of forming a listening base, as, just like with language, we would not expect someone to speak without having the previous experience of extensive listening. The aural discrimination that is learned by training tonal and rhythmic patterns can give improvisors the necessary background to respond spontaneously to external constraints encountered in improvisation (Gordon, 2007). Gordon felt that music should be learned through aural training, and that its elements, especially rhythm, should be studied in context.

> When rhythm is taught visually in terms of music theory and notation apart from movement and breathing, it rests solely with time and the brain. As a result, teachers appear to have no alternative but to teach counting, note values, and definitions. And that leads to emphasizing relative time values of individual isolated notes rather than groupings of durations that take on musical meaning. (Gordon, 2009, p. 4)

His work echoes the notion of rhythmic embodiment discussed previously in this chapter. He believed that "rhythm is felt" and that it is not possible to understand rhythm "apart from its interaction with movement and breathing" (Gordon, 2009, p. 2).

Christopher Azzara

As a professor of music education at Eastman School of Music, Christopher Azzara is a widely published author of pedagogical material, research, and articles. In an important study in the field that demonstrated the positive benefits of improvisation on musical learning, Azzara used audiation-based techniques to teach improvisation to young children (1993). His approach to teaching improvisation has shown a likeness to that of teaching jazz improvisation:

> Improvisation involves specific guidelines that provide a framework for the performer– for example, the tonality, the harmonic progression, the meter, and the form of the music. Challenging these 'restrictions' by playing inside and outside of them results in creative improvisation. In fact, many improvisers and composers find that they are most creative when making music within certain restrictions. (1999, p. 22)

Azzara explains that a "person must create organized musical meaning in his or her thought processes in order to be able to manipulate the structures of music into an organized, spontaneous, meaningful performance" (1993, p. 338). He has presented his approach to teaching improvisation in various iterations; among them, an *Aural Approach to Improvisation* (1999, p. 23) proposes nine suggestions for improvising:

1. Learning to sing and play basslines of the tunes by ear in order to understand the harmonic progression,
2. rely on ears instead of notation,
3. chant rhythmic patterns,
4. sing tonal patterns that outline the harmony,
5. learn solfège and rhythm syllables by ear,
6. improvise rhythm and tonal patterns alone and with harmonic reference,
7. make up melodies,
8. embellish a melody,
9. listen to improvisers.

A focus on listening and ear training, as well as patterns and harmonic progression of a piece are coupled with improvising with harmonic reference to both invent and embellish melodies. This general approach also guides his publications with Richard Grunow (Azzara & Grunow, 2006), a series entitled *Developing Musicianship through Improvisation* (DMTI) that teaches improvisation through aural development, based on folk and traditional songs.

Patricia Shehan Campbell

Patricia Shehan Campbell has been a key figure in reforming music education, publishing works that have helped to push the field into the 21st century. Besides her important work in improvisation (Campbell, 2009; Campbell, 1991; Campbell et al., 2014; Higgins & Campbell, 2010), she has been influential through her work with young children (2011; Campbell & Scott-Kassner, 2013), listening (2005), and working for multicultural perspectives in music education (1991, 2003; 1990; 2004). In her contribution to Solis and Nettl's, *Music Improvisation: Art, Education, Society*, she provides three operational definitions of improvisation (2009). The first, "improvising to learn" (p.120), considers the learning of improvisation as a path towards more comprehensive musicianship. The second approach she considers is "learning to improvise music" (p.120), when the act of improvisation is the ultimate goal, such as in a musical tradition like jazz. The third is "improvising music to learn," in which the learning is framed outside of a purely musical experience, and "people learn whatever can be learned of self and others and of the world beyond music" (p.120).

Campbell offers another perspective on the notion of temporality—the relationship of improvisation to previous listening and practice: "Music that is improvised is at once the creation of new ideas on the spur of the moment and an expression anchored in many long hours of listening and practice" (Campbell, 1990, p. 44).

Ed Sarath

Ed Sarath is a professor of music at the University of Michigan, where he founded the Department in Jazz and Contemporary Improvisation. He is also the founder and president of the International Society for Improvised Music in the US and is a proponent of creativity and consciousness development in music study (2013).

Like Azzara, Sarath has transferred a pedagogy of jazz improvisation to musicians studying outside of this genre. His book *Music Theory Through Improvisation: A New Approach to Musicianship Training* (2009) was developed for college-level musicianship classes, and incorporates a similar approach to Azzara, though he employs jazz music as musical material.

Sarath is actively involved in the process of reforming university music programs to include a larger component of improvisation, as well as increased inclusion of a consciousness based world-view called "Integral Theory" (2013).

Emilio Molina

In 1993, improvisor and educator Emilio Molina founded The Instituto de Educacíon Musicale (IEM). This group of over 30 Spanish educators in their respective conservatories teach an integrated method of musical learning called *La Improvisación como Sistema Pedagógica* (Improvisation as a Pedagogical System) (Molina, 2005, 2007; Roca Arencibia, 2013). This system is based on analysis and improvisation, and is applicable to students at all levels of music learning, from young children to advanced performers. Basic tenets of the approach include the unification of all subjects into one methodology and the notion that improvisation is a consequence of controlling the musical language. Instrumental skills must be based on control of the language, and analysis and listening are crucial components in this pedagogical approach.

The teaching process is based on creativity, in which the teacher is a guide and conductor of musical learning.

The methodology has two approaches to be varied in teaching. In one, the musical work is a point of departure, in which the score analysis reveals the elements to be practiced in improvisation. The second approach is the musical work as a goal; in this case the teacher presents activities that eventually lead to a score. In both of these approaches there are four steps considered as crucial to the methodology.

1. Selection and analysis of the score or musical work
2. Extraction of melodic, rhythmic, harmonic, and formal processes
3. Proposal of practical instrumental activities derived from analysis
4. Improvisation and composition of works or fragments similar to the original work

IEM has published over 40 method books, covering various instruments, styles, composers, and subjects. These are available in the Spanish language, published through Enclave Creativa.[8]

Violeta Hemsy de Gainza

Violeta Hemsy de Gainza (2000) is an influential music educator and advocate for improvisation from Argentina. While her work is little known outside of Spanish speaking cultures, she has been publishing in the field of music education since the 1960s and is cited frequently in the works of other authors from Spain and Latin America (Hemsy de Gainza, 1964, 1988, 2000, 2004). She considers three coordinates, or parameters, as essential to improvisation (2000):

1. Materials of improvisation (“with what one plays”)
2. Objectives of improvisation (“why one plays”)
3. Techniques of improvisation (“how one plays”)

[8] www.enclavecreativa.com

Hemsy de Gainza makes the distinction between two forms of improvisation, *absorption* and *externalization*. Absorption is the internalization of new forms, and externalization is the expression of that which an individual already possesses. She argues that the integration of both of these processes leads to the simultaneity of communication and awareness, two primordial objectives in all education (2000).

Models and Classifications

The following models and classifications represent three distinct manners of examining the process of improvisation from different perspectives. Kratus, from the field of music education describes seven levels of improvisation that extend from a novice improvisor to an expert improvisor. From within the parameters of cognitive psychology, Pressing's work in the area of feedback is discussed as well as his classification of pedagogical approaches that are historically found in improvisation texts. Finally, Nardone takes a phenomenological perspective that represents the dualities inherent in the practice. The work of Pressing and Kratus are influential and serve as frames of reference for research and analysis in the field. Nardone's treatment of improvisation represents an interesting alternative to these objective accounts.

John Kratus

John Kratus (1995) differentiates improvisational expertise from that of a novice improvisor with five elements: the extent to which an expert improvisor is concerned with the creation of the improvisation as opposed to product, the ability to audiate, the ability to play in a way that appears "automatic", the ability to shape a beginning middle and end, and an ability to improvise within a particular style. He has developed a seven level sequential model for the development of improvisation skills based on cognitive research: exploration, process-oriented improvisation, product-oriented improvisation, fluid improvisation, structural improvisation,

stylistic improvisation, and finally, personal improvisation. While the boundaries he developed are arguably not as compartmentalized as they appear to be, the levels are nonetheless considered important by many within the field of improvisation pedagogy (Biasutti, 2015; Gagne, 2014; Healy, 2016; Hirschorn, 2011; Wall, 2016).

Jeff Pressing

Jeff Pressing (1988) produced perhaps the most explicit treatment of how one improvises in his work *Improvisation: Methods and Models.* As an improvisor himself, he explains the process of improvising from a cognitive and psychological perspective. Before discussing his classification of pedagogical approaches, various concepts from his work are presented, as they provide important cognitive groundwork for modern pedagogical treatment of improvisation.

One important aspect that Pressing discusses is the role of feedback in improvisation. He contends that feedback is vitally important due to its ability to enable error correction and allow the improvisor to adapt; furthermore, feedback is motivational and has attention-focusing effects. The particular forms of feedback he discusses are visual feedback (such as when one plays the piano), and kinesthetic feedback. He cites the increased difficulty of improvising a scat solo over improvising with a saxophone due to the different levels of kinesthetic feedback inherent in the two forms, explaining the difficulty vocalists face. Pressing differentiates between three levels of feedback, first distinguishing between short and long term: "Short term feedback guides ongoing movements, while longer term feedback is used in decision-making and response selection" (p.135). He then identifies a longer term feedback called "knowledge of results" or "KR" for cases of external evaluation, such as playback of recordings of students' own improvisations. Based on research by Partchey (1974), Pressing concluded that this technique (listening to one's

recordings) was superior to "listening to pre-composed model melodies or repetition as an improvisation learning technique" (p.135).

Besides these three levels of feedback, Pressing suggests that "feedforward" plays an essential role in the cognitive process of improvisation. Due to the necessity when improvising to keep both intention and result in mind, preparation of motor actions and musical effects can enable feedforward (Pressing, 1988). It is through the preparatory work of establishing a basic vocabulary and an understanding of melodic and harmonic movement that one learns to perceive distinctions that therefore enable the ability to read feedback and enable feedforward, as they occur in improvisation.

Pressing also discusses automaticity, or the feeling that "the performer is played by the music" which actually occurs as a result of "extensive skill rehearsal" (p.139). It is through extensive preparation that the artist is able to achieve a state of automaticity in improvisation.

Pressing encourages a balance between self-discovery and directed learning. Citing the psychological works of Holding (2013), Hendrickson and Schroeder (1941), and Newell (1981), he contends that self-discovery must be coupled with simple instructions. While he recognizes that "less formalized self-discovery techniques are certainly characteristic of much learning in the arts" (p.141), he likewise recognizes the importance of structural prescription. He gives the following suggestion regarding the manner in which these instructions should be presented: "instructions seem particularly effective when kept simple, and when focusing on goals and general action principles rather than kinematic details" (p.141). Pressing elaborates that "[p]robably too much intellectual detail both interferes with the fluid organisation of action sequences, as mentioned earlier, and strains attentional resources" (p.141).

Pressings' classification of improvisation pedagogies

Pressing classifies the various approaches to improvisation found in the literature into five "approaches" or "techniques". The first is that of real-time composition, dominant in pre-Baroque and rare by the 18th century. The second approach concerns patterns, models and procedures for learning stylistic improvisation. He cites the figured bass and melodic embellishment texts of the 17th and 18th centuries as well as the "riff compendia and how-to-do-it books in the field of jazz" (p. 142).

The third approach sets out improvisational problems or constraints. He cites the composition-like problems used by Dalcroze in his approach to improvisation that included "problems in rhythm, melody, expressive nuance, and harmony; muscular exercises; imitation of a teacher; exercises in hand independence; the notation of improvisation just after performing it" (p. 143). Pressing also considers jazz lead sheets in this category, as a type of musical problem to be solved. Although he makes no mention of it in his text, the practice of partimento, uncovered in larger detail after Pressing's work, could be considered in this category due to its nature as a problem-solving guide for improvisation.

Pressing's fourth approach is "the presentation of multiple versions of important musical entities (most commonly motives) by the teacher, leaving the student to infer completely on her own the ways in which improvisation or variation may occur by an appreciation of the intrinsic 'fuzziness' of the musical concept" (p. 143). This approach, he contends, concerns imitative self-discovery, such as that found in the tradition of the Ghanaian traditions or the Persian *radif*, in which a collection of musical material becomes increasingly complex throughout the musician's development. He also includes extracting material through transcriptions and song-form based improvisation, such as in jazz and blues. Hickey, in her discussion of Pressing's classification

(2009), adds Lucy Green's work with garage bands (Green, 2002, 2008) to this category in which students learn by "copying, playing by ear, and self-expression" (Hickey, 2009, p. 288).

The fifth approach is based on concepts of creativity as well as expressive individuality. Here he cites the work of Carl Czerny, Carl Orff, Zoltán Kodály, Shinichi Suzuki, Jacques-Dalcroze, and R. Murray Shafer. He allies this approach to the ideas of self-realization from humanistic psychology.

Patricia Nardone

Patricia Nardone (1996) conducted a phenomenological psychological analysis to distinguish the artistic activity of improvising from that of performing non-improvisational works. Her work stands in contrast to the two previously discussed treatments, but presents a constructive means of viewing the complex activity of improvisation, one that entails more than just the levels of skill acquisition. Nardone identifies different experiences that are involved throughout the learning process. She concluded that eleven "lived meanings" emphasized the psychological experience of improvisation as well as the musical context in which improvisation occurs (p. 2-3):

a) ensuring spontaneity while yielding to it
b) being present and not present to musical processes
c) exploring familiar and unfamiliar musical terrain
d) drawing from a corporeal and incorporeal source of musical inspirations
e) attending moment to moment to temporality
f) having trust and confidence in oneself and musical others in musical risk-taking
g) being sustaining of and sustained by the musical other
h) extending toward the listening other in musical risk-taking
i) perceiving temporality as altered
j) identifying the narrative context as grounding and structure for concretization of expression
k) recognizing the sociocultural context as liberating and transforming.

She further concluded that the body has its own non-rational intelligence separate from cognition that oversees expression.

Improvisation Research

Research examining improvisation pedagogies has become increasingly prevalent in recent decades as the skill becomes more accepted and incorporated by educators. While many of these studies make important contributions to the body of knowledge, it is not within the scope of the present work to elaborate on all. The following discussion highlights those studies that provide particularly salient results for potential application to autonomous learning contexts.

Studies of Jazz Improvisation Pedagogy

As previously mentioned, the largest collection of research in the field has dealt with jazz improvisation. The following studies examine pedagogies of jazz improvisation; they collectively found that factors such as imitative ability, self-evaluation, knowledge of theory, experience, memory, and aural modeling are successful strategies for learning improvisation.

Many studies have looked at the difference between aural and notated forms of instruction. Laughlin found that beginning students of jazz improvisation produced greater improvements when given aural instruction as opposed to notated instruction (2001). Watson (2010) found that aural instruction created more significant gains in self-efficacy than did notated improvisation instruction. May (2003) examined the factors that underlie instrumental jazz improvisation, concluding that self-evaluation followed by aural imitation ability were the best predictors of achievement. Bash (1986) examined the effectiveness of three instructional methods for learning to improvise jazz. He discovered that an enhanced method that includes aural perception techniques with vocal and instrumental responses was superior to a standard technical procedure of chords and scales.

Madura examined vocal jazz improvisation and found that high achievement was best predicted by the following three factors: imitative ability, jazz theory knowledge, and jazz experience (Madura, 1996). The study also determined that instrumental lessons, voice lessons, gender, and general creativity were not found to be significant predictors of jazz improvisation achievement. While gender was not found to affect achievement in Madura's study, Wehr-Flowers examined gender differences of confidence, anxiety, and attitude when participating in jazz improvisation, concluding that there were in fact significant differences and suggesting that woman are affected by social-psychological issues in this context (Wehr-Flowers, 2006).

Norgaard (2011) interviewed seven jazz musicians and determined four strategies for generating note content in improvisations: recall of well-learned ideas from memory, choosing the notes based on melodic priority, choosing notes based on harmonic priority, and repeating material from earlier in the improvisation. The process of monitoring and evaluating their improvisations in the moment was also found to be a crucial component for these musicians.

Frasers study of "Jazzology" examined the most typical, common and persistent processes by which jazzmen and jazzwomen have learned to improvise traditionally, as well as the values inherent in the tradition. He concluded that the five developmental stages through which jazz improvisors traditionally pass are: (1) attraction to jazz music; (2) ear training and observation; (3) music per se and manipulation of instruments; (4) emulation of models and refinement; (5) self-actualization and individual stylistic development (Fraser, 1983).

There is a wide range of other important research in the field of jazz pedagogy. Of these, many researchers have specifically examined jazz programs and education in universities (Balfour, 1988; Brenan, 2006; Goldman, 2010; Hart, 2011; Javors, 2001; Prouty, 2008; Ward-

Steinman, 2008). Others have created or examined novel approaches to teaching jazz (Berard, 1998; Campbell, 2015; Louth, 2012; Schwartz, 2010; Vernick, 1990; Wetzel, 2007).

Analyses of Methodologies and Processes of Learning Music Improvisation

There are ample studies that examine students' experiences of improvisation outside of jazz. While numerous studies have illuminated the positive benefits of improvisation (Azzara, 1992; Guderian, 2008; Hickey et al., 2016; Montano, 1983), the following studies specifically look at the particular processes and practices of improvisation pedagogy. Many of these examine student reactions to specific improvisatory musical training.

Beegle (2006) examined young students' processes of improvisation using Orff-Schulwerk techniques. She found that children's musical products differed depending on the given prompt, a technique commonly employed in the Orff Approach. She also found that the children used strategies such as imitation, memorization, and motivic development, as well as material from their past experience with Orff-Schulwerk. Brophy (2002) also employed Orff-Schulwerk techniques with children aged 6-12, examining age-related differences. Not surprisingly, older children had increased motivic repetition and development, greater attention to pulse, increased generation of rhythmic patterns, and increased structural organization.

Whitcomb (2005) studied improvisational activities employed in elementary general music classrooms. Based on data collected through questionnaires, she found that teachers often employ improvisation in combination with other musical skills. She concludes that teacher training programs should include more improvisation components.

In an ethnographic, open-ended study into eight-year-olds' practice of spontaneous music making, Kanellopoulos (1999) determined three analytic concepts that captured the essence of the children's experience of improvisation. These concepts were (a) objectification and joint

creation of an improvised "piece", (b) thoughtfulness and the children's awareness of self-determined musical thinking, and (c) shared intentionality and music making as a form of joint action and communication of intentions.

Koutsoupidou and Hargreaves (2009) used *Webster's Measure of Creative Thinking in Music* – MCTM II to assess children's creative thinking before and after a six-month teaching period. The control group had a didactic, teacher-centered musical program, while the experimental group had a variety of improvisatory activities. They found that improvisation significantly affected the development of creative thinking, specifically with regard to musical flexibility, originality and syntax in music-making.

Gagne (2014) examined improvisation resources for beginning band curricula, finding four factors that influence student achievement in improvisation. These four factors were based on the following studies, as indicated in the citations: self-evaluation (Ciorba, 2006; May, 2003) imitation (Madura, 1996; May, 2003), modeling (Bitz, 1998), and harmonic accompaniment (Guilbault, 2009).

Stringham (2010) examined high school students learning to improvise and compose. He found that the students felt the two processes were related, and that a sequential curriculum that focused on aural training was beneficial. Pignato (2010) used ethnographic techniques to analyze two New York state educators teaching improvisation in a way that transcended traditional jazz ensembles or elementary school methods. The data collected over a one-year period revealed the challenges these teacher face included a lack of resources, conflicts with traditions, and expectations.

Using the phenomenological lenses of time, space, and responsivity, Custodero (2002) paired improvisational performances of two children with two adult composers, analyzing the

"origins of spontaneous musical creativity associated with childhood dispositions and the musical expertise gained from practice, training and experience" (p. 77). She found that both origins and expertise were operational in the experiences of children and adults alike.

Chess (2005) examined keyboard improvisation of university vocal and instrumental music majors. Analyzing questionnaires, recorded improvisations, and interviews, she concluded that melody and melodic material are useful for teaching fundamental musical concepts. McMillan (1999) investigated university students involved in an innovative program of contemporary music improvisation, looking specifically at the conditions under which these students could acquire their own personal voice in improvisation. The study concluded that the use of individual compositions as the source for improvisation, as opposed to standards, was beneficial in the development of a personal voice.

A quantitative study of adults by Biasutti & Frezza (2009) illuminated the complex interactions between various factors affecting the subjects' processes (anticipation, emotive communication, flow, feedback and use of repertoire) and abilities (instrument played, being or not being skilled at several instruments, and the kind of preferred music for performance) with regards to improvisation. They concluded that the five factors: anticipation, emotive communication, flow, feedback and use of repertoire may help to develop a cognitive curriculum focused on processes rather than products.

Baker and Green (2013) found that students who learned through audio recordings scored better than those who learned from notation in every criterion (pitch, rhythm, contour, tempo, closure, holistic). They concluded that learning by ear from a recording may be beneficial for a child's aural development.

Delia-Pietra and Campbell (1995) conducted an ethnographic study of improvisation training in a music methods course using analytical listening and the imitation of patterns and phrases. They found that one means of developing independent musicianship was "listening to examples from many styles while drawing students attention to pulse and patterns" (Delia-Pietra & Campbell, 1995, p. 120). The conclusions of this study assert that students in music methods courses can successfully be trained to improvise, and that development of the necessary skills can effectively be incorporated into these courses (Delia-Pietra & Campbell, 1995).

Shevock (2015) performed three qualitative research studies on confident music improvising (CMI) in which he employed Bandura's self-efficacy model (1994) to examine confidence as an improvisor. Expert improvisors indicated listening, criticism-free environment, sequential experiences, passion for a style, and openness to learning as important to the process of improvising. Aural instruction was found to represent the way in which confident improvisors teach improvisation.

Biasutti (2015) developed a teaching approach to improvisation based on process development with the following five characteristics: anticipation, use of repertoire, emotive communication, feedback, and flow. His approach aims to "organically develop the specific and basic processes of musical improvisation by keeping in mind a complete picture of the various processes involved in musical improvisation" (p. 9).

The following three studies are examples of research that focused on the creation or adaptation of new teaching strategies. Wetzel (2007) found that jazz methods for middle school students relied too heavily on notation as opposed to aural modeling and subsequently designed his own classroom pedagogy called *Learning Jazz Language* that was found to have successful outcomes in school jazz band settings. Chyu (2004) used an existing improvisation approach

developed by Robert Pace. She expanded the approach and successfully applied it to various levels of keyboard improvisation. Skidmore (2002) examined three Renaissance improvisation treatises, and successfully adapted them to children with little piano experience. These three studies were innovative in their approaches to improvisation by adapting and creating new forms of learning and successfully applying them with students.

Among the many results of the previous studies, the following factors, discussed further in the conclusion of this chapter, were found to be effective or beneficial for teaching improvisation:

- self-evaluation
- knowledge of theory
- experience
- aural modeling
- imitation
- harmonic accompaniment
- a sequential curriculum that focused on aural training
- use of individual compositions as the source for improvisation
- listening to examples from many styles while drawing students' attention to pulse and patterns
- listening
- criticism-free environment
- passion for a style
- openness to learning
- anticipation
- use of repertoire
- emotive communication
- feedback
- flow

Critical Studies in Improvisation

Lastly, a number of recent books have been published from the emerging field of critical studies in improvisation. Lewis and Piekut (2016) have edited Volume One of the *Oxford Handbook of Critical Improvisation Studies*, which covers the broad spectrum of literatures in this emerging field. Heble and Laver (2016) have coalesced a diversity of essays by accomplished authors entitled *Improvisation and Music Education: Beyond the Classroom* in which the authors challenge music education to more effectively adapt to an improvisatory musical landscape. Borgo's (2005) contribution to improvisation studies, *Sync or Swarm: Improvising Music in a Complex Age*, promotes the idea that "fostering improvising music has the potential to overcome the inherent problems of a slow-moving traditional hierarchy, providing an effective way to handle unstructured problems, to share knowledge outside of traditional structures, and to inject local knowledge into the system" (p. 194). Other works in the body of literature on improvisational music practices bear mention for their importance in the field. Nettl and Russell's (1998) edited collection of essays, *In the Course of Performance,* is a survey of literature on improvisation from an ethnomusicological standpoint; *The Other Side of Nowhere: Jazz, Improvisation, and Communities in Dialogue* edited by Daniel Fischlin and Ajay Heble (2004) focuses specifically on jazz improvisation; and *The Fierce Urgency of Now: Improvisation, Rights, and the Ethics of Co-creation* (Fischlin et al., 2013) connects improvisation to struggles in human rights and social change.

Solis and Nettl (2009) presented a collection of essays exploring a range of improvisational practices and pedagogies entitled *Music Improvisation: Art, Education, and Society*. Ed Sarath (2013) has recently published *Improvisation, Creativity, and Consciousness: Jazz as Integral Template for Music, Education, and Society,* which connects jazz to social

transformation. Berkowitz's (2010) *The Improvising Mind* explores improvisation treatises from the classical tradition and situates learning the skill within the domain of cognitive science. This incomplete list represents the emergence of a rich dialogue about the importance of improvisation in the musical context of the 21st century.

Conclusions and Analysis

It is apparent that a rich body of writing and studies in the domain of improvisation pedagogy exists, and while this chapter is only introductory in nature, some conclusions may be drawn that may work towards advancement in the field. Many of the concepts and objectives were identical in the various treatments and studies.

The historical classical tradition of learning to improvise emphasized developing musical understanding while cultivating agility. Students were expected to learn a command of all keys and of their instrument, along with knowledge of harmony and familiarity with the work of great composers. The practice of partimento evoked a musical problem, much like the jazz lead sheet and techniques from the Dalcroze approach. In jazz, as in partimento, students assimilate patterns (*schemata*) and rules (*regole*) to then apply to improvisation, guided by a skeletal score. Training for this kind of problem solving requires the study and practice of musical elements in context. And while the practice of patterns is an aspect of each of these methodologies, the focus on aural training and listening is essential. One prevalent strategy in jazz, impossible in the time of partimento, is the practice of playing along with records in order to develop tone quality, phrasing, and time feel. Developing one's aural understanding and skills is of paramount importance, as demonstrated in the experiments and almost all of the pedagogical treatments covered in this chapter, most notably in the work of Gordon. His emphasis on audiation places listening at the forefront of musical learning, over notation, and musical concepts are learned

within the context of musical works and through improvisation. Furthermore, various studies showed that aural training was superior to notated training techniques.

It was demonstrated that a key objective for learning to improvise must be a familiarity with the chord sequence, and an ability to keep track of one's place within that sequence. One way to practice this is through the use of accompaniment as a practice tool. In jazz, Dalcroze, and Orff approaches to improvisation, as well as in the work of Azzara and Molina, this is an important component. Numerous research studies that were discussed also made use of this strategy with successful results.

The use of feedback was considered essential by Pressing and is supported by research. Feedback not only aids in error correction and adaptation, but serves as a motivational and attention-focusing element. This feedback can be visual or kinesthetic, as well as short or long term. Pressing also stressed the importance of listening to one's own recordings. He suggests that a balance between self-discovery and directed learning with simple instructions is the most effective way to teach improvisation.

Issues of trust, confidence, a criticism-free environment, risk-taking and flow were substantiated, with particular relevance to developing expressivity and creativity.

With this extant body of knowledge, practical applications, and research for learning to play music spontaneously, it bears question why so many musicians remain incapable of improvising. It could be that they simply are not interested in this aspect of music making, or they have not been exposed to it and do not understand it. Perhaps, despite the large body of pedagogical treatments, it still seems inaccessible to many.

It appears that finding a more accessible format with which to learn improvisation may be a positive way to increase the number of improvising musicians in our musical society,

especially within the domain of classical music. Perhaps technology could play a role in this advancement. The following chapter addresses the next research question: What technological tools exist to aid students in the acquisition of musical improvisation skills?

CHAPTER 4: CONSTRUCT/IVISM/IONISM, TECHNOLOGY AND MEDIA FOR IMPROVISATION PEDAGOGY

Technological innovations have and will continue to significantly alter music learning, especially with regards to musical fluency and improvisation. This chapter begins with a theoretical discussion of constructionism and constructivism that works to clarify and situate the importance of technology for 21st-century music learning. Following this discourse is a review of music technology for music learning with specific attention to tools for autonomous study. After this broad overview, a history of media for improvisation is presented, tracing the use of technological tools to aid learning within this specific domain. This historical overview ends with mobile technologies and transitions to the final component of the chapter, an evaluative survey of iOS applications for improvisation.

Construct/ivism/ionism

The inclusion of technology in music learning aligns with the basic tenets of "constructivism", originally a cognitive theory by Jean Piaget, as well as "constructionism", developed by Piaget's protégé, Seymour Papert. Whereas other theories view learning as a primarily cognitive endeavor, constructivism places emphasis on creativity, considers experience as the basis for learning, and seeks to motivate learning through activity (Wadsworth, 1996). Constructivism also posits that learners are more likely to be intellectually engaged when working on activities that are "personally meaningful" (Kafai & Resnick, 1996). In any discussion of technological tools whose aim is to enhance learning, it is important to examine the extent to which these activities provide meaningful educational encounters with music (Cain,

2004). Since various studies have shown that pupils are enthusiastic about music technology (Mills & Murray, 2000; Savage, 2007), it is paramount to consider the potential of music-learning tools to assist in a more creative, student-centered process. While constructivism is applicable to this context, Papert's learning theory, "constructionism" (Papert & Harel, 1991), may provide greater insight into the potential for new tools.

Defined as a student-centered, discovery-based learning process, and often referred to as "learning-by-making," constructionism follows the philosophical foundations of Dewey's notion of experiential education (1948), Piaget's writings concerning "learning by inventing," integral to the development of constructivism (1973), and Bruner's insistence on discovery learning (Bruner & Bruner, 2009). Papert used constructivism as a point of departure in the development of his learning theory. His theory of constructionism differs in its insistence on the importance of creative exploration in the *making of something*, such as an improvisation.

The application of constructionism to the field of music education introduces the imperative of a learning process that emphasizes improvisation as a fundamental objective. The learning theory of constructionism asserts the importance of creativity and exploration in an active learning process (Papert & Harel, 1991). In music, such a process can be more easily achieved if students are given the free will to make choices and assert agency. In cognitive studies, improvisation has proven to be more of an active learning process than reproduction of music by singing, playing an instrument, or moving to a teacher-created dance (Bengtsson, Csíkszentmihályi, & Ullén, 2007; Haier & Jung, 2008). Learning to improvise music applies the learning theory of constructionism to music learning.

Another core idea of constructionism is that we are continuously building cognitive structures as we learn, and as we attain stability with these structures, they become a platform

upon which new structures can be built (Papert & Harel, 1991). Applied to music education, constructionism calls upon students to constantly manipulate the building blocks of music, therefore developing a comprehensive understanding of musical form and elements. Furthermore, Papert's constructionist vision asserts that the role of technology in learning is an essential component in creating new kinds of activities that develop students' doing, learning, and thinking (Harel & Papert, 1990).

Peter Webster is a scholar of music education and technology who has written extensively about constructivism and constructionism applied to music education (Barrett & Webster, 2014; Webster, 2002; Webster, 2011). He argues for models of musical learning that consider the place of technology for engaging students in constructivist learning (Webster, 2011). Constructionism's emphasis on technology as a valuable learning component (Kafai & Resnick, 1996) becomes increasingly relevant as we consider the ubiquity and expansion of technological tools for making and learning music.

Drawing on the field of digital humanities and specifically within the pedagogy branch of this domain, we can imagine the potential benefits of engaging learners by connecting to their interests and technological habits (Hirsch, 2012). Technological innovations throughout the last century have created new distribution models as well as new tools for learning and practicing. In the last 50 years specifically, technology has brought forth complex instructional interactions that have changed the learning landscape significantly. The interactive complexity made possible by these tools may lead to a favorable constructivist paradigm in which users have more control of their learning environments (Reiser, 2001; Siemens & Tittenberger, 2009).

Computers and mobile devices have become ubiquitous and provide great potential to reach a broader student population. Innovative gameplay, a combination of intrinsic and extrinsic

reward, and continuous active engagement may foster an active learning process that resonates with constructionist learning theory.

Jonassen, Myers, and McKillop argue that control of technology should be invested in the learners rather than teachers, thereby becoming a constructionist tool rather than an instructionist activity (1996). With this goal, technologies can be advantageously adapted to constructive learning environments in order to support the making, experiencing, receiving, and creating of music (Folkestad, 2006). Research conducted by experts in educational technology such as Katie Salen (2011) and Mimi Ito (Ito et al., 2013) is helping to clarify our understanding of how young people use digital media. Technology can offer students control over their creative process in a self-directed and personalized manner. Furthermore, learners in the present digital age may be able to benefit from the motivating qualities and ease of access to technology in learning.

21st-Century Learning

It is clear technology will only become more pervasive, and failure to connect with students via this medium could be a great loss. The modern-day student has a drastically different relationship with music than in the past, one in which technology is intricately entangled. Prensky (2012) noted that the "singularity" of the recent shift in musical practice has arisen from the fact that the dissemination of digital technology has changed the world so radically there can be no going back. He coined the terms "digital natives" and "digital immigrants" arguing that today's students are digital natives because they have been surrounded by technology their entire lives. Despite critiques of this theory (e.g., Bennett, Maton, & Kervin, 2008), it is evident that in today's musical landscape, technology presents numerous possibilities for new forms of music creation and learning.

Many scholars have already examined recent technological advances, as well as how they have changed the field and praxis of music education (Bauer, Reese, & McAllister, 2003; Finney & Burnard, 2007; Rudolph, 2004; Savage, 2007; Theberge, 1997; Webster, 2007). For example, young people on the web who are engaged in reading about, listening to, and watching musicians perform are participating in an unprecedented cultural/musical immersion, one that is not defined by location or financial means. Also, listening to music is now often accompanied by a visual component, such as a music video or performance. Watching musical performances on YouTube is currently one of the most prevalent forms of music consumption (Cayari, 2011; Krause, North, & Hewitt, 2015), and through this medium, students can discover music from all corners of the world.

The extensive capabilities of computers and portable devices present the potential for students to have an autonomous and intimate playground for learning, discovering, and engaging in music. With this autonomy, students can be inquisitive, creative, and experimental as they forge identities through the many musical and social processes now available to them. As explained by Finney and Burnard (2007):

> Young people's fluency of access to music, and their capacity to exercise finely grained judgements about the way they choose to use it, create ever greater challenges for the music educator at the beginning of the new century. By the early years of secondary school, young people demonstrate a capacity to design their own music curricula and musical educational program, as well as to question the authority of music in school. Accorded full human rights and entitlements, these young people are quick to show social maturity and an insatiable search for autonomy. Music and its technologies feed their quest. Interaction with and through technology becomes the medium through which their social maturity can be harnessed and matched by intellectual challenge. (p. 2)

Technology for Music Education

Although the field of music education is making efforts to adopt technology as an aid to learning, music educators often feel inept at implementing technology themselves (Bauer et al., 2003). Teaching music with technology often implies knowing less than your students about the teaching tools, and requires a willingness to create a co-learning environment between teacher and student. There is an unfortunate lack of updated theory and curriculum for music education and technology that integrate students' vast autodidactic capabilities and autonomous motivations into positive learning experiences (Savage, 2005).

There is a breadth of ever-growing literature that addresses the effect of technology on music education (Bauer, 2010; Finney & Burnard, 2007; Nickerson & Zodhiates, 2013; Partti & Karlsen, 2010; Rudolph, 2004; Theberge, 1997). While many authors have addressed issues concerning music technology in the classroom (Cain, 2004; Ho, 2004; Petko, 2012; Savage, 2005; Wise, Greenwood, & Davis, 2011), far fewer have discussed the positive potential for technological advancement specifically within the context of autonomous student learning (Tsao-Lim, 2006).

In a study of the use of technology by UK music teachers, Savage (2007) found that despite significant cultural changes, music education in the classroom is still technologically conservative, and has not developed in line with technological advances in other disciplines. Cain (2004) notes that there are many teachers who embrace the use of technology in the classroom wholeheartedly, and others who almost completely ignore it. Teachers who are comfortable using music technology and are aware of currently available tools take advantage of these contexts for engaging their students. Many others, however, teach their students primarily

in the way that they were taught by their own teachers, before new technologies were available (Rostvall & West, 2003).

Tools for Autonomous Music Learning and Creating

Software directed at autonomous learning of musical skills is becoming both more widespread and effective at enhancing the music education of children and adults. Aside from simply functioning as instructional tools for teachers and students, these new learning environments need to be understood as new contexts for musical tuition, outside of the realm of traditional music education (Webster, 2011). These environments hold tremendous importance for the future of music education (Beckstead, 2001; Finney & Burnard, 2007; Greenhow, Robelia, & Hughes, 2009; Rudolph, 2004; Webster, 2011).

Whereas pianos were once found in living rooms as the center of family musical practices, a home studio with a computer can now often be found in the bedroom or basement of a musical family. This provides an isolated laboratory of musical production and consumption (Theberge, 1997). Theberge considers this site an outgrowth of the "democratization" that has occurred through advances in music technology (1997). These technologically-enhanced environments provide the ability to produce music at home, an innovation that has revolutionized and democratized the music industry.

Support for music production in software that offers digital audio editing, loop-based composition and arranging, and notation and composition can likewise be important for creative musical processes. Recording software such as *Audacity,*[9] *GarageBand,*[10] *Pro Tools*[11] and

[9] http://www.audacityteam.org/
[10] http://www.apple.com/ca/mac/garageband/
[11] http://www.avid.com/pro-tools

Cubase,[12] allow students to make high-quality recordings straight from the computer's microphone and soundcard. There are also hundreds of applications that engage students in creative musical composition, ranging from abstract art to intelligent accompaniment and simulators.

Students' ability to digitally record themselves also opens up a range of other creative possibilities. *Cubase,* for example, allows students to put sound to film, and Propellerhead's *Reason*[13] offers composition and post-production capabilities. Self-producing an album is now a feasible possibility. In addition, not only can music be produced with relative ease, but file-sharing and self-publishing allows for the immediate dissemination of the music, a service provided for free by platforms such as *CD Baby,*[14] *Bandcamp,*[15] and *SoundCloud.*[16]

Notation software can also be included in this realm. *Finale*[17] and *Sibelius,*[18] or free notation software such as *MuseScore,*[19]*, Noteflight,*[20] and *Finale Notepad*[21] provide an ability to compose, transcribe, and arrange using traditional notation.

There are likewise numerous programs and websites that offer useful tools for learning music theory, practicing ear training, and developing musicianship skills. Often these websites contain progressive testing software that can be used to report progress to the teacher. *Musictheory.net*, t*eoria.com*, *musition.com* and *emusictheory.com* are a sample of the structured online sources available to learn music theory. *Teoria.com* and *emusictheory.com* also offer ear-

[12] https://www.steinberg.net/en/products/cubase/start.html
[13] https://www.propellerheads.se/reason
[14] http://www.cdbaby.com/
[15] https://bandcamp.com/
[16] https://soundcloud.com/
[17] https://www.finalemusic.com/
[18] http://www.avid.com/sibelius
[19] https://musescore.org/
[20] https://www.noteflight.com/login

training components, as do many other websites specifically dedicated to this purpose such as *iwasdoingallright.com*, *good-ear.com*, *miles.be*, *auralia.com*, *earmaster.com* and *earpower.com*.

Sight-reading practice software presents another tool currently available to students. *Earmaster.com*, *practicesightreading.com*, *sightreadingfactory.com,* and *sightreadingmastery.com* offer auto-generated or musical excerpts sequentially presented for student mastery. Most of the programs that focus on theory, ear training, and sight-reading track students' progress and incrementally increase difficulty, providing students with progressive guidance in learning these fundamental skills.

Performance practice tools such as *SmartMusic*[22] allow students to practice band and orchestra music at home while accompanied by recordings of a full ensemble. With looping, recording, and feedback operations, *SmartMusic* allows students to benefit from more interactive practice routines. *BestPractice*[23] is one of numersou programs that slows down recordings in order to transcribe or study them in greater detail. Numerous applications that present instrument-specific learning tools exist as well.

For example, there are sites and applications for the guitar that may be potentially useful to students learning the instrument. *Guitar Practiced Perfectly*[24] offers a practice log and organizer, and guides students through routines designed to accelerate learning. *Wholenote.com* is a guitar-specific online community that allows members to create and share lessons, participate in forums, and access a range of material such as tablature, play-along tracks, and instrument and equipment demos.

Technological advances in communication are also benefitting music learners.

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[21] https://www.finalemusic.com/products/finale-notepad/
[22] http://www.smartmusic.com/
[23] http://bestpractice.sourceforge.net/

Teleconferencing software such as *Skype*[25] and *Google Hangouts*[26] can allow teaching and learning to occur when a student and teacher are physically separated, for example, through travel or weather complications. Students living in remote areas can study their instrument online with teachers not available in their communities. These students may likewise find value in the growing number of online lesson subscription services such as *www.branchoutguitar.com* by guitarist John Branch. Often these educators include a combination of video lessons, reference material for download, and live video chat.

Students could also benefit from the advent of online music communities, where members can share and discuss their own music, and develop music-related knowledge (Partti & Karlsen, 2010). In fact, many of the websites and software mentioned above also provide online communities where users can interact with each other. These communities can be a source of information, motivation, and identity formation (Salavuo, 2006).

As students become increasingly versed in technological tools and language, it is likely that we will see an even deeper integration of technology and music. More students are becoming fluent in programming languages such as *Supercollider,*[27] *Pure Data (Pd),*[28] *Max/MSP*[29] and others, through which they are learning to create their own musical tools and instruments (Allison et al., 2016). The relatively recent development of Scratch, a simple-to-use programming environment originally designed for use with economically disadvantaged youth in after school programs (Maloney et al., 2004; Maloney et al., 2008), signals an important shift in the educational climate with regards to programming.

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[24] http://www.guitarpracticedperfectly.com/
[25] https://www.skype.com/en/
[26] https://hangouts.google.com/
[27] http://supercollider.github.io/
[28] https://puredata.info/

A further example of the changing climate is the increase of open source software. Open source refers to a popular computer programming trend in which software is developed free from licensing and copyright issues. This allows for programmers to build upon the work of others and facilitates designing software and musical instruments specifically for their own use. In 2011, the International Conference for Research in Music Education (RIME) dedicated their conference to examining how open source technologies can be used in music education. Likewise, in July 2012, a special issue in the *Journal of Music, Technology & Education* was centered on open source solutions for use in music education. In the words of Resnick et al. (2009), "'digital fluency' should mean designing, creating, and remixing, not just browsing, chatting, and interacting" (p. 60).

Though many of these tools can be useful for developing skills needed in improvisation, none are specifically aimed at this particular aspect of music learning. Therefore, the remainder of this chapter will explore the tools and advancements that are specifically pertinent to improvisation pedagogy in autonomous learning settings.

A History of Media for Improvisation Pedagogy

Throughout the literature in music education, there is little mention of any relationship between media and the teaching of improvisation. The following discussion attempts to fill this need, tracing the various forms of media that specifically support music improvisation pedagogy. This discussion has five categories: Instructional Media and Improvisation Pedagogy, Computer Software, Recorded Video Media for Instructional Purposes, Increased Listening Possibilities, and Improvisation Pedagogy on Mobile Phones and Tablets.

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[29] https://cycling74.com/products/max

Instructional Media and Improvisation Pedagogy

Instructional media is a term used to refer to all physical means of delivering instruction including a live instructor, a textbook, or a computer (Reiser & Gagné, 1983). Certainly, an important mechanism for learning improvisation has always been passionate musicians and educators who can offer personalized training in the art of improvisation. Educators breathe human life and spirit into the pedagogy as they work with individuals and their unique characteristics and knowledge.

However, often due to their own inability to improvise, many music educators may not be able or interested in teaching this skill. For this reason, opportunities for autonomous improvisation study with and without technology provide additional ways for musicians to learn and engage with the art of improvisation. As mentioned in Chapter 3, method books for learning improvisation abound, many of which have specifically influenced the pedagogical approaches to classical improvisation in the 18th and 19th centuries, as well as students of jazz in the 20th century. However, this discussion is particularly concerned with understanding the role of technology in media for improvisation. The first important advent in this regard is recorded music.

Recorded Music and Accompaniment

Recorded music can enhance music learning by allowing for repeated listening and study of the music at hand. Known as "records" at the time, phonograph cylinders, invented by Thomas Edison in 1877, were the earliest form of sound reproduction available for commercial use (Thompson, 1995). The first cylinder recordings were sold in America in 1890; before the advent of this technology, it had been impossible to hear music unless it was being performed live (Day, 2002). The first record player became available in 1895, with numerous advancements

on the original design taking place into the 1940s. At this point, the modern 12-inch vinyl LP was released by Columbia Records, replacing the 78s produced from shellac (Thompson, 1995). These new records spun at 33 1/3 rpm, and became the standard form of recorded music. Improvisation in classical music was not common at this particular moment in history, therefore, the following discussion traces the affect these innovations had on learning jazz improvisation.

Listening to jazz became a useful form of study for aspiring improvisors, as recorded music presented an excellent tool for "the transmission of musical skills which are not easily described verbally" (Witmer & Robbins, 1988, p. 12). Listening to records now provided an ability to transcribe music, a common strategy among jazz musicians and students. Records could be slowed down, and despite pitch distortion, provided a useful strategy for uncovering the secrets inside the fast solos of the great jazz players (Berliner, 1994). Panning a track to the right or left allowed users to listen to particular instruments in isolation, a technique that precludes the large business of "minus-one" tracks and "play-along" recordings, which are specifically created to accompany the practice of melody and improvisation.

In the 1930s, the "Acampo Records" were released, providing orchestral accompaniment for practice, as well as "Jam at Home" records with rhythm section accompaniment, produced in the late 1940s (Suber, 1976, pp. 367, 369). The "Music Minus One" series began in the 1950s, providing further material for practicing jazz autonomously (Witmer & Robbins, 1988, p. 12).

In the 1960s, compact cassettes and cassette recorders introduced the widespread ability to record oneself and listen to the performance (Burgess, 2014). Like records, cassettes also presented possibilities for instructional material to accompany method books. The further advent of the low-cost Sony Walkman in 1980 made listening portable for the first time, changing listening habits and introducing the widespread use of headphones (Sexton, 2007).

In 1967, jazz educator Jamey Aebersold published his first play-a-long book and cassette tape in his series *A New Approach to Jazz Improvisation* (Witmer & Robbins, 1988). To date, he has published over 130 collections[30] (Aebersold, 2000). Each publication presents a recorded collection of songs in the form of accompaniment tracks. A companion book contains a description of the appropriate scales that correspond with the harmonic structure of each piece. The accompaniment tracks are played by a professional rhythm section that typically includes piano, drums, bass, and occasionally guitar. For musicians without a network of other musicians to play and practice with daily, this series, as well as the previously discussed accompaniment records, provide a convenient method for practicing improvisation over jazz standards. The instructional material published in Aebersold's accompanying book provides a pedagogical element to the backing tracks that has made them immensely popular among jazz students.

In the latter part of the 20th century, autonomous pedagogies of improvisation have proliferated as the capabilities of multimedia have increased. Compact discs, or CDs, became available in 1982, becoming the next standard for recorded music. Unlike LPs and cassettes, CDs had no loss of quality when mastered and pressed, which meant they sounded as good as the original master. Furthermore, while LPs and cassettes suffer deterioration over time, a CD does not (Day, 2002).

Computer Software for Improvisation Pedagogy

Beginning in the 1970s, computers for home and personal use became prevalent, introducing an increased capacity for transmitting improvisation pedagogy and tools for learning and practicing (Brown, 2007). This environment presented a platform for autonomous learning that has evolved continuously since its advent.

[30] http://www.jazzbooks.com/jazz/category/aebpla

A range of music education software has been released in the last three decades for Windows, Mac OS, and Linux computers. Presenting music learning in a context of computer software provides the ability to align text instruction with audio examples, both for reference, and for practice on an instrument. Some software was not designed specifically for learning improvisation but has nonetheless been successfully employed for enhancing improvisation training. A sampling of software attempts to examine the developments presented in this context.

Following floppy disks and other storage devices, CD-ROMs (Compact Disc Read-Only Memory) entered the setting in 1988 (Sexton, 2007), providing an easier ability for publishers to disseminate larger software. Simultaneously, another important technological advancement in music technology was MIDI. Short for Musical Instrument Digital Interface, MIDI presented new potentials for supporting music learning, including an ability to connect electronic instruments to computers. One development that resulted from this innovation was accompaniment software.

In 1990, PG Music[31] released the *Band-in-a-Box* (*BIAB*) software, a MIDI arranger for Windows that offered musicians the ability to create their own backing tracks to use for composition or to practice improvisation. Today, *BIAB* has developed to employ real audio recordings as opposed to MIDI and is available for Mac OS as well. The fundamental mechanism has not changed as *BIAB* allows the user to input the chord changes, style, meter and tempo, creating personalized backing tracks for solo musicians. The advent of *BIAB* marked an advancement in accompaniment possibilities, facilitating autonomous and customizable improvisation practice. While a pedagogical component has never been included in the software, there is a solo generator that can provide a sample solo over chord changes.

[31] www.pgmusic.com

Other examples of accompaniment software that used MIDI include *MiBac Jazz*, made available on CD-ROM in the 1990s (Ellinger & Baker, 1990), *DigiBand* (Wall, 2005), a drumming/guitar simulator. More recent examples include *OneManBand* (Maas, 2010), which features a virtual keyboard and sequencer, and *SoundTrek Jammer* (*Jammer Professional*, 2016), which creates musical arrangements and accompaniment. These software programs allow players to simulate the experience of playing with live musicians, providing autonomous musical environments in which to hone skills and practice improvising.

Improvisation simulators such as *OMax* (Assayag, Bloch, & Chemillier, 2006) and the related *ImproteK* (Nika & Chemillier, 2012) present systems for human-machine interaction that result in co-improvisations. While not designed for music learning, these emerging software environments may have potential application for the field of improvisation pedagogy.

In addition to accompaniment software, many other uses of computational assistance could be of interest to the field of music education. Simple audio recorders that allow for slowed down playback and looping of particular sections can be useful for repeated practice. Transcription software could likewise be useful as it slows down and loops segments of the music in order to transcribe improvisations. Many examples of music production software allow users to create their own backing tracks along with numerous other capabilities.

A number of instrument specific software programs focus on teaching improvisation within very specific styles. The *Master Solos* series by PG Music teaches users to improvise within the styles of their favorite jazz musicians through transcription, analysis and exercises (*Master Solos Series*, 2011). *Impro-Visor* is free open source software released by Harvey Mudd College (Keller & Morrison, 2007). Though it does not contain a pedagogical sequence, the software does offer improvisors options such as playback, transcription, and a solo generator.

Users can construct solos and determine which notes are consonant or dissonant with the harmony.

Micrologus' *Musician Training Center*[32] is downloadable music education software consisting of various courses, including *Improvisation by Degrees.* The software provides a rigorous introduction to musical elements such as harmony and melodic development in a manner similar to many jazz method books, but not specific to that genre. Besides well-structured lessons, the software also boasts a computer solo generator, giving users the advantage of seeing and hearing individual examples of the specific pedagogical strategies being taught.

Software such as *Children's Musical Journey*[33] incorporate elements of teaching improvisation within a larger framework of music tuition aimed at children. This particular program teaches students the basics of piano playing and music theory, presented by famous animated composers.

Besides computational treatments of musical improvisation, recorded video has likewise presented a plethora of opportunities for learning to improvise.

Recorded Video Media for Instructional Purposes

Beginning with the advent of Betamix (or Beta) and VHS videocassettes in the seventies and eighties, then DVD's in the mid-nineties (Meigh-Andrews, 2013), recorded video media have provided the opportunity for teachers to record and disseminate video lessons to teach many aspects of improvisation. Teachers effectively reached much broader student populations through this medium (Willis, 1992), providing in depth explanations and modeling examples. Book and DVD combinations, or book and CD-ROM sets, provided additional advantages such as incorporating software features and other media.

[32] http://www.micrologus.com/

The World Wide Web

Connecting the world together in new ways, the internet has had a profound effect on our music culture since its advent in 1994 (Brown, 2007). Before discussing the implications for instruction made possible by the internet, the changes in music listening behavior due to this technology are addressed.

The internet provided for the first time the ability to hear almost any musical recording. Relatively new audio formats such as the Waveform Audio File (WAV) and the MP3 could now be easily distributed (Day, 2002). This allowed those involved in music to hear and discover a wide range of artists and to evaluate and learn from various interpretations of musical works. Whereas once our listening was limited by the amount of records, tapes, or CDs that were available in local record stores or libraries, since the advent of the internet, students are able to access a plethora of audio files in seconds (Day, 2002).

As music became digital, the Walkman was replaced by Apple's iPod, first released in 2001, and similar portable media players, which provided users with the ability to carry thousands of songs, downloaded from the World Wide Web, on a small device (Bull, 2006). A more recent change to listening occurred through the advent of monthly subscription streaming services that provide the user with the ability to hear an ever increasing amount of materials. Spotify, as an example, currently has an estimated 30 million songs (Williams, 2015) and 100 million users ("Spotify monthly active user base reaches 100 million," 2016), 40 million of whom are paying users (Resnikoff, 2016).

YouTube has been an exceptionally influential advancement in the history of music and music education. Created in 2005, YouTube is the third most visited website in the world,

[33] www.aventus.com

following only Google and Facebook (Cayari, 2011). YouTube is a site for music listening, especially among younger audiences, boasting historic music performances and newly released music videos. This new venue for music listening and sharing provides the added advantage of a social infrastructure (Cayari, 2011).

The site has also helped to spread and increase the number of video lessons available. Educators ranging from amateur to professional post video music lessons covering a wide selection of musical subjects, including improvisation, or 'jamming'. A recent study into YouTube music lessons (Kruse & Veblen, 2012) found that the videos tend to be geared towards beginning music students and that opportunities for improvisation were infrequent. The quality of the instructional material also varies greatly.

Since the advent of the world wide web, educators have had increased ability to share their pedagogical methods on websites that contain a combination of text, audio, and on occasion, video. Many of these websites are personal sites, but websites like *Udemy*[34] provide a marketplace for instructional resource videos. *Udemy,* founded in 2009, hosts numerous videos for learning improvisation such as the video by classical and jazz pianist Jeffrey Chappell (2014). Established in 2002, Berklee College of Music is an example of an online extension school that offers improvisation courses, as well as certificates and degrees ("Improvisation Courses, Certificates, Degree - Berklee Online," 2002).

Peter Shubert, a music theorist from McGill University, has created a series of videos for learning to improvise a canon (2012). Schubert is an expert in counterpoint, which he has identified as improvised polyphony rather than strict composition (Cumming, 2013). His first

[34] https://www.udemy.com/courses/

video on YouTube has over 13,000 views, indicating the dissemination of a little-known form of improvisation pedagogy in the classical tradition.[35]

A number of websites dedicated to improvisation pedagogy exist. Some notable examples include jazz support for improvisation such as www.playjazznow.com by bassist Bill Harrison, www.jazzadvice.com by Forrest Wernick and Eric O'Donnell, www.chickcoreamusicworkshops.com by pianist Chick Corea, and pianist Dave Frank's website www.davefrankjazz.com. Outside of jazz, www.musicarta.com, www.improviseforreal.com, www.pianoforall.com, www.kenzuckerman.com, and www.improvinsights.wordpress.com written by Jeffrey Agrell are a few examples of additional resources for improvisation.

Improvisation Pedagogy on Mobile Phones and Tablets

The recent advent of devices such as smart phones and tablets has introduced yet another new medium for educational technology (Kearney et al., 2012). These devices are fast and have significant storage capabilities. Software applications for mobile devices are relatively inexpensive and can be downloaded and used on mobile phones and tablets. Previous media lacked the convenience and simplicity of having one's instructive media in-hand at any moment of the day. These devices have the unique addition of touch-screen capabilities, opening up new potentials for interaction with music. They also provide the ability to have many forms of media embedded together in one interactive application. Instructional material and music recordings can be presented together in new ways.

Software applications for learning to improvise are among the wide variety of educational software being released in the ever-growing market of mobile applications. There are a number of benefits of using this context for learning improvisation. Mobile devices can make the ability

[35] https://www.youtube.com/watch?v=n01J393WpKk

to transpose music examples and notation both simple and portable, providing advantages to text- or audio-based pedagogies. Playback tempo can also be easily manipulated, and some applications offer the ability to record. Recording can facilitate self-evaluation by providing the ability to listen back to one's own recordings (Morrison, Montemayor, & Wiltshire, 2004). A mobile device can also make it decisively simple to send recorded improvisations to teachers for feedback. The following section will examine more closely the available tools for learning to improvise on mobile devices.

An Evaluative Survey of Existing iPad and iPhone Applications for Music Improvisation

Smartphones are now ubiquitous in our society, with an estimated 64% of Americans owning a smartphone in 2015 (Smith, 2015). Of this majority, 30% of smartphone users in the US accessed educational content on their device in 2013 (ibid). Because they came into widespread use only recently – the iPhone was unveiled in 2007, and the iPad in 2010 (Arthur, 2012), our understanding of their place in the domain of music education is not yet fully understood. While some researchers and educators have looked at this new context for music learning (Kuzmich, 2014; Rinsema, 2012; Brown, 2014; Moreno, 2014), no one has of yet looked specifically at the available applications for learning to improvise on mobile devices.

As such, this survey is guided by the following research question: What software applications exist for iPads and iPhones that are intended to teach or support the practice of musical improvisation on one's instrument? In order to answer this question, a survey of individual software for music improvisation currently available on the iOS App Store has been completed.

Background Information

After the iPhone 3G was debuted in 2008, the term "app" was adopted to refer to the applications available on a mobile device ("app - definition of app in English | Oxford Dictionaries," n.d.). This term has come to represent smaller applications that are quick to open and easier to operate than traditional software, primarily due to the natural constraints of the mobile hardware. The word has become synonymous with application, however it is more frequently used when referring to smaller, more specialized software.

The iOS App Store first opened in 2008 as a distribution platform for mobile apps on iOS[36] (Friedman, 2013). As of June 2016, the iOS App Store had over two million apps available for download ("App Stores," 2016).

Due to the inherent subjectivity of observational interaction, this survey is being called an evaluative survey. Ideally, the confluence of subjective and objective facts does not distract from the overall goal of being an informative tool for educators, music learners, and developers. Each of the 65+ apps below were found via the Google search engine coupled with the iOS App Store search engine embedded in the App Store between January and October of 2016. The App Store provides complete descriptions of the apps, screen shots (images) from the app, and reviews, when available. This information helped to classify the apps according to general characteristics. Some of the apps contain variations that are published as separate apps but are reported together in one entry. Most of apps were downloaded and tested for a period of five to forty-five minutes from January to October of 2016. Based on these testing sessions, observations about the app are included in the following survey when deemed helpful.

[36] the Apple operating system used on mobile devices

This survey is limited to apps that are available for iPhone and iPad in the App Store; Android apps[37] are excluded due to an initial analysis that revealed a great deal of repetition between the two stores. Android apps are available on the Google Play store. Preliminary research into the Google Play app store found that many of the apps in this survey are also being sold on the Google Play marketplace, especially those that are from more well-known and/or popular publishers. There are also a number of titles that are exclusively available on Apple devices as well as a collection of apps that appear to be only available on Android.

The apps included in this survey were listed on the App Store as being available for download in Canada and/or the United States. A future study in the same market would differ in reflection of the continual publication of new apps and the removal of others from the market.

Three pricing strategies are commonly used for mobile apps, across platforms: freemium, premium, and subscription (Deubener, Velamuri, & Schneckenberg, 2016) with freemium being is the most highly employed. In this model, apps are free to download with some of the features inside the app made available for purchase. This gives the user the advantage of being able to experiment with the app first prior to purchase. With Apple devices it is simple to make small purchases individually, so this provides the further benefit of being able to incrementally invest in the software. For many of the apps discussed in the study, this model allows developers to have users download one song or one collection of backing tracks at a time.

Premium apps are apps that have a fixed download price. Eventual upgrades to the software are then free to the purchaser. The final pricing model is subscription-based services; for example, *Jazz Conception Company* has a yearly subscription that entitles a user to watch the

[37] Android apps are apps that run on the android operating system, as opposed to iOS. They are sold in the Google Play Store.

10 videos and access the extra content as frequently as they would like throughout the year. *SmartMusic* uses a subscription model as well, providing access to all content for a yearly fee.

It is difficult to ascertain the number of users who have downloaded an app, as Apple unfortunately does not make this information available. Researchers have created algorithms for inferring approximate numbers based on public data and inferred rank demand in the App Store (Garg & Telang, 2011). Viewing the number of ratings and reviews may help ascertain approximately how many users there are per app. *App Annie* is an online Analytics company that provides paid services for deep market and competitor analysis ("*App Annie*," 2016). They also have a number of useful statistics available at no cost concerning the individual apps on the App Store. In September and October of 2016, these statistics were consulted in order to determine App Store ranking information.

This evaluative survey found over 65 apps, from 30 companies that purport to assist the learning or practice of musical improvisation. There are many metrics and features that can be used to classify these apps. For the purpose of this survey, the apps are grouped into three broad categories, broken down further below:

1. Instructional apps – these apps provide instructional sequence and pedagogical depth.
2. Accompaniment apps – this group includes all types of musical accompaniment specifically designed for employing while one improvises.
3. Reference apps – these apps contain primarily reference material for improvising on one's instruments.

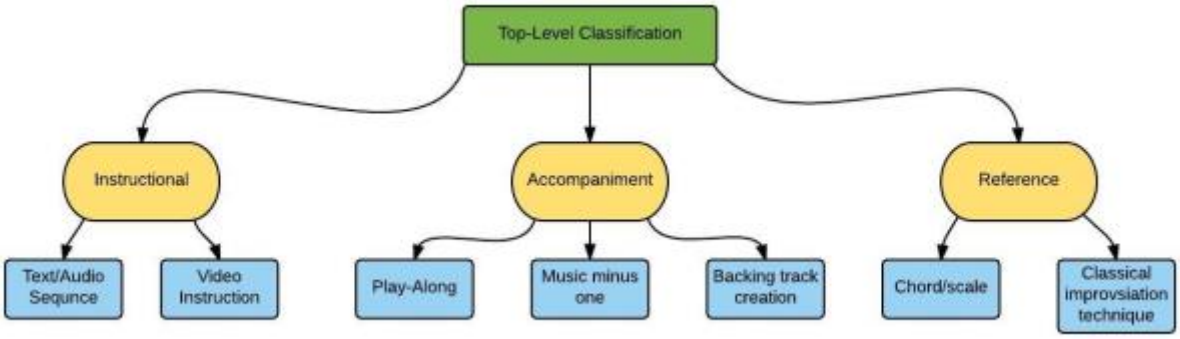

Figure 4-1: Top-level classification of apps

Organized in the categories described above, in the following sections, the apps are each outlined in detail. A final section presents a collection of apps that support creative music making and engage users in improvisatory musical play. They are not included in the primary classification because they do not address learning improvisation on one's instrument, however, these apps are useful tools for engaging students in improvisational music making. Their creative musical constitutions support playfulness, invention and creativity, characteristics with particular resonance for those wishing to learn or teach musical improvisation.

Instructional Apps

This first category involves apps that are specifically designed to teach improvisation with sequential pedagogically guided material. These apps are the most similar to method books, as they offer instruction and support for improvising. Each of these apps could be considered a stand-alone tool for learning to improvise. They have been broken down into two categories: text/audio sequences and video instruction. Those in the text/audio sequence category are instructional frameworks that provide users with an interactive sequence of text and audio. The video instruction apps use video as the primary medium of training, supplemented with exercises

and play-along tracks that correspond to the video segments. Figure 4-2 is a chart that outlines the classification and titles of the instructional apps.

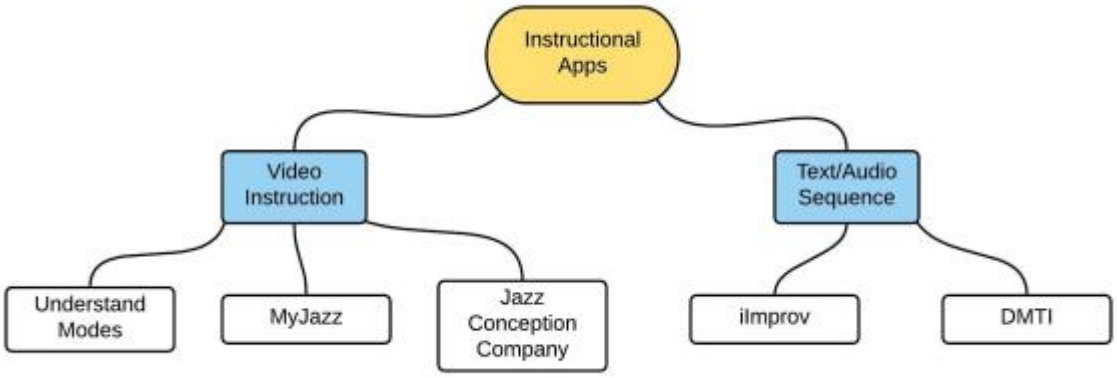

Figure 4-2: Second-level classification–Instructional Apps

This first subsection of apps is unique in that they each present a sequence of activities for learning music improvisation on one's own instrument. There are only two that were found to meet this criteria, *Developing Musicianship through Improvisation*, and the *iImprov* series. These apps do more than just provide reference tools and/or play-along, and may actually guide the user in a complete instructional sequence. These apps do not make use of video, using instead a combination of text, musical notation, audio examples, and play-along tracks for users to practice with their instrument.

Developing Musicianship through Improvisation (DMTI)[38]

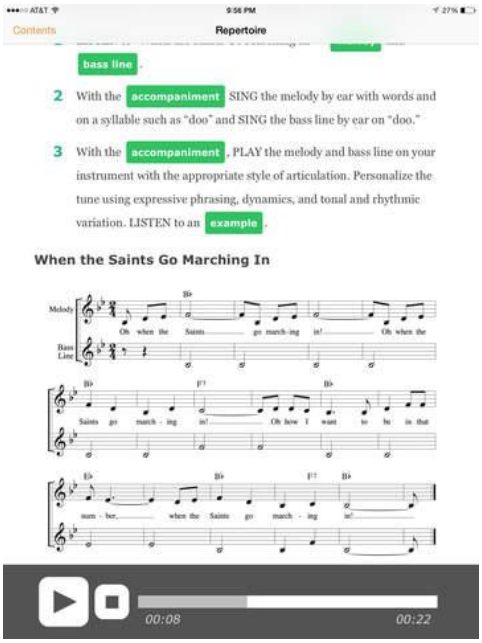

Figure 4-3: DMTI screenshot

This app was developed by Christopher Azzara and Richard Grunow from the Eastman School of Music, using content from Books 1 and 2 of the *Developing Musicianship through Improvisation* series, originally published in 2006. The app became available in 2015, and thus far has two modules. *DMTI* has a logical sequence of tasks that support a user in the learning process of stylistic improvisation. Notably, the app has users focus on one piece of musical repertoire at a time, and walks them through a series of listening and performing exercises taken from isolated parts of the music. At present, there are only two songs lessons available on the App Store, Joshua, and When the Saints Go Marching In. The original pedagogy from the book series is not dissimilar from the practices of learning to improvise jazz found in many published pedagogies. However, from an interactive standpoint, the app is lacking an incorporation of technological affordances. It functions in many ways like an eBook – the user scrolls down the page, clicking play and listening and performing with the iPad. Backing tracks are included for practice with the songs.

This app is suitable for musicians from an advanced beginner performance ability, as reading notation is necessary to at least some degree. The musical material however is not complex, allowing young students and beginning instrumentalists to be directed in first steps

[38] https://itunes.apple.com/us/app/developing-musicianship-through/id921392453?mt=8

towards improvisation. Using the simple tonal and rhythmic vocabulary of these two songs is much simpler than starting improvisation with jazz.

iImprov Series[39]

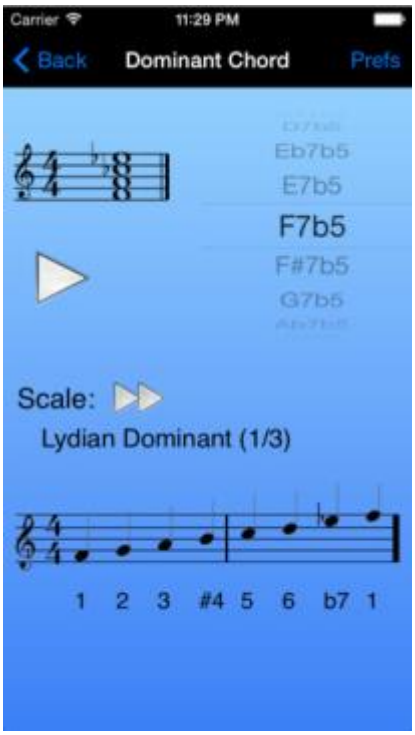

Figure 4-4: iImprov screenshot

This jazz improvisation series is the other app in the survey found to have significant depth of pedagogical content. The series includes six total apps: Chord/scale compendium, Fundamentals, Modal, The Minor ii-V, Bebop, and Contemporary.

Each of these apps includes lessons and "Jam-a-longs" that can be looped. The lessons are in the form of scrollable text and notation. Both tempo and key can be modified in the play-along tracks. Some demonstrations of particular concepts are also included. The apps are not instrument specific, and the ability to transpose the music selections make them applicable to most instruments.

The series is a popular tool for those learning to improvise jazz, as is reflected in the download numbers on *App Annie*. Content is similar to many jazz method books, providing a clear explanation of chord/scale theory. However, the addition of multimedia components augments the pedagogical functionality.

Video Instruction Apps

The following three apps, *Jazz Conception Company*, *My Jazz*, and *Understand Modes* use video as the primary medium for delivering improvisation instruction. Video has many

[39] http://jazzappsmobile.com/

advantages, capable of representing many of the nuances that are otherwise only possible in live interaction with a teacher. The teacher can model and explain with inflection, particularly useful when talking about a subject as alive and deep as musical improvisation. The apps that are listed below also take advantage of the ability to intertwine video and text lessons, along with notated musical examples and play-along tracks. They are in many ways similar to the medium introduced in 1995, DVDs. However, these apps have added features and the ability to be entirely portable on one's personal device.

Jazz Conception Company[40]

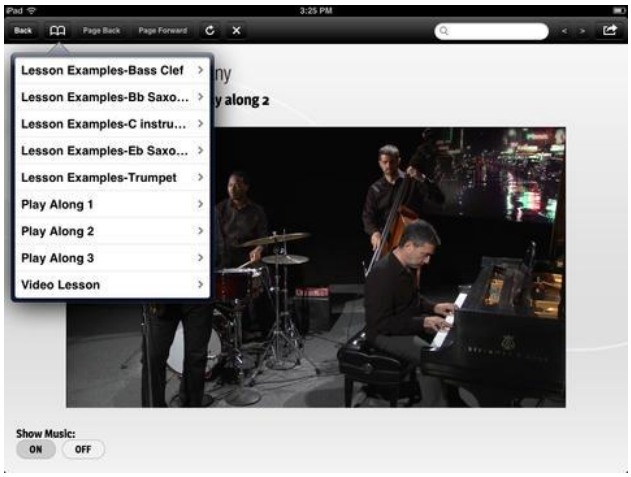

Figure 4-5: Jazz Conception Company screenshot

Jim Snidero is an American jazz saxophone player who has performed and taught widely over the last three decades. He has a popular method book series of etudes and with *Jazz Conception Company* has created two video collections, one specific to saxophone, and the other, offering jazz improvisation instruction on any instrument. This collection, accessible on a computer, but offered on portable devices as well, makes use of features such as play-along tracks and downloadable pdfs. The video lessons are supported with notation that is fully transposable for any instrument.

This app differs from most apps in this survey as it is based upon a subscription to the material, accessible even on one's computer. The subscription has a cost of $49.99[41] per year, significantly more than most apps on this list. This service was not tested for the present survey,

[40] www.jazzimprovisation.com

however, Snidero is a reputable jazz educator and his product has the backing of many well-known jazz educators on the website.[42]

MyJazz[43]

Figure 4-6: MyJazz screenshot

Similar to the previous app, *MyJazz* offers a subscription for accessing a collection of 25 digital lessons. Ben Wilcock teaches these lessons, which are focused on learning jazz on the piano. The subscription includes video and supporting documentation.

There are high-quality backing tracks with which to practice, and topics include all aspects of playing jazz piano, not just improvisation. No ranking information for Canada or the US exists at present, and therefore the present usage of this app is unclear.

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[41] All prices are in US dollars.
[42] https://www.jazzimprovisation.com/
[43] http://my-jazz.com/

Understand Modes[44]

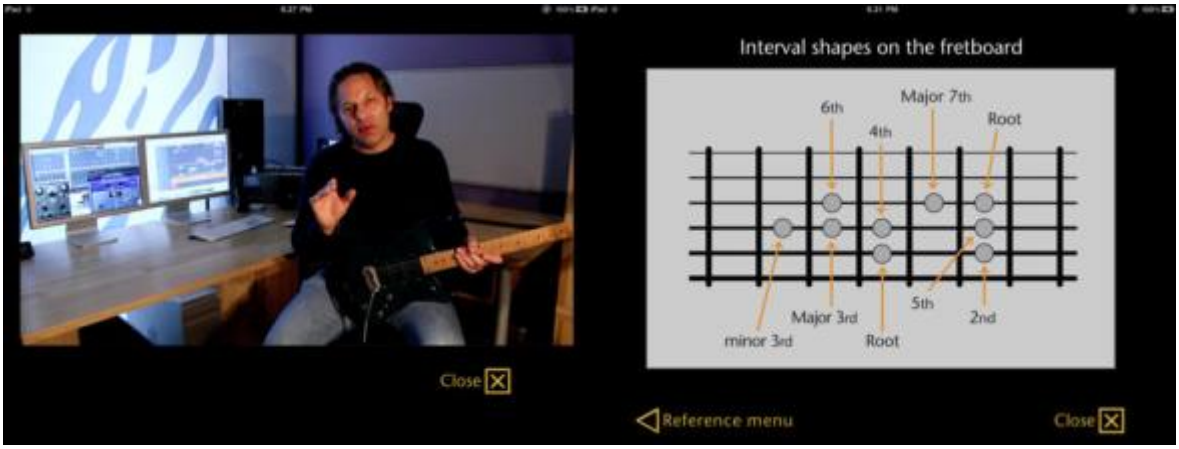

Figure 4-7: Understand Modes screenshots

This video instruction app features the musical instruction of Mark Wingfield, a British guitarist as he explains the use of modes for improvising on the guitar. It is similar to the previous two apps in its inclusion of video and text. Although rich with diagrams, this app does not make use of play-along tracks. It is not a subscription, rather the app may be purchased for $1.99. This app presents an affordable resource and practice tool for guitarists interested in learning how to use modes in their improvisations.

[44] https://itunes.apple.com/us/app/understand-modes/id502571435?mt=8

Accompaniment Apps

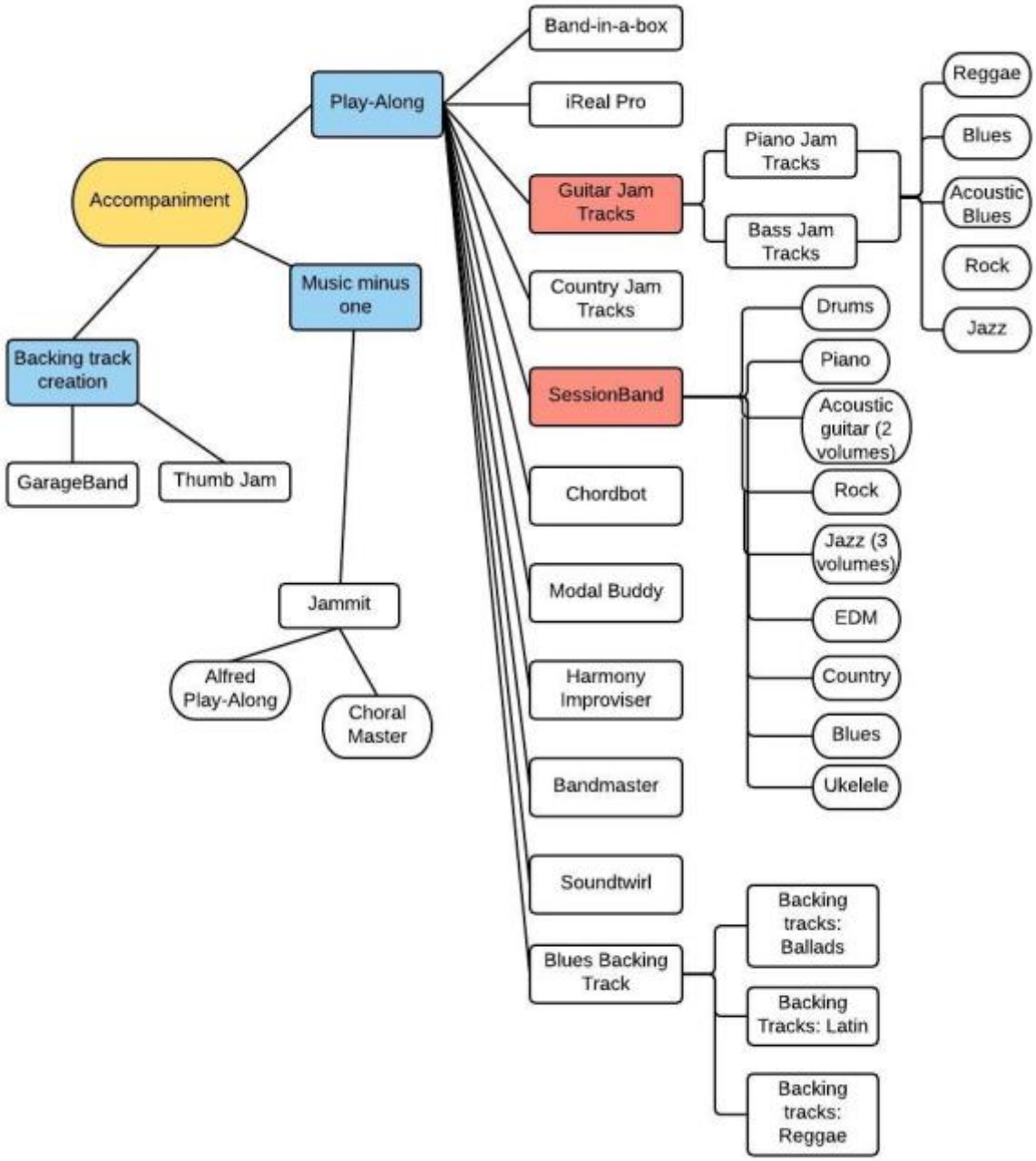

Figure 4-8: Second-level classification–Accompaniment Apps

Since almost the very beginning of iPhone apps in 2008, software developers have been making play-along apps. Having these backing tracks to accompany improvisation in a handheld device is an innovation with regards to improvisational practice media. What once required a

group of musicians can now be accomplished with a few clicks on a device that is often in the users' pocket. Sometimes known as a jam-track, the music in a play-along track provides structural support over which a musician may practice improvising. Play-along tracks are used to emulate playing along with a band, allowing users to practice musical elements and figures in time rhythmically and in harmonic and temporal contexts. The following apps vary greatly, but all have in common the primary objective of providing users with backing tracks for working on improvisation. Some use MIDI, some use audio samples, and some use recordings of live musicians. Some use well-known music, some have complicated structures, and others are simple one chord vamps. Some of the apps provide the user with the ability to manipulate the tracks to varying degrees, while some are limited to predetermined tracks.

The use of accompaniment for practicing improvisation is commonplace. The largest number of apps in this survey are within this category, as it takes advantage of a notable characteristic of mobile devices—the easy access and adjustability of audio tracks. Having this auditory and structural point of reference provides a foundation for practicing improvisation. Stylistic improvisation follows specific harmonic, rhythmic and formal structures, and auditory accompaniment gives context for students to practice patterns and experiment with their instruments. It offers the benefit of hearing how one sounds when together with an ensemble, thus preparing students to play with live musicians. These accompaniment apps are broken down into three categories: play-along, music minus one, and backing track creation. Play-along refers to pre-made accompaniment tracks, music minus one refers to the subtraction of one musical instrument, and the backing track creation category refers to apps that assist the user in building their own backing tracks.

Play-Along Apps

As previously discussed, Jamey Aebersold began publishing his collections of "play-a-longs" book and tapes in 1967, and has since released 135 collections on book and CD[45]. In the 1990's *Band-in-a-Box* was released as a MIDI music arranging software. These two products have been useful tools for thousands of jazz students around the world, as they provide a harmonic and rhythmic base over which to practice improvising.

Band-in-a-Box[46]

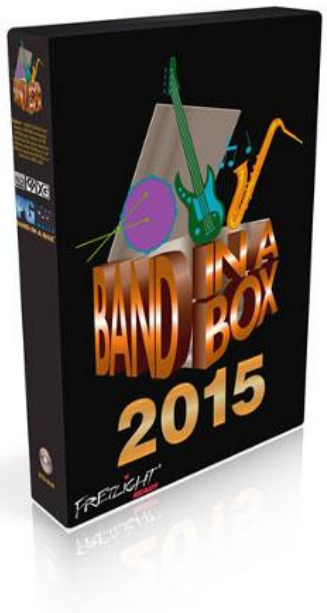

Figure 4-9: Band in a Box

Band-in-a-Box was the original backing track creation software, originally released for use on Windows and Atari in 1990. This software is and has been a useful tool for many aspiring as well as accomplished improvising musicians, especially within the world of jazz (Dunscomb & Hill, 2002). Unlike play-along tracks in the Jamey Aebersold collections that are fixed, *Band-in-a-Box* allows users to input chord changes and create backing tracks in any number of styles with adjustable tempos and keys. Whereas once the software was strictly MIDI, current versions have thousands of real tracks available for use as well and present day performers seeking accompaniment for solo performance in a variety of contexts may use *Band-in-a-Box* as backing tracks for live performance.

Band-in-a-Box is software for purchase, on one's computer, with a base price of $129. Once the software is purchased, there is an iPad version that will allow users to use the software

[45] http://www.jazzbooks.com/jazz/category/aeball

on their portable device as well. With a price ranging from $129 to $669, *Band-in-a-Box* is the most expensive software in this survey. The recent rankings[47] of 979 in September 2016 in music in Canada, and 1368 in October 2016 in the music category in the US, suggest a small base of users. However, the forums on the Band-in-a-Box website suggest that there is a steady base of dedicated users.

iReal Pro[48]

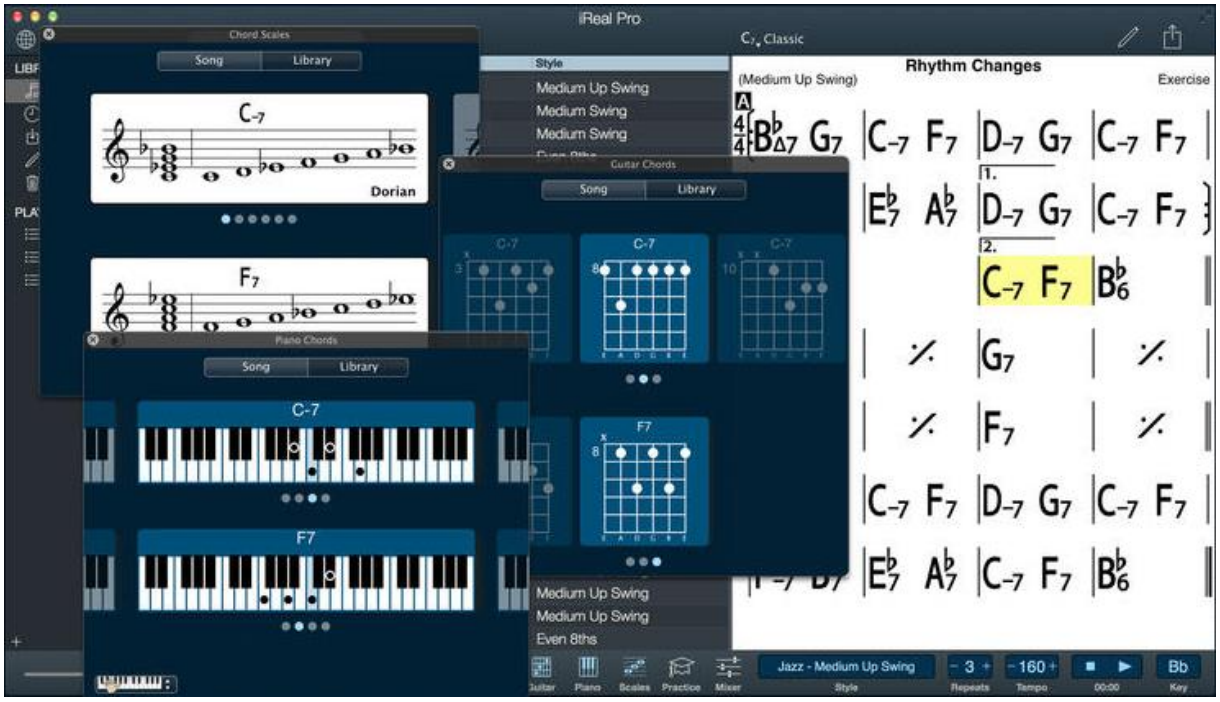

Figure 4-10: iReal Pro screenshots

As the price for *Band-in-a-Box* has increased, *iReal Pro* has entered the app market and garnered a considerable audience. The simplicity of the app makes it practical for musicians, as it provides backing tracks for practicing a vast selection of songs. Thousands of backing tracks have been uploaded to the forums, which are freely accessible from within the app, or users can make their own tracks. Besides the backing track, *iReal Pro* also offers the ability to display

[46] www.PGMusic.com
[47] App Annie website

chord charts for guitar, piano one hand, and piano two hand. It therefore crosses over into instructional material and offers beneficial features for students of improvisation, as well as seasoned improvisors seeking to amplify their repertoire.

The price of the app is $14.99, a one-time purchase. The versatility and simplicity of the tool combined with the extensive library of songs accessible for free download make this tool a useful resource for musicians. The app has 126 ratings on the App Store, with an average of 4.5 demonstrating extensive use and a favorable reception. *iReal Pro* is often in the top ten ranked apps in the music store in the US and has high popularity in Canada as well. It has reached number one in the Music category of the App Store in 75 countries[49].

Guitar Jam Tracks[50]

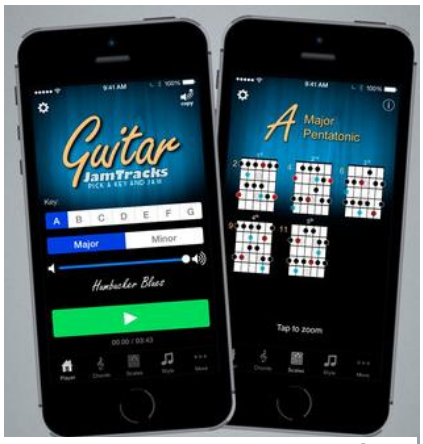

Figure 4-11: Guitar Jam Tracks screenshots

Ninebuzz has multiple apps that incorporate scale training with play-along tracks, such as *Guitar Jam Tracks – Scale trainer and Practice Buddy* (2015). There are 14 different *Jam Tracks* apps for iPhone (only four available on the iPad). These apps are offered for guitar, bass, and keyboard, within the genres of blues, acoustic, acoustic blues, jazz, modal, rock, and reggae. Each app provides play-along tracks as well as chord and scale shapes on the instrument at hand. By using two different colors in the scale notation, the app indicates which notes are in the particular chord and which notes are passing tones. There is a strong focus on pentatonic scales.

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[48] www.irealpro.com
[49] Statistics from App Annie website
[50] http://ninebuzz.com/jam-tracks-app/

Despite the limited scope of instruction, there are numerous pedagogical elements in this collection of apps.

Having the backing tracks in conjunction with corresponding scales is certainly a benefit, however, this particular app has only major, minor, pentatonic, and blues scales. The interface is easy to navigate and the play-along tracks are good quality recordings, making this a useful app for practicing improvisation. The diagrams clearly tell users what notes are harmonically related without complicating matters with extraneous information. The guitar app costs $4.99 and has 141 ratings on iTunes with an average of four and a half stars. This scale trainer app has over 800 ratings and numerous reviews, as well as being offered in nine languages. It is the most used improvisation app in this survey. Many of the reviews are positive, with users reporting that they enjoy practicing improvisation with the help of these apps.

Country JamTracks[51]

Not from the same company as the previous app, *Country JamTracks* is a simple app offering six country backing tracks. The backing tracks are presented in isolation of any accompanying information, offering no guide for determining appropriate scales for accompanying. However, this app is the only country music backing track app besides the country app included in the following, more robust software collection, *SessionBand.*

[51] https://itunes.apple.com/ca/app/country-jamtracks/id434512030?mt=8

SessionBand[52]

Figure 4-12: SessionBand apps displayed in the App Store

SessionBand has a collection of apps that function as chord-based backing track creators. Each of the apps use an audio-roll visual editing screen that makes inputting chords simple. The app has features such as record, transpose, and automated mixing, auto-transpose and Audiobus capabilities (the ability to use the app in conjunction with other apps).

Initially released in 2012, the *Session Band* app collection has expanded to 13 apps, available on both iPhone and iPad. Each particular app is dedicated to one style: jazz (three volumes), acoustic guitar (two volumes), piano, EDM (Electronic Dance Music), rock, country, blues, drums, and ukulele. The app has been translated into 21 languages and has a substantial quantity of reviews, indicating widespread usage.

[52] http://www.sessionbandapp.com/

Chordbot[53]

Figure 4-13: Chordbot screenshots

Chordbot is a simple accompaniment tool that allows users to select chords and adapt them into songs by controlling parameters such as chord inversion and effects on the chosen instruments for playback. The simple user interface for controlling the arrangements and mixes make this a useful app for accompanying improvisation.

Figure 4-14: Modal Buddy screenshot

Modal Buddy

Backing tracks in conjunction with theory concerning scales and modes make this application a useful app for learning to improvise modes on the guitar. Modes are an important subject in many pedagogies of improvisation as they may be found in virtually every genre of music. Modal Buddy is one of few apps that deals exclusively with this subject.

[53] http://www.chordbot.com/

Harmony Improviser[54]

Figure 4-15: Harmony Improviser screenshot

This app is a basic generator of play-along accompaniment of short harmonic progressions, generated by the user, or selected from a list of options. The app presents harmonic sustain, completely independent of rhythm, and the particular chord selection may make this a particularly useful practice tool for classical musicians. As seen at the top of Figure 4-15, users are given four instrument choices for the playback which trigger the corresponding harmonic pads. Figure 4-15 also displays the circle of fifths key selector. Chord choices are displayed for the diatonic notes in the key, and include 7ths, 6ths, 9ths, dominant, sus chords,[55] and diminished chord options. Audio is played with a pad MIDI effect and the chord progressions are customizable by the user. While not solely for classical music, the app easily supports classical harmonic theory. The app is purely harmonic pedal/pad tones and is limited by the lack of rhythmic features for the play-along tracks.

Bandmaster[56]

Bandmaster provides jazz and blues customizable backing tracks, programmed by the user. Using a chord chart-style of notation, it is similar to *iReal Pro* and jazz chart notation. There are templates as well as fully customizable options for creating backing tracks, all playable using the samples included in the app. The app is easy to navigate, allowing for customization of bass, drums and piano tracks.

[54] https://itunes.apple.com/ca/app/harmony-improviser-harmonic/id966607333?mt=8
[55] sustained chords
[56] ogame.com/bandmaster.html

Figure 4-16: Bandmaster screenshots

Soundtwirl[57]

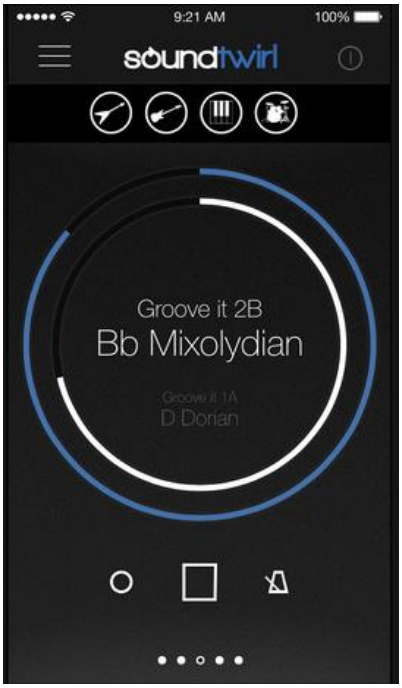

Figure 4-17: Soundtwirl screenshot

This app is focused exclusively on playback of a particular set of customizable play-along tracks. The app, which comes with six songs, allows users to choose between 16 musical styles and define the key and tempo of the track. Sessions may be created by adding multiple tracks to a playlist, which can then be saved and shared. Inter-app audio support (Audiobus) allows users to play along with the app on other iPad instruments, or use their own instrument with virtual amps or audio FX on their device. The primary scale corresponding to the backing track is also displayed, with multiple instrument views possible.

There are options for displaying guitar, piano and drum diagrams, as well as music notation, lead sheets, and grand staff notation for pianists. Users have the ability to record

[57] www.soundtwirl.com

improvisations within the app, mute or solo any instrument in the jam track, as well as loop the track.

One limitation is the inability to program self-composed tunes into the software. There are only six different tunes available in the free download of the software with in-app purchasing possibilities to increase the library. Each additional track is $.99. There are 12 ratings so far, averaging 4 star and it is available in 31 languages.

Woodshedr[58]

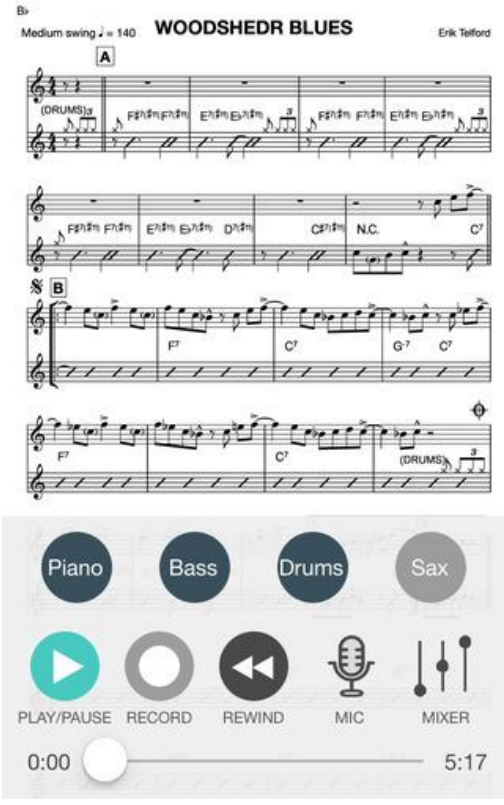

Figure 4-18: Woodshedr screenshot

Woodshedr is a play-along app that provides users with lead sheets of the available songs on the app, as seen in Figure 4-18. This software uses backing tracks recorded by professional musicians as opposed to samples. An asset of this app is the ability to record one's performance with the microphone on the device. Whether this is done for personal use, for sharing with a community, or for use with a teacher in order to receive feedback, recording one's improvisation in an app is a particularly promising advance of mobile technology. Another interesting feature of the app involves automatic scrolling of the musical score, in time with the playback, which simplifies playing one's instrument. Unfortunately, there are only a few song selections available to download.

[58] https://woodshedr.com/

Other Backing Track Apps

There are other backing track apps available that have no additional features beyond the backing track itself. Some of these provide music for more niche musical genres. For example, *JustDrones*[59] is for practicing with tunable Irish bagpipe drones and *iTanpura*,[60] which boasts a tanpura and shruti box sound for practicing Indian classical music. Other drone apps exist, as well as various basic blues apps such as *Blues JamTracks*[61], and *Blues Backing Tracks*[62].

Music minus one

"Music minus one" refers to the ability to listen to audio recordings while excluding one instrument from the playback. This allows users the ability to practice their own instrument within the broader context of an ensemble's recording. There has been one company to publish music minus one apps, constituting the only collection of apps in this sub-category.

Jammit[63]

Figure 4-19: Jammit screenshot

Jammit, *Alfred Play Along*, and *Choral Master* are three apps created by Jammit, Inc. that offered the ability to isolate or to remove an instrument from the original multitrack master recordings. The idea behind this collection of apps focused on the ability to substitute one's own playing within the original context of the entire

[59] http://www.tradlessons.com/JustDrones.html
[60] http://upasani.org/home/itanpura.html
[61] http://www.guitarjamz.com/app/blues_jamtracks/#
[62] https://itunes.apple.com/us/app/blues-backing-tracks/id423070636?mt=8
[63] https://en.wikipedia.org/wiki/Scott_Humphrey

band, minus one particular instrument. The app also allowed for isolation of just one instrument, which may be useful for deciphering elements of the music. Removing an instrument from a professional master recording and improvising in its place has benefits over playing along with lesser quality recordings.

Jammit is no longer available, and has been removed from the App store. Music minus one applications present an interesting and useful mechanism for music learning and can be especially useful for practicing improvisation.

Backing track creation

The possibilities are numerous for creating one's own backing track "from scratch" on the iPhone and iPad. While Band-in-a-Box is explicitly for this purpose, full features, including creating musical tracks, are only available on Windows or Mac computers, not on mobile devices. There are, however, hundreds of music production apps on mobile devices that can be creatively used to design all or some of the elements of an audio track with which one may improvise. Many of these are relatively simple to use and provide users with an opportunity for experimentation. User-friendly interfaces and a wide variety of sounds and options are some key features. *GarageBand* and *ThumbJam* are often cited as good examples, and have been employed in studies with young people and iPads (Carlisle, 2014; Giotta, 2015; Healy, 2016; Hickey et al., 2016). These applications can be used to create a composition, or just a simple loop, for use as a backing track (by a teacher or student). They also provide powerful and user friendly internal instruments that can be used for improvising.

Figure 4-20: GarageBand screenshots

GarageBand[64]

The robust and well-designed combination of touch instruments, audio production studio, and recording capabilities makes *GarageBand* a useful tool for improvising. Users can make backing tracks with relative ease, over which they can practice, improvise, record and playback. *GarageBand* has "smart instruments" that can "fix" playing to sound more correct or more professional. Templates and customizable grids make composing a simple process and numerous effects give the user the ability to adjust, edit, and enhance the sounds. *GarageBand* also makes sharing the music a simple process. Just as the computer version of *GarageBand*, the mobile version is a useful tool that makes songwriting and composition accessible and easy for musicians without extensive technological skills.

[64] http://www.apple.com/ca/ios/garageband/

ThumbJam[65]

Figure 4-21: ThumbJam screenshot

ThumbJam is a user-friendly instrument, with high-quality audio samples and an intuitive design that allows users to easily build their own loops and perform over them. The app contains a vast selection of instruments and a large collection of scales. The app also boasts many additional features such as Audiobus support and import and export capabilities. Live microphone recordings using the built-in microphone give users the ability to play their own instrument and listen back. It also has Bluetooth capabilities to broadcast tempo, key and scales to friends nearby in order to jam together. This is a complex and well-designed app that holds many uses for educators and musicians.

[65] http://thumbjam.com/

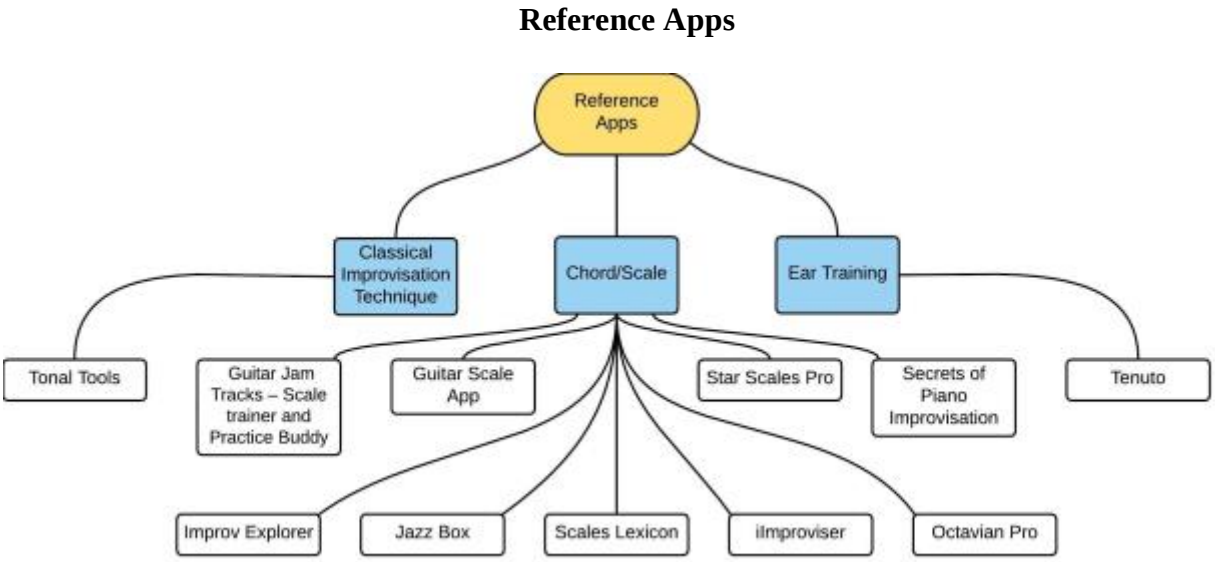

Figure 4-22: Second-level classification–Reference apps

The next section of the review covers reference apps that vary in their level of pedagogical depth. Many of these are instrument specific and the majority of them are concerning scales. Two additional categories are included: classical improvisation technique and ear training; each of these only include one app. All of the apps in this section are similar in their lack of interactive technologies. For this reason, the reviews are brief.

Chord/scale

Chords and scales form a crucial component of most pedagogies of improvisation. For many instrumentalists, an app that teaches how to play the scales on an instrument could be useful and serve as preliminary step to improvisation training.

Instrument specific apps

Apps that display scales for the guitar include *ScaleBank: Guitar Scales*[66], and *Star Scales Pro*[67]. Ninebuzz has a Guitar app (mentioned above) that incorporates scale training with

[66] https://itunes.apple.com/ca/app/scalebank-guitar-scales/id595522927?mt=8
[67] http://www.joyapps.net/starscales/

play-along tracks, called *Guitar Jam Tracks – Scale trainer and Practice Buddy*[68]. *Improv Explorer*[69] provides guitar diagrams indicating appropriate note choices for improvising over particular chord changes with a limited number of backing tracks for practice.

Scales Lexicon[70] offers a large collection of scales for piano, including jazz, Hindustani, and scales of China, Japan, and other parts of the world. Users are able to hear the scales played with a rhythmic accompaniment. *Secrets of Piano Improvisation*[71] notates scales and the corresponding chords in each key.

Non-instrument specific

Octavian Pro[72] is a non-instrument specific reference app that boasts a large number of scales and chords, with ample listening and cross referencing options. There is, however, no practice mode with play-along tracks. *Jazz Box*[73] is a similar chord/scale reference tool for jazz players, although it contains no audio features.

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[68] http://ninebuzz.com/jam-tracks-app/
[69] https://itunes.apple.com/vn/app/improv-explorer/id786204898?mt=8
[70] http://www.patrickqkelly.com/index.php/ipad/scales-lexicon
[71] https://itunes.apple.com/us/app/secrets-piano-improvisation/id566965895?mt=8
[72] http://www.bitnotic.com/octavian.html
[73] https://itunes.apple.com/ca/app/jazz-box/id532325909?mt=8

Classical improvisation technique

When analyzing the selection of apps for learning improvisation skills there is a conspicuous scarcity of apps dealing with classical music techniques or approaches. The following app is one exception discovered in this survey.

Tonal Tools[74]

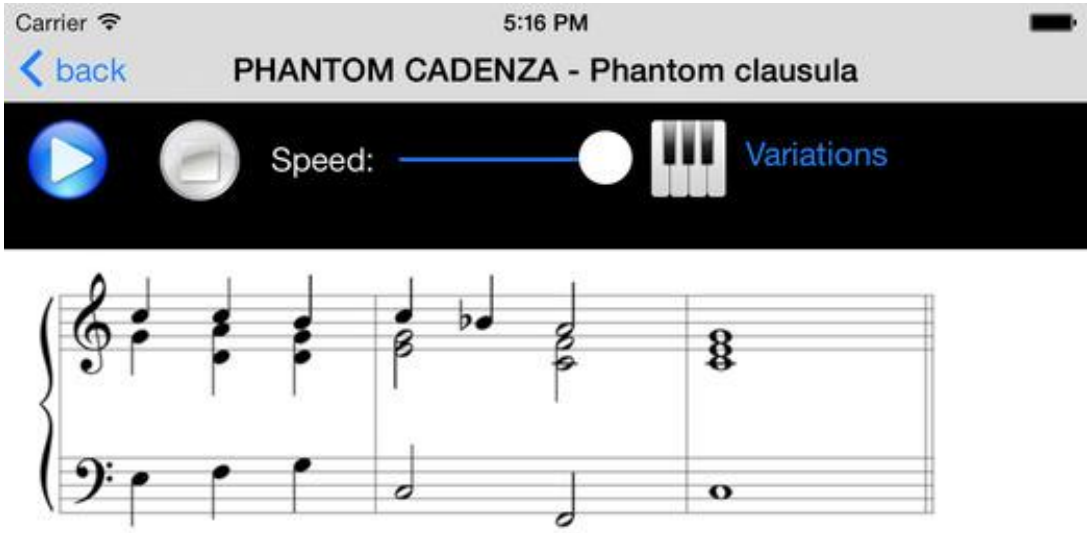

Figure 4-23: Tonal Tools screenshot

Developed by Lieven Strobbe in affiliation with "Musica, Impulse Centre for Music in Belgium", *Tonal Tools* introduces foundational improvisation components of partimento keyboard practices from the 18th and 19th centuries. Nine components are presented on the musical staff, with brief descriptions of their usage and the ability to hear them represented in MIDI. The app also offers links to videos on the Tonal Tools website.

There are no play-along tracks or other interactive features with this app, however it is the only app that explains traditional keyboard improvisation strategies from the classical

[74] https://itunes.apple.com/us/app/tonal-tools/id797585650?mt=8

tradition. The app may be beneficial for improvising not only within a classical idiom, but in other keyboard practices as well.

Ear training

As much as scales are an important part of learning to improvise stylistically, ear training is likewise integral. Although there does not exist an ear training app explicitly for improvisation, there are many apps that aim to teach ear training. For example, *Tenuto*[75] is a reputable ear training app made by the same people who created musictheory.net, a popular resource for teachers and students (Adkins, 2005; King, 2005).

Music Practice Software

SmartMusic

SmartMusic[76] has made a profound impact on music education through its desktop-based application for practicing band and orchestra music at home (Sánchez-Jara, 2014). An iPad version of the software was released in 2013 that allows subscribers to access the software on mobile devices. The software assists users in practicing their orchestral or band repertoire, by having them play their part along with a recording of the larger ensemble. It also provides instrumentalists real-time feedback about their performance, including timing and intonation. At this time, there is no real-time feedback for student improvisations, however, there are modules within the software for learning fundamental skills of jazz improvisation. Additionally, there are backing tracks over which one may improvise. Also, because it is customizable, teachers may create improvisation lessons in *Finale* that may be used by their students in *SmartMusic*. This

[75] https://www.musictheory.net/products/tenuto
[76] http://www.smartmusic.com/

software provides the ability to record one's work and share it with a teacher, which creates the possibility for a teacher to provide individual feedback regarding a student's improvisations.

The ability to record improvisations for listening, comparing, and sharing represents one important pedagogical resource that this technology brings to the pedagogy of improvisation. *SmartMusic* is subscription-based software; at present a yearly *SmartMusic* subscription costs $40 for students and $140 for educators. It also requires the purchase of a special USB microphone that *SmartMusic* sells for $30. So while this software is revolutionary in many aspects, the price may not be accessible for some students.

Yousician[77]

Yousician is an interactive practice companion for learning guitar that has similar feedback capabilities to *SmartMusic*. However, rather than basing musical instruction on traditional notation, like *SmartMusic, Yousician* uses a guitar diagram with a system of bouncing notes to indicate the correct placement on the strings, somewhat akin to tablature. The company began with just a guitar version, but *Yousician* apps now include ukulele, bass, and piano.

The *Yousician* format is simple and user-friendly and provides motivational rewards for student progress. There is an extremely large user base for this software (the website claims 25 million users),[78] and although it does not teach improvisation explicitly, there are modules that cover aspects of soloing. A subscription to *Yousician* costs $19.99 per month, or $119 per year for one instrument. The ratings are very high on this app, and it represents a new form of music learning. The app has an educator's option that allows teachers to use the software with students.

[77] www.yousician.com
[78] www.yousician.com

Creative Apps for Improvisation

The primary intention of this evaluative survey is to describe the existing mobile applications for assisting one to learn to improvise stylistically on an instrument. However, other genres of music apps can serve as useful tools for inviting students to become creatively involved with music in an improvisatory manner. These apps include instruments and artistic multimedia platforms. The apps listed below represent a set of tools for engaging students through an ability to create, tinker, and experiment with music, without obligation to improvise on their instrument. A few synthesizers, samplers, and looping apps are also mentioned. These creative applications make exploratory, playful musical engagement accessible to a wide audience.

Musicians are now using the technological affordances of the iPad to create interactive soundscapes that utilize their own compositions. Many are audio-visual music simulators that have varying degrees and mechanisms of control. *Thicket*[79] by Joshue Ott and Morgan Packard is an artistic spider web of visuals and sound that is malleable to the touch. Björk's *Biophilia*[80] presents an intriguing and complex audiovisual playground. *Biophilia* is a suite of apps that are connected to Björk's album of the same title. It explores music, nature and technology, and has been implemented as a teaching tool in an Icelandic initiative aimed at promoting children's creativity.

There are dozens of other apps available on mobile devices that promote creative engagement with multimedia components. More examples include *PolyFauna*[81] by Thom Yorke

[79] http://apps.intervalstudios.com/thicket/
[80] http://bjork.com/
[81] http://universaleverything.com/projects/polyfauna/

Figure 4-24: AUMI live camera screenshot

of Radiohead, and *Scape*[82] and *Bloom*[83], collaborative projects by Brian Eno and Peter Chilvers. There is also a growing list of modular synthesizers and music generators that have endless creative potential for exploring sound in an improvisatory manner. The interfaces range from simple to complex. Yamaha released *Tenori-on*[84], Korg released the *ikaossilator*[85], and Moog produced the *Filtatron*[86]. Other examples include the *Reactable*[87] app, and *Musyc*[88], which uses space and gravity to drive the sound mechanics.

AUMI[89], or the *Adaptive Use Musical Instrument* project led by Pauline Oliveros and supported by work and research through the International Institute for Critical Studies in Improvisation (IICSI) is a musical instrument that enables people with limited voluntary movement to independently engage in music making (Oliveros et al., 2011). This software is being used in numerous alternative school and therapy settings with positive results (Finch, Quinn, & Waterman, 2016; Oliveros et al., 2011). The software, which allows users to control music with even a small degree of movement, makes improvisation accessible to anyone with access to the software.

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[82] http://www.generativemusic.com/scape.html
[83] http://www.generativemusic.com/bloom.html
[84] http://ca.yamaha.com/en/products/apps/tnr-i/?mode=model
[85] http://www.korg.com/us/products/software/ikaossilator/
[86] https://www.moogmusic.com/products/apps/filtatron
[87] http://reactable.com/mobile/
[88] https://itunes.apple.com/ca/app/musyc/id489836689?mt=8

A large number of digital instruments are available on tablets and smartphones. *iBone*[90] is a pocket trombone. Other instrument apps include *Honey Harmonica*[91], *Pocket Guitar*[92], *Pocket Shaker*[93], and *Ocarina*[94]. A plethora of drum apps and other percussive tools are also on the App Store including *Drums!*[95] and *Drum Master*[96]. Guitar and piano apps abound as well, such as *Guitar!* by Smule[97], *Tiny Guitar*[98], *Tiny Piano*[99], *Piano Infinity*[100] and *Go! Piano*[101]. *Bebot*[102] is an example of a more complex synthesizer housed in the form of a controllable singing robot. There are also hundreds of samplers available, many that allow for recording audio as material. *MadPad*[103] and *Keezy*[104] are two that stand out for their simplicity and usability. Finally, looping software such as *Take*[105] and *Loopy*[106] can provide an avenue for improvisatory music making, as users can record loops and play over them.

Conclusion

This survey reveals a broad collection of mobile applications available for learning to improvise. While there are many useful support tools for improvising, there are few that incorporate the pedagogical depth found in other published pedagogical materials for

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[89] http://deeplistening.org/site/content/aumipadhome
[90] http://ibone.spoonjack.com/
[91] https://itunes.apple.com/ca/app/honey-harmonica/id503040693?mt=8
[92] https://itunes.apple.com/ca/app/pocketguitar-virtual-guitar/id287965124?mt=8
[93] https://itunes.apple.com/WebObjects/MZStore.woa/wa/viewSoftware?id=313139592&mt=8
[94] https://www.smule.com/ocarina/original
[95] https://itunes.apple.com/us/app/drums!-studio-quality-drum/id311549739?mt=8
[96] https://itunes.apple.com/us/app/drums-master-hiqh-quality/id502360445?mt=8
[97] https://www.smule.com/
[98] http://www.squarepoet.com/tinyguitar/
[99] http://www.squarepoet.com/tinypiano/
[100] https://itunes.apple.com/ca/app/piano/id485362757?mt=8
[101] https://itunes.apple.com/ca/app/go!-piano/id606617937?mt=8
[102] http://www.normalware.com/
[103] https://www.smule.com/apps
[104] https://keezy.com/
[105] https://allihoopa.com/
[106] https://loopyapp.com/

improvisation. The applications in the first section of the review have the heft to teach improvisation autonomously to students on their musical instruments. Of these, the first two, *Developing Musicianship Through Improvisation (DMTI)* and *iImprov* achieve this without the use of video. However, *DMTI* is limited to two songs at present. By contrast, *iImprov* has significant content and presents a solid option if jazz is the desired style to be learned. However, neither of these applications utilize feedback, touch-based musical interaction, or recording capabilities. *The Jazz Conception Company, My Jazz* for piano, and *Understand Modes* for guitar provide pedagogical guidance through the use of video instruction but are again limited in scope.

Many of the apps that lack pedagogical structure could be used as supplemental tools, perhaps suggested by a teacher, or included within a larger pedagogical model. Accompaniment apps are useful for practicing improvisations, and the reference apps can provide important information about specific instruments, or inform the learner of chord/scale relationships. Those apps that combine reference and accompaniment such as *iReal Pro* and *Guitar Jam Tracks* could be a convenient way to access reference and accompaniment features together. *Tonal Tools* and *Harmony Improviser* may be particularly useful for classical musicians learning to improvise within that genre.

Yousician and *SmartMusic,* while not specifically for improvisation, have the advantage of allowing for input from the user, therefore providing interactive feedback. They utilize technology in a manner the other apps do not and are the most advanced learning tools in this collection of apps.

While the survey clearly indicates that there is a vast selection of tools available, the absence of some features is apparent. For example, although gaming features have been shown to increase motivation in learners (Denis & Jouvelot, 2005), they are not incorporated into the

improvisation software currently available. Similarly, while listening is considered an integral component in music learning, the survey revealed an absence of applications that incorporated prolonged listening sessions. While there are many music games that incorporate this feature, their aim is not specifically to teach musical elements, and they are not intended to relate specifically to playing an acoustic instrument. For example, games like *Guitar Hero*[107], *RockBand*[108], *Piano Tiles*[109], and *Magic Piano*[110] engage users in tapping responsively to music throughout prolonged listening sessions. This feature has unexplored potential for application in music education.

Creating a tool that integrates many of the features found in the survey—backing tracks, chord/scale information, feedback, and record and playback—with motivational gameplay and interactive listening may represent a novel context for learning to improvise. The following chapter will present the framework for Creative Music Learning with Technology that incorporates these aspects with many learning principles from the previous chapter on improvisation.

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[107] https://www.guitarhero.com/ca/en/
[108] http://www.rockband4.com/
[109] https://itunes.apple.com/ca/app/piano-tiles-dont-tap-white/id848160327?mt=8
[110] https://www.smule.com/listen/magic-piano/80

CHAPTER 5: A FRAMEWORK FOR CREATIVE MUSIC LEARNING WITH TECHNOLOGY

In an effort to expand upon existing contexts for creative music learning, while embracing the latest advancements in digital technology, the framework for Creative Music Learning with Technology (CMLT) has been developed. This framework is based on extensive theoretical work that incorporates pedagogical principles and technological features in order to create a novel learning system. The system is at once a tool for musical understanding and for creative experimentation. The five core principles of this framework are:

1. Learning Through Interactive Listening
2. Sequential Pedagogy
3. Knowledge and Skill Transfer
4. Continuous Creative Engagement
5. Assessment and Tracking

The principles and instructional strategies that make up this framework have not previously been encountered together in one music learning context. Together, they present an empowering pedagogical structure and a creative context that aim to enhance the musical lives of learners through deep immersion in the music. The literature from Chapter 3 concerning existing pedagogies, theories, models, and research studies from the field of improvisation pedagogy was synthesized in the construction of this framework. Further research is likewise included in the present chapter to strengthen the pedagogical foundation and process of CMLT. Figure 5-1 shows the core principles of the framework. Learning through listening has been placed at the center of the diagram due to its essential defining role in the framework.

The CMLT framework presents an approach to learning musical elements while listening to musical recordings. Because of the multidimensionality of music, the possibilities for guided interactive content taught in conjunction with music listening are vast. Recent technological innovations make it possible to present lessons embedded within music listening experiences, facilitated through the use of touchscreen interaction. In this way, learning can take place simultaneously while listening and interacting with the music. This concept constitutes the principle component of the framework, as all other aspects depend upon this interactivity with recorded music.

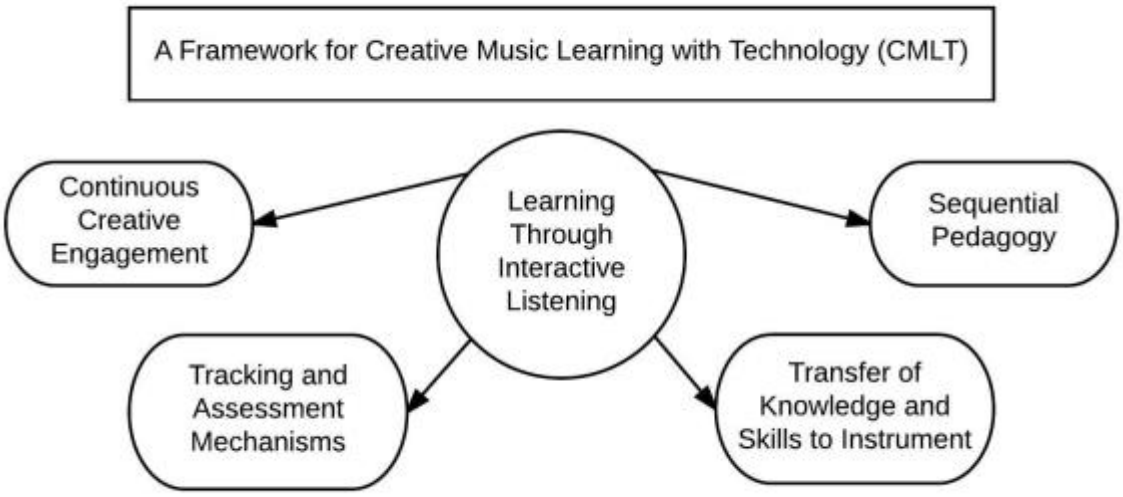

Figure 5-1: A Framework for CMLT

While this framework has the potential for application in a variety of music learning scenarios, in the present chapter, this framework is elaborated within the particular case of learning musical improvisation. Each of the five core principles has a number of specific clarifying features that work in tandem to create a framework for learning musical improvisation with technology.

For instance, *Learning Through Interactive Listening* has four defining structural components: (a) listening as the foundation of musical learning; (b) a focus on one musical work at a time, further defined by listening to multiple interpretations of the musical work; (c) constructing a cognitive model of the song form; and (d) touch-based interaction.

The second principle – *Sequential Pedagogy* is elaborated into: (a) progressive skill development; and (b) specific tasks extracted from the musical work, framed within the musical elements of rhythm, harmony, and melody.

The third principle – *Transfer of Knowledge and Skills* is defined by: (a) immediate transfer to an instrument of skills acquired in interactive listening; and (b) the use of accompaniment tracks.

The fourth principle – *Continuous Creative Engagement* hinges on the following three features: (a) improvising with touch-based interaction throughout listening sequences; (b) improvising on an instrument; and (c) autonomy and safe space.

The final principle is *Assessment and Tracking Mechanisms*. This principle is supported by: (a) real-time feedback; (b) progress tracking; (c) record and playback of one's improvisations; and (d) motivational gameplay.

Many of the principles and components are interrelated and indeed could be organized in any number of arrangements; the present structure of the framework is simply a guide for development of innovative learning tools. At its core, however, stands the first principle: Learning Through Interactive Listening**.**

Learning Through Interactive Listening

At the heart of the CMLT framework is the key principle of engaging learners in a contextual learning process through "interactive listening". For the purpose of this work,

interactive listening, as opposed to passive listening, refers to a responsive interaction with musical elements, at the moment in which they sound. Favoring an aural perspective of music rather than a focus on the written score, the goal is to situate learning within listening, as a concurrent, parallel, and multimodal process, while also providing direct engagement with the subject material via interactive exercises. This streamlined learning environment can open up numerous possibilities for rhythm and ear training, harmonic analysis, theory, and expression. All too often, these materials are presented divorced from the actual music. A typical listening sequence in music education, for example, often involves alternating between listening and responding (Campbell & Scott-Kassner, 2013). Situating learning concurrently within listening provides a more holistic form of music learning. As Goldstein questioned: "Why, in classes of musical analysis, is the object of study dissected in terms of harmonic structure but the *sound* of the living music omitted?" (1988, p. 30).

Contextual learning, or situated learning, is an important concept in constructivist learning theory (Savery & Duffy, 1995). In a constructivist learning environment, learners are constructing knowledge and actively participating in a process that connects to prior understanding. Activity theory (Jonassen & Rohrer-Murphy, 1999) further supports the importance of contextual learning, with the assumption that if instructional structures are technically oriented, and fail to engage the learner in real-life activity, they will produce little if any real understanding of the material. In the CMLT Framework, an engaging creative listening experience guides the instructional sequence of learning musical elements. This context of aural immersion allows learners to actively deepen their musical comprehension in direct relation to the auditory elements of music. Furthermore, immediate interactive feedback is provided to students during the course of listening, as they complete instructional exercises via touchscreen.

The instantaneity of the response provides reinforcement of the learning and possibilities for adjustment even before the next beat or note is heard.

Listening as the Foundation of Music Learning

Listening to music is arguably the most essential activity for learning music. In all musical cultures, listening forms the foundation of an experience with music, informing those who come to interact with the language through any means, including performance, movement, composition, and improvisation. It stands as a core objective for learning to play an instrument and is the most direct way to understand the language of music (Small, 1998). Comprehension of the basic building blocks of rhythm, melody, timbre, pitch, and tempo is most appropriately taught with the addition of an auditory representation of the music. It is through listening that music has meaning.

Many educators, researchers, philosophers and performers have given considerable attention to the subject of listening. Campbell likens it to the "heart and soul" of music education (Campbell, 2005, p. 30). In her pedagogy of listening, Campbell defines three stages: "attentive listening", which focuses on musical structures; "engaged listening", in which the user participates in some way; and "enactive listening", which refers to intense listening to nuances of the music with the aim of performing the music oneself (Campbell, 2005, pp. 31–32). The CMLT principle of interactive listening described above encompasses aspects of all of these definitions, with a particular emphasis on enactive listening since students are tasked with interacting in real-time as they listen.

For Christopher Small (1998), listening is a crucial facet of "musicking", the term he uses to describe the activity of music, differentiated from the idea of music as a concrete object. Musicking is applied to the many different ways of interacting with music, from listening to

improvising. The framework for CMLT presents a music learning platform that supports continual musicking throughout learning.

For Edwin Gordon (1988), the creator of *Music Learning Theory*, listening forms an essential part of developing the skills of "audiation", or the ability to hear and understand the sound of music in the mind. Learning through interactive listening may present a particularly salient means of developing audiation.

Pauline Oliveros was a foremost expert on listening. She spent many decades dedicated to exploring her practice of deep listening (Oliveros, 2005). Born in part from an observation of musicians' tendencies to 'hear' as opposed to 'listen', Oliveros investigated the processes of human listening and developed a practice for deepening one's experience of sonic engagement. Her influential work produced new methods of interactive listening and represents an important 21st-century pedagogy of listening.

Campbell and Scott-Kassner (2013) have their own mode of deep listening, here discussing listening instruction in elementary school while differentiating between functional listening and active listening:

> Increased sophistication in listening can also be developed through listening to recorded music. This does not mean the kind of functional listening most people do when they use music as a background to help them celebrate, relax, clean house, or study. In most of these instances, the music is a kind of tonal bath that surrounds and washes over them but is not seriously attended to. The teacher needs to foster *active listening*, in which the learner focuses on musical events such as patterns that repeat or contrast, the creative use of tone colors, or the shaping of the music through dynamic change. Campbell calls this "deep-listening" (Campbell & Scott-Kassner, 2013, p. 240)

Both Campbell and Oliveros use the term deep listening to refer to active, engaged listening that invites creative participation and meaningful experience. Interactive listening as

proposed by the framework presents a way to incorporate deep listening directly into the process of music learning.

Music listening constitutes the principle interaction with music for the majority of young people. It is an activity that defines them, providing personal soundtracks to their lives (North, Hargreaves, & O'Neill, 2000; Schwartz & Fouts, 2003). What we cannot know for sure is the extent to which their listening activities impact their understanding of the musical language at hand. Certainly not all manners of listening are equal and we must differentiate between mere appreciative listening and analytical listening. In analytical listening, auditory attention is given to basic building blocks such as timbre, tempo, and pitch (Truax, 2001).

Music educators have devised strategies for teaching music listening such as describing pieces using "words, diagrams, charts, gestures, metaphors, and other symbols" (Elliott, 1995, p. 123). Other approaches include the use of listening guides to engage groups of students in listening or helping individual students place their attention on particular aspects of the music in guided listening sessions. Often students are asked to listen to music on their own and there is little way to ascertain their attention to particular musical elements. Elliot, in his work *Praxial Music Education* (PME) (2005) places great emphasis on having students keep "listening logs" (p. 285), in which they record their thoughts and feelings as they listen to music. He examines music listening and methods for teaching music listening extensively in PME: "Music listening is a multidimensional form of thinking and knowing that can be progressively developed to meet the demands made by the multidimensional nature of musical works" (Elliot, 2005, p. 101).

This multidimensionality becomes particularly useful when we introduce music listening as an instructional device for learning improvisation. Since improvisation is playing music spontaneously (Azzara, 1993), the use of standard musical notation may be of limited value in

this new learning context. Watson, for example, found that an aural approach to learning instrumental jazz improvisation was superior to a notated form with regards to achievement and self-efficacy (2010). Baker and Green found that aural development had superior results to notation with regards to students' pitch, rhythm, tempo and contour (2013). Alternative forms of musical notation demand exploration in a learning context that is centered on listening.

A Focus on One Musical Work at a Time

The second component of Learning Through Interactive Listening places the focus of learning to improvise on one musical work at a time. While stylistic, genre-based improvisation requires familiarity with many works from the genre, it likewise requires a deep understanding of individual works. Therefore, multiple interactive listening exercises should be provided for each particular musical piece, and students can be tasked with re-listening to the work numerous times, experiencing different recordings, varying instrumentation and alternate arrangements. Learning to improvise requires the development of an aural understanding of music (Gordon, 2003). Instrumental and vocal students are typically familiar with a collection of musical works—those they study, and the music they listen to in their leisure. These listening experiences all contribute to the foundation of a context for developing one's musical voice. However, listening and performing from the score do not necessarily cultivate the skills necessary to improvise. A deep exploration of one particular work at a time allows learners to develop substantial familiarity with the music such that they may more easily engage in a process of embellishing, varying, and inventing. Furthermore, they may develop confidence as they achieve mastery of the musical elements at hand. With each successive musical work of study, they expand their musicianship and improvisatory capabilities.

Focusing on one musical work at a time is a common pedagogical approach amongst improvisational traditions around the world, including jazz, Partimento, Hindustani, and Carnatic music, and the Persian *radif*. Through this process, learners become familiar with the specific musical elements of rhythm, harmony, and melody that are encountered in the work of study. They may also develop a strong understanding of the form of the particular work. Furthermore,

as they become "experts" within the specific language inherent in the musical work, they may be freed up to engage more fully with the expressive elements of the music.

Listening to Multiple Interpretations of the Work

With a focus on one work at a time, extended listening periods are a crucial learning mechanism. Including multiple interpretations of the work becomes an important asset for facilitating extended listening sessions. Research has shown that being exposed to a variety of interpretations is beneficial. For example, when combined with discussion, Blom (2006) found that listening to multiple interpretations can encourage students to think about their own musical voice, potentially influencing originality and creativity. Hearing various artists may help students to become aware of nuanced expressive differences in the music and have a lens into the artistic and creative nature of musical interpretation. This exposure may eventually help students to cultivate and develop their own musical voice.

Furthermore, providing multiple versions of a song helps to develop flexibility with the music. In Persian classical music, for example, in which students also learn through active listening, they typically play four or five versions of a piece. "By learning multiple teaching versions of a *dastgāh*, the student develops the flexibility so necessary in the creative process of improvisation" (Campbell, 1990, p. 45).

Constructing a Cognitive Model of the Song Form

A process of repeated interactive listening aids in the construction of a clear working mental model of the song form. In order to improvise with meaning, it is crucial to be aware of one's place in the music, something achieved through the cultivation of attention to structure and form. Interactive listening exercises must assist users to build this conceptual framework of the musical work so that they may eventually know "automatically" where they are in the music.

Pressing considered the *referent,* or the formal scheme of the piece as conceived by the improviser, to be an essential aid for the real-time cognitive processing involved in improvisation (Pressing, 1988). This referent can be gradually cultivated over time through guided listening.

Touch-Based Interaction

The recent technological innovation of touchscreens and mobile devices present a new context for music learning, one that is portable and interactive. Users can be presented with tasks that focus on any element of the music and be asked to tap responses in real time. Software can then provide instant feedback regarding their accuracy, or other information as to how to adjust future input. In a previously mentioned study, Delia-Pietra and Campbell (1995) successfully taught improvisation using analytical listening and the imitation of patterns and phrases. Touch-based interaction while listening can provide a novel context for students to listen and respond to rhythmic patterns and other elements of the music.

This recent innovation has significant potential to enhance autonomous music learning, providing the opportunity to frame instruction within the auditory experience of the music. Touch-based interaction allows for responses in real-time, essentially removing a step from traditional music study. At the same time, the student's experience is enhanced by receiving immediate evaluation of their responses. In this way, the touchscreen serves as a gauge of what the students are listening to, and what they are listening for. The input data can be analyzed, and software can dynamically adjust the pedagogical progression based on student responses. Instructional sequences can thus be made to advance according to a student's achievement or mastery of skill.

Sequential Pedagogy

Correct sequencing of instructional goals is a key feature of successful pedagogies (Dick et al., 2001). When learning a new task, it is essential that learners not become frustrated by material that is beyond their capabilities. Furthermore, the order in which the musical elements of rhythm, harmony, and melody are presented is an essential component of the sequential pedagogy feature of the framework. Also integral is the extraction of specific learning tasks directly from the music at hand.

Progressive Skill Development

Learners must be given the opportunity to master skills in a progressive sequence of knowledge acquisition. This begins with a consideration of the musical selections. Students should begin with simpler works that allow them to succeed. Likewise, within the particular lessons, exercises and tasks should begin with simpler concepts and advance as the student displays mastery.

Discussing an ideal progressive development of student skills, Duke (2005) writes about a hypothetical video game that can "systematically modify the difficulty levels of the tasks with which the player is confronted, allowing numerous successes, but also creating numerous, well-timed challenges that are difficult enough that they require the player's best efforts but not so difficult as to be insurmountable" (p. 135). This is possible due to intelligent software design able to interpret responses and adjust the sequencing of material appropriate to the student's level. Duke suggests this type of structure would help students develop a sense of confidence, self-efficacy, patience, and genuine skill.

Specific Tasks Extracted from the Musical Work

The framework is based upon deep immersion into one musical work. The specific learning objectives are to be extracted from this music; the rhythmic patterns, harmonic concepts, and melodic guides are derived from the music under study. This again makes the selection of musical material paramount as the elements contained within the music should be accessible to the student. The rhythms that occur in the music, as well as the chords, the form, and the melody, will dictate the learning sequence.

The musical elements of rhythm, harmony, and melody should be presented in that sequence, as explained below.

Rhythm

An important aspect of the Sequential Pedagogy situates rhythm before the learning of other musical elements. This approach, encountered during ethnographic study of the Spanish pedagogy IEM and discussed in Chapter 3 (Khoury, 2015), was observed and experienced as an effective way of presenting improvisation. By having students begin by performing and improvising rhythms within a given musical work, even novice IEM participants were able to improvise from the outset. Improvising rhythm presents a simpler task than melodic improvisation, as pitch and harmonic elements of music require more complicated cognitive processing. This can work to build student confidence as well as develop familiarity with the musical selection through repeated listening.

Rhythm is a logical entry point for improvising for two reasons. First, rhythmic accuracy is an accessible skill; Paananen (2007), for example, found that 10-11 year olds were capable of playing complex rhythmic improvisations while following the beat of the given accompaniment. Second, rhythm is fundamental to many aspects of music. As Gordon explains, many of the more

complex musical elements depend upon rhythm: “musical phrasing, interpretation, style, and expression have their bases in rhythm” (Gordon, 2009, p. 4). Referring specifically to jazz musicians, Berliner notes that “within the musician’s scale of values, rhythmic aspects of performance are fundamental” (Berliner, 1994, p. 244).

Touchscreen interaction, like clapping, can constitute an effective form of rhythm training, despite the absence of duration. As Johnson-Laird explains, “the critical feature of a rhythm is the sequence of onsets of its notes. Hence, if you clap the rhythm of a familiar piece, then listeners will be able to identify it. Clapping, of course, provides information only about onset times” (2002, p. 431). Touchscreen interaction mimics the exercise of clapping or playing a percussion instrument along with music, a common approach in music learning (Campbell & Scott-Kassner, 2013).

Touch-based interaction engages students in modelling, accurate rhythmic performance, and even improvisation from the beginning of their study. Modelling or imitative performance is a common music learning principle, and has been proven to be an important predictor in jazz improvisation achievement (Madura, 1996). It is likewise a fundamental mechanism in language learning (Reynolds, Long, & Valerio, 2007).

By focusing on the rhythms in the selected song of study as opposed to rhythmic exercises that are broad and varied, students connect to the music and build the rhythmic instincts that will carry over to improvising with harmony and melody. The real-time feedback can help them to improve their accuracy and evaluate their own rhythmic abilities in the context of the music at hand.

Harmony

Harmonic study, also through interactive touch-based lessons with the musical work, forms an essential component of this framework, one that, like rhythmic training, is especially enhanced by the use of technology. Students gain knowledge of the harmonic structure of the music while engaging in repeated listening sessions.

Stylistic improvisation requires an understanding of the harmonic structure of a musical work in order for melodic improvisation to "fit" the music. Charlie Parker referred to landing on the chord tones as "targeting" (Christiansen, 2001), an essential skill cultivated in jazz improvisation (Meadows, 2013). "Improvisation depends on the ability to extemporize new melodies that fit the chord sequence" (Johnson-Laird, 2002, p. 415). While this is arguably a narrow conception of improvisation, educators acknowledge that understanding harmonic progressions constitutes an essential first step for learning to improvise stylistically (Azzara, 1999). Musicians often use chord tones as target notes in the melodic construction of compositions and improvisations, as these notes provide the contextual relationship between melody and harmony. It is essential that students develop an aural awareness of what chord they are hearing, as well as the knowledge of what notes constitute this chord. Learning these skills while listening and interacting with the music builds a foundational capacity to creatively engage with the music.

Melody

Following rhythmic and harmonic elements, melodic improvisation should be the next task presented to students in the sequential pedagogy. Improvising a melodic line constitutes a principle goal in learning to improvise, but requires preliminary preparation. After building a foundational understanding of the rhythm and harmonic structure of the work, students are ready

to focus on improvising melodies based on the given musical work. Students can begin to understand and use the many melodic components that make music interesting and expressive. Starting from the melody of the given work, students may begin to vary, embellish and invent new melodies.

The presentation of melodic pedagogical elements will assist students to explore and experiment with melodic invention. Evaluation of this improvisation may or may not be incorporated in the development of a tool.

When presenting melody, it may not be necessary to represent music within the standard system of Western notation. There are advantages to exploring alternative methods of representing pitch and rhythms. Goldstein writes:

>  = a history of implications–Western European music–with attitudes and valve systems based on pitch and duration structure; not the fullness of sound, but rather the organization of certain aspects to be worked with and focused on. To hear a sound… is to experience much more than can ever be notated." (Goldstein, 1988, pp. 17–18)

Exploring alternative methods of notating pitch to use with interactive listening should constitute an important developmental aspect of a learning system that employs the framework for CMLT.

Transfer of Knowledge and Skills

The transfer of knowledge and skills from one situation to another is a key educational principle. "If the goal of education is that students learn to use knowledge and skills effectively in the future, even in unfamiliar circumstances, the *transfer must be defined as the goal* of instruction" (Duke, 2005, p. 156, emphasis in original). Transfer of musical knowledge and contextualized learning have been explored extensively by researchers and educators (Duke & Pierce, 1991; Goolsby, 1999; Healy, 2016; Jørgensen, 2004; Scheuzger & Joy, 2006). The

present framework proposes an organization based on providing multiple contexts of study that share an underlying structure. “The extent to which learners will transfer knowledge and skills is influenced by both contextual similarity and learners’ recognition of the applicability of acquired knowledge and skills” (Duke, 2005, p. 150). Having students listen to multiple interpretations of a musical work is one possible method to facilitate the transfer of understanding. Learners may begin to cultivate the ability to recognize structures and patterns, even when the musical work is otherwise distinct. The use of accompaniment tracks based on the musical work may provide further support for creative transfer of material and skills.

Immediate Transfer to an Instrument of Skills Acquired in Interactive Listening

A crucial component of the framework for CMLT is the transfer from interactive listening to actively playing one’s instrument. Interactions with rhythm, harmony, and melody from the touch-based listening exercises can be transferred directly to sessions that involve playing an instrument. Visual cues from the interactive listening sequences can be carried into the instrumental sessions, engaging the working musical memory of the learner. However, unlike the musical memory used in repertoire performance which focuses on exact replication, the musical memory is engaged in improvising, based on deeper musical comprehension. The foundational understanding of the music, developed through interactive listening sessions, becomes a springboard for improvisation.

Use of Accompaniment Tracks

The use of a backing track while students play their instrument can provide a context for easier transfer of musical elements. This backing track can be played in conjunction with the visual cues used during previous modules. Having a visual guide of the rhythmic, harmonic, and melodic portions of the pedagogy may help to guide students in the transfer of musical

comprehension, including form, rhythm, harmony, and melody. As addressed in the previous chapter on technology, the use of accompaniment tracks has played a part in jazz pedagogy for over fifty years. Providing an aural context to transfer musical skills to one's instrument offers significant advantages for learning to improvise stylistically.

Continuous Creative Engagement

Improvising music is a creative act and therefore learners should be engaged creatively throughout the process. A continual alternation between task performance and improvising may allow them to deepen their conceptualization of the musical elements and provide an increased sense of agency. It can make the experience more personal, and therefore more meaningful. Meaningful learning experiences can help to build a "deep and enduring understanding of complex ideas, and skill in working with complex problems and content that are both central to the discipline and relevant to students' lives" (Ashburn, 2006, p. 8). The present framework proposes interspersion of improvisational components within the interactive listening sequences. Furthermore, inviting students to improvise on their instruments using accompaniment tracks that match the musical work may further deepen their creative engagement.

Improvising with Touch-Based Interaction Throughout Listening Sequences

The interactive learning process that involves touch-based responses to musical listening provides a novel way to engage users with the various elements of music. Not only do touch-based responses facilitate assessing the accuracy of student performance, touchscreens can also engage learners in improvisatory play. In the rhythm sessions, students can be asked to improvise by tapping rhythms freely. This process of improvisation can be enjoyable, akin to dancing or tapping along to music. It is also a relatively simple task to master and may work to build confidence in improvisatory capabilities. Improvising with a digital instrument via touchscreen

in the harmony and melody sessions provides a way of understanding complex musical elements, in context, but apart from one's instrument. Learners build a foundation of musical understanding by experimenting with chord tones and non-chord tones, without the added constraints presented by specific instrument limitations. Touchscreen interaction with the music creates a constructionist learning environment in which students learn musical relationships and hone their own musical preferences in a process of creative trial and error.

Improvising on an Instrument

Following interactive listening sessions based on harmony and melody, learners can apply the acquired musical understanding and experimentation to their instrument. All of the interactive listening sessions lead up to this activity. Learners are guided first in simple improvisations that focus on playing with the chord progression. They can learn to play the chord roots and then add thirds, fifths, and eventually patterns as they master the harmonic progression in time with the music. Eventually, they can combine the skills from the three separate sections—rhythm, harmony, and melody—into their improvisations on their instruments. As with the interactive listening sessions, improvising on an instrument is facilitated in an open and experimental context that invites students to be creative while simultaneously building an understanding of harmonic and structural form.

Autonomy and Safe Space

Learning improvisation can be intimately connected to issues of confidence and vulnerability. Student anxiety has been found to be a major impediment to students learning to improvise (Schopp, 2006). Outside of the comfort of pre-defined musical actions like performing repertoire, when individuals are asked to improvise they are asked to expose their inner musical voice. At the outset of learning improvisation, this can mean not sounding polished or practiced,

something that can deter learners from feeling confident. Furthermore, creative inspiration is intimately connected to one's feelings of self-efficacy. Aaron Copeland (1952) said that "inspiration may be a form of super-consciousness, or perhaps a sub-consciousness—I wouldn't know. But I am sure that it is the antithesis of self-consciousness" (Nachmanovitch, 1990, p. 51).

Unfortunately, fear is all too common for musicians, whether improvising or performing. Werner identified four aspects of fear in musical performance: fear-based practicing, fear-based teaching, fear-based listening, and fear-based composing. To improvise, he asserts, requires "the taming of the mind, the dissolution of the ego, and the letting go of all fears" (Werner, 1996, p. 75).

If we think of the analogy to language learning, the idea of a safe space can be akin to the safety a child feels in the company of family when learning to speak. The safety of trusted adult relationships is crucial in language acquisition of young children as they take risks while beginning to speak a language (Reynolds et al., 2007). It is a long process that begins with initial soundings and babbling, gradually becomes coherent words, then sentence fragments, and finally full communicative abilities.

Csikszentmihalyi's concept of "flow" describes a state of complete absorption in an activity. In order to obtain a state of flow, there must be no worry of failure (Csikszentmihalyi, 2009). When we enter into a state of flow, we can lose our critical self-consciousness; we are in a state of "optimal experience" (Csikszentmihalyi & Rich, 1997). This may in fact play an important role in motivation and incline one to pursue further artistic development (Csikszentmihalyi & Rich, 1997).

Dove, in his work with youth in Houston, found that creating a safe space for teaching improvisation is a critical step to supporting student success (Khoury & Dove, 2015). Providing

students with a safe space to experiment with musical improvisation autonomously may cultivate confidence that could transfer to improvising in the company of other people.

Assessment and Tracking

One great affordance of software for learning music is the ability to easily provide real-time feedback and track user engagement and progress. These capabilities are simply not present in more traditional forms of learning and practicing. Their incorporation into the framework can provide advantages that may positively affect the learner and give teachers added insight into their students' skills and progress.

With technological tools such as *SmartMusic* or *Yousician*, not only are users able to see their own progress and hear their own recordings, these mechanics can be shared with teachers and/or parents for assessment purposes. Furthermore, current technologies can track the time spent working with the tool, the percentage of accurate responses, as well as particular problem areas that may need more attention. This kind of information can be immensely useful for educators and students.

Real-Time Feedback

Providing learners with real-time feedback can enhance their understanding of their own abilities, allowing them to make adjustments concurrent with their musical learning. This kind of feedback has not been traditionally available when students work autonomously and represents one of the greatest advancements for musical learning that technology affords. Learners can be alerted to rhythmic discrepancies and may be better supported in correcting mistakes earlier rather than later.

Duke states that the implicit and explicit purposes of feedback used while teaching are "to inform the learner of the quality or accuracy of her work and to impel her to take action or

refrain from certain behavior in the future" (Duke, 2005, p. 128). For Duke, giving ample feedback is characteristic of expert teachers. Feedback allows the teacher to "carefully control the difficulty level of each successive task in a learning sequence" (p.134). He further emphasizes the importance of frequent feedback in order to motivate learners and modify their skills.

A system properly designed for music learning with technology can provide feedback for each interaction the student has with the software, enhancing learning and motivating the student.

Progress Tracking

Technology makes it possible to keep an exact record of metrics such as the time spent engaged in particular activities and the percentage of correct responses. Even specific details about the particular tasks that were completed correctly and those that were missed can be easily recorded and displayed. Progress tracking implies an ability to monitor these metrics over time so that improvements or regressions can be assessed. It may also play a role in determining the sequencing and timing with which individual tasks are presented.

Assessment and tracking mechanisms are beneficial for self-learning but can also allow for increased transparency between students, teachers, and parents. A student's progress is something teachers and parents are interested in knowing. Accessing a record of the student's problem areas and their strengths can assist the teacher and parent in their process of supporting a young learner.

Record and Playback of One's Improvisations

Previous methodologies for learning to improvise were unable to include capabilities such as record and playback of one's recordings. Present technology makes this task relatively

simple, and can provide an integrated tool for reviewing one's progress and performance. This can be important for a learner's ability to hear their application of musical elements and assess their improvisation.

Williamon states that "effective practice in the field of music requires the feedback provided by self-evaluation" (2004, p. 27). Self-evaluation can be difficult in improvisation; recording and listening to one's improvisation may provide one solution to this problem.

A review of research evidence on student self-assessment (Ross, 2006) found that self-assessment can in fact contribute to higher student achievement, leading to notions of self-efficacy. The cognitive process of self-efficacy is one's perception of one's ability to perform a certain task successfully (Bandura, 1997). As seen in Figure 5-2, this perception is the outcome of a complex interplay of assessing one's achievement with regards to goals and effort. Notions of achievement based on this assessment can positively affect their self-efficacy.

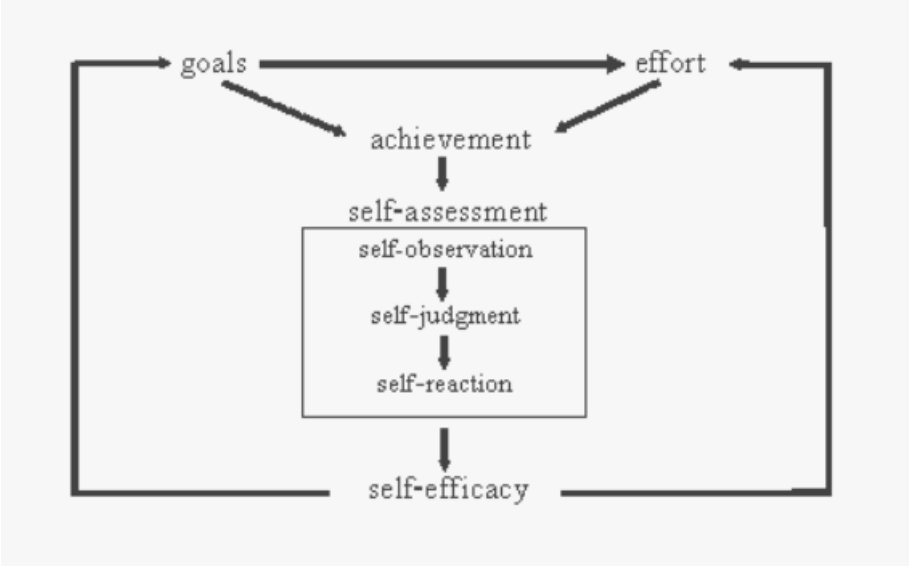

Figure 5-2: How self-assessment contributes to learning. Reprinted from "The reliability, validity, and utility of self-assessment" by J.A. Ross, 2006, In *Practical Assessment, Research and Evaluation, 11*(10), p. 6. Reprinted with permission.

Motivational Gameplay

Research shows that reward and gratification are successful motivational factors for

many students (Denis & Jouvelot, 2005; Przybylski, Rigby, & Ryan, 2010). A study by Denis and Jouvelot looked specifically at intrinsic motivation with regards to educational game design in music (2005). They describe motivation, or the justification of action, through Deci and Ryan's Self-Determination Theory (SDT) (Deci & Ryan, 2000). "Within SDT, the humans' social development is driven by the satisfaction of innate psychological needs for *competence, autonomy,* and *relatedness"* (Denis & Jouvelot, p. 1, 2005 emphasis in original).

Motivation leads to sustained interaction with learning material; "a motivated learner can't be stopped" (Prensky, 2003, p. 1). Denis and Jouvelot (2005) explain the need for educational games to provide intrinsic motivation:

> The overall goal of educational games is to draw the student learning curve dynamics nearer to Vygotsky's zone of proximal development (Vygotsky, 1978), with games in lieu of teachers as knowledge mediators. …learners will be pushed by their own motivations rather than pulled by teachers. (p. 2-3)

Vygotsky's zone of proximal development is defined as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978). The diagram in Figure 5-3 illustrates the complicated relationship between challenges and skills and places an optimal situation of motivational gameplay in the center of the diagram. Achieving optimal balance produces ludic tension, actualization of learning, and a feeling of flow.

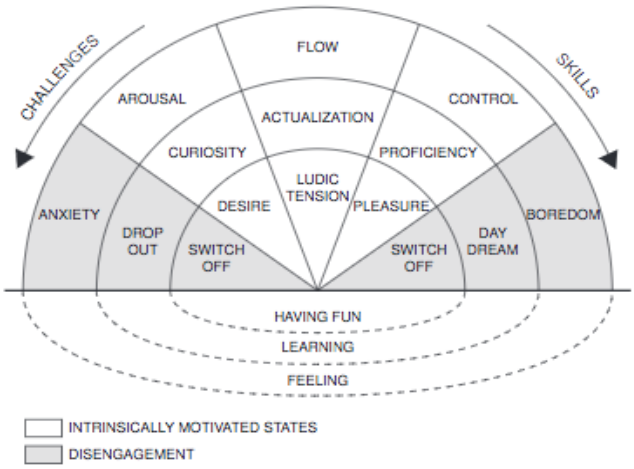

Figure 5-3: Intrinsic motivation as a balance between challenges and skills. Reprinted from "Motivation-driven educational game design: Applying best practices to music education," by G. Denis & P. Jouvelot, 2005, In *Proceedings of the International Conference on Advances in Computer Entertainment Technology*, p. 2. Reprinted with permission.

Conclusion and Hypothesis

This chapter explained the five core principles and their supporting structures that relate to the specific application of learning music improvisation. This framework then becomes part of a hypothesis: Can the framework for Creative Music Learning with Technology be successfully employed in the form of a digital tool for learning to improvise?

The following chapter presents the application of this framework in the design of an interactive software application for creative music learning.

CHAPTER 6: AN INTERACTIVE SOFTWARE APPLICATION FOR CREATIVE MUSIC LEARNING WITH TECHNOLOGY (CMLT)

An interactive software application was built in order to test the framework for Creative Music Learning with Technology (CMLT) with students. Taking the form of a touch-based mobile application (or app), this prototype was designed using the core principles of the framework described in Chapter 5 and presents a creative music learning environment for learning musical improvisation. Students are meant to engage in an interactive pedagogical sequence that uses listening, touch-based interaction, and playing along with musical recordings. The app guides students through a series of game-like tasks of musical interaction with a work (with a choice of touch-based musical instruments or physical instruments), and thus ultimately teaches students to improvise with the musical language. The application is not instrument specific. Rather, the focus is on acquiring fluency with the musical language: principally rhythm, form, harmony, and melody, as goals for musical comprehension and improvisational interaction. It is divided into "Lessons", where each lesson presents an interactive pedagogy for one specific musical work; this could be a classical piece or a folk or pop song. The alternation between active listening and improvising with accompaniment weave together a deep cognitive musical foundation based on the structure and musical elements of the selection.

As opposed to performing isolated exercises and drills that often separate musical technique and theory from actual music, the application encourages the learning of key musical components directly within the process of musical listening and improvising. All interaction with

the application is musical; students learn to play notes and rhythms while being continually immersed in the music.

Structural Overview

The eventual goal of the application is to provide a number of lessons that span multiple genres of music, thus providing comprehensive exploration of several musical works. Each lesson thus focuses on a particular song or musical piece, but is not limited to just one recording or interpretation—rather, several variations, covers, and remixes may be presented. The lesson is then divided into "Modules", each of which features one full play-through of a variation of the song (approximately 2-5 minutes) and contains a number of "instructional tasks". The task set included in a module typically addresses one aspect of musical pedagogy—such as rhythm, harmony, or melody, each with an embedded emphasis on learning the song form. Figure 6.1 presents a hierarchical breakdown of the information presented in the app.

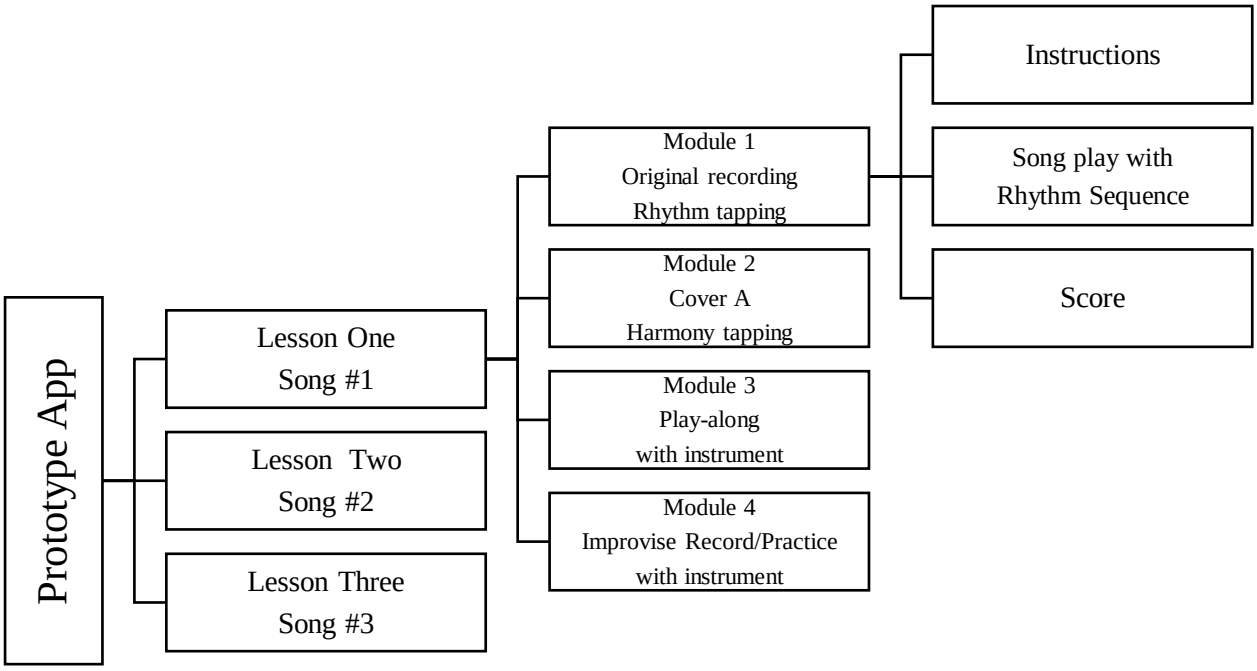

Figure 6-1: Overview of application structure (Lesson Two and Three not yet completed)

Prototype Design and Development

The prototype was built in collaboration with a software developer, Mike Wozniewski. The design specifications were given to the programmer, and the researcher was involved throughout the development process to assure that the software closely followed the initial design. The software was programmed in *Unity3D*, a tool for cross-platform game development with the ability to easily integrate touch-based interaction, adaptive control of audio, and real-time feedback of player progression.

One of the primary challenges in developing the software was the creation of a method for encoding instructional tasks that could synchronize with music, display instruction at specific times, and analyze user input. To address this, a track annotation system was created that provides an editing tool with which parts of the audio track can be labeled with extra metadata. For instance, it is possible to label beats, rhythms, chord changes, choruses, instrumentation changes, harmonic structure, melodic parameters, and other features of the music that can be compared to user input. Likewise, it is possible to choose moments of the song to present one form of instructional component versus another, thus defining which user interface (UI) elements should be displayed on screen, their configuration, and the underlying interactivity. Figure 6.2 shows a screenshot of the editing interface, where the track waveform is displayed and the various interactivity changes for the lesson can be annotated.

Figure 6-2: View of the software interface and track annotation in Unity-3D

Musical Selection

For the purposes of the prototype and testing, Lesson One was developed, consisting of several variations of a popular song[111]. The song was chosen because of its simple harmonic progression, which involved a continual repetition of four chords. The original commercial recording of the song was used in the first module of the lesson, while a cover version (the same song recorded by another artist) was used in a subsequent module. Additionally, a backing track of the song was used that closely models the original version, minus the vocals and instrumental melodies.

Exposure to a variety of interpretations provides multiple benefits. Students can hear some of the various interpretive possibilities, and attention is brought to the artistic and creative

[111] Due to copyright infringement issues, the name of the song and artist cannot be included in this document. The song selection was made before this information was learned. Since no melodic module was completed, this does not negatively affect the design description or lessen the value of the subsequent reporting in the testing phase.

nature and differences of musical interpretation. This exposure may be useful in helping to cultivate the development of one's own musical voice.

Another benefit is the cultivation of attention to structure and form in music. When students are asked to attune to various components of the music, they may learn to recognize the replication of structure despite numerous differences in instrumentation, key, timbre, expression, tempo, dynamics, and other expressive elements. This in turn can help to form a strong foundational understanding of music based on aural development. As students cultivate the ability to recognize and replicate structures and patterns, they may have more creative freedom and command when they themselves are creatively engaged in music making.

Learning Through Interactive Listening

"Interactive listening" constitutes the principle mechanism of interaction with the prototype, guiding the temporal and structural sessions of each lesson. Several tasks were developed for the initial prototype–Lesson One, each providing interactive game-like exercises that can be performed during the course of listening. The interactivity is defined by the annotation of audio tracks in correspondence with a "live notation" system and accompanying task-specific objectives that guide the student. This is a key element that distinguishes this design from existing software or method books. The instruction is based on active listening, the learning takes place aurally, and music theory and other components of the musical language are taught by having students respond in real time via touchscreen.

Live Notation

In order to provide appropriate and intelligible cues for user interaction, a "live notation system" was developed as an alternative to the traditional notation system that involves reading symbols for whole, half, quarter, and eighth notes, etc. This alternative notation system is driven

by annotated temporal cues in the music and provides a real-time animated visualization of structures within the music. The circles at the top of the screenshot in Figure 6-3 show one such visualization, with beat indicators that pulse according to annotations of rhythmic content in the song. The pulsations are necessarily dependent upon the audio track being played, in exact correlation with the music track. They are meant to function almost peripherally for students once they begin to fully engage with the rhythm, but also help them get back in sync with the rhythm if they lose their place, becoming once again a temporary focus point.

Figure 6-3: Screenshot of the live notation system: The circles pulse in correspondence with each of the eight eighth notes in a 4/4 measure of music. Rather than reading actual eighth notes, the circles allow users to experience the beat in live notation that pulses in time.

The live notation system does not have the ability to define precise duration, although the use of arrows (see Figure 6-4) in conjunction with control of pulsations can dictate specific onset rhythms. For the purpose of rhythmic tapping exercises, or even playing most percussion instruments, knowing exactly how long a note sounds is secondary in importance to the ability to tap the beginning of the note.

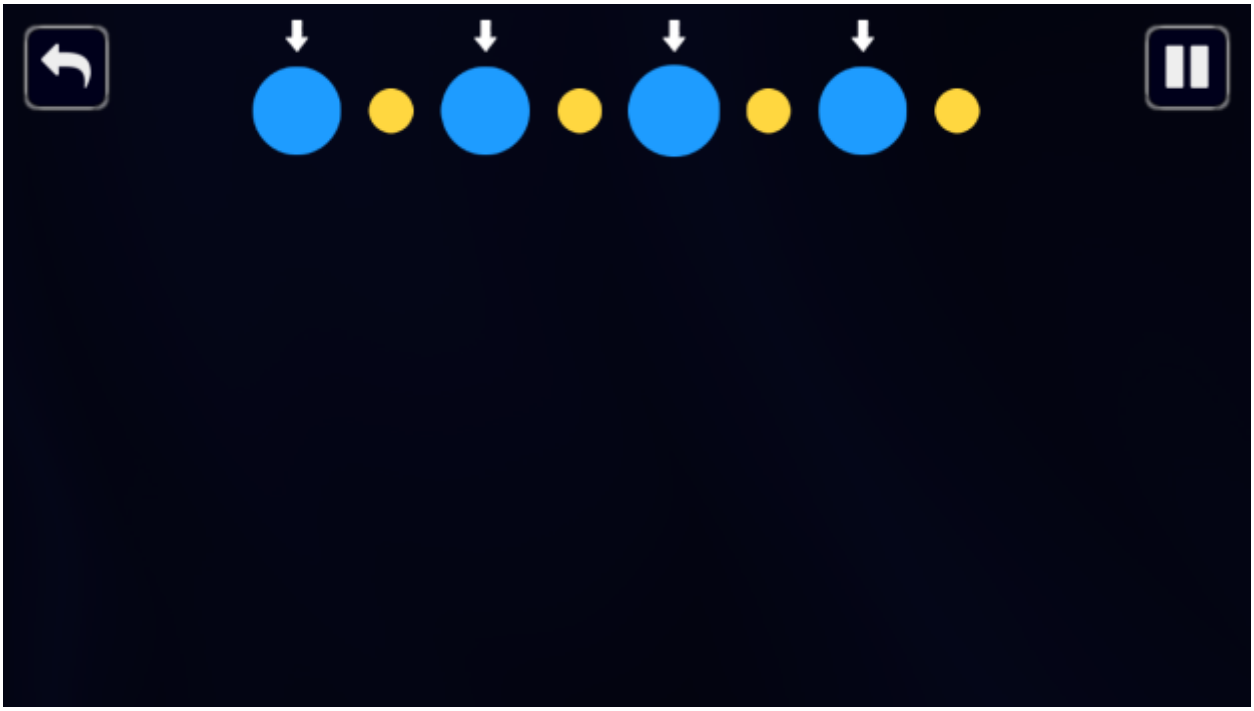

Figure 6-4: Specific task, tap on arrows (representing 4 quarter notes)

Transfer to a Musical Instrument

A core objective of the software is the ability to directly transfer musical knowledge from the interactive listening to playing on one's instrument. All lessons thus start with instructional modules that focus on listening and touchscreen interaction, with later modules offering opportunities to play along with an instrument. The live notation displayed in early instructional modules are also displayed in the instrumental play modules, allowing users to follow similar cognitive roadmaps as those they developed earlier in the lesson. The application aims to cultivate a working knowledge and flexibility in operating the diatonic tonal system. Because users have already done the instructional listening tasks that required them to accurately perform rhythm and harmony within the formal structure of the music, they have developed tools that may now be directly applied on their instruments.

Prototype Lesson One Overview

During the course of this research, one prototype lesson was developed and tested. This section will describe the four modules and a typical user flow of the software prototype, as experienced by the user testers in the qualitative study (Chapter 7).

Lesson One (see Figure 6-5) included two instructional listening modules: Module One: Rhythm tapping and Module Two: Harmony tapping. Module One was based on the original recording of the song, and Module Two used a cover version of the song. Module Three incorporates the rhythm and harmony aspects from the first two modules in a module intended for playing with an instrument. This module uses a corresponding play-along track of the song at hand. Following this practice module, Module Four provides an opportunity to practice and record playing one's instrument along with the accompaniment track. Module Four also allows for saving and playing back one's recordings. Figure 6.5 depicts a typical user flow that might be experienced when playing through this first lesson.

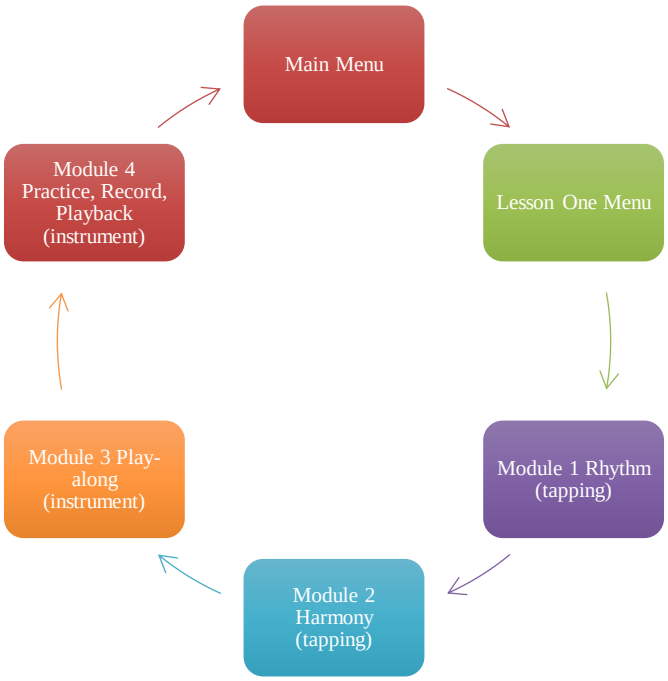

Figure 6-5. A typical user flow through Lesson One. Modules One and Two involve interactive listening and touchscreen interaction, while Modules Three and Four involve playing an instrument with the backing track.

Module One – Rhythm

In the first module, students are guided through a sequence of rhythm tasks in real time as they listen to a recording. Responses are made via touchscreen interaction, alternating between performing fixed rhythms and improvising rhythms in time with the music. Minimal visual feedback in response to touch-based input provides just enough information for users to confirm the software is picking up their response and to determine whether they are in time, too late or too early. The software uses tracking mechanisms to register and record all user input. User input is compared to the annotations associated with the audio track, allowing for assessment of accuracy. The software assesses accuracy within a predetermined percentage (20% on either side) of the rhythmic pulse of the music annotated on the track, displaying the feedback “great”. Any input that occurs before or after that window is assessed as “too early” or “too late”.

The objective of Module One is for students to listen actively to the work and correctly

perform and improvise rhythms in time with the musical selection. Students are presented with a sequence of instructions prior to commencing (see Figure 6.6), including the principle instruction to follow the rhythmic pulses by tapping anywhere on the screen. They are also directed to follow the indicated rhythms, demarcated with arrows and limited pulsations (only the specified rhythm pulses). Students are guided through a succession of ten rhythms which they perform in time with the music (see Figure 6.7). These rhythms are interspersed with periods in which they are invited to improvise. During these periods, all eight beats in the live notation pulsate in time.

Instruction Sequence
In this module we will learn to improvise rhythm, by tapping beats with the music.
The song is a popular song.
The song is in 4/4 time.
Rhythms will be displayed with pulses and arrows.
You can tap the rhythm anywhere on the screen.
Your tapping will be measured, so try to be as accurate as possible.
You get a one bar grace period to learn a new rhythm.
When the arrows disappear, improvise your own rhythms.
Just make sure to stay in time with the music and have fun!

Figure 6-6: Instruction sequence for Module One

Rhythm sequence in Module One Computational Input	Rhythm sequence in Module One Standard notation equivalent
1	𝅝
1-3-5-7	♩ ♩ ♩ ♩
1-2-3-4-5-6-7-8	♫ ♫ ♫ ♫
Improvise!	Improvise!
1-5	𝅗𝅥 𝅗𝅥
1-3-5-6-7-8	♩ ♩ ♫ ♫
6-7-8	𝄽 𝅘𝅥𝅯♫
Improvise!	Improvise!
1-2-3-4-6	♫ ♫ 𝅘𝅥𝅯𝄽
2-3-4-6-8	𝅘𝅥𝅯♫ 𝅘𝅥𝅯𝅘𝅥𝅯
1-2-3-5-7	♫ 𝅘𝅥𝅯𝄽 ♩
Improvise!	Improvise!

Figure 6-7: Rhythm sequence in Module One

The first rhythm that students are instructed to perform in Lesson One, Module One, is simply playing on the first beat of each four beat bar, which they are guided to repeat for eight bars. Following this, users are guided to play four quarter notes per bar, for a period of eight bars, followed by consecutive eighth notes. After the eighth note sequence, users are invited to improvise. During this period, they continue to receive feedback concerning their timing, but their accuracy is not counted towards or against their score. As the module progresses, more complex patterns emerge. Figure 6-7 represents the ten rhythms that were used for Module One.

The software gives the user instantaneous feedback in the form of text messages placed directly at the location where they are touching the screen. The three feedback messages “great,” “too early,” and “too late” fade out within a period of approximately one second. Figure 6-8 shows a screenshot of Module One in which students are asked to tap a one bar rhythm of two quarter notes followed by four eighth notes. The feedback messages on the screenshot are located at the three spots that the user has just touched. The numbers at the bottom of the screen indicate the number of correct responses so far compared to (/) the total number of correct responses in the song. The top left of the screen has a return to menu button, and the top right has a pause button so that the user may pause the music and the visual interaction at any time.

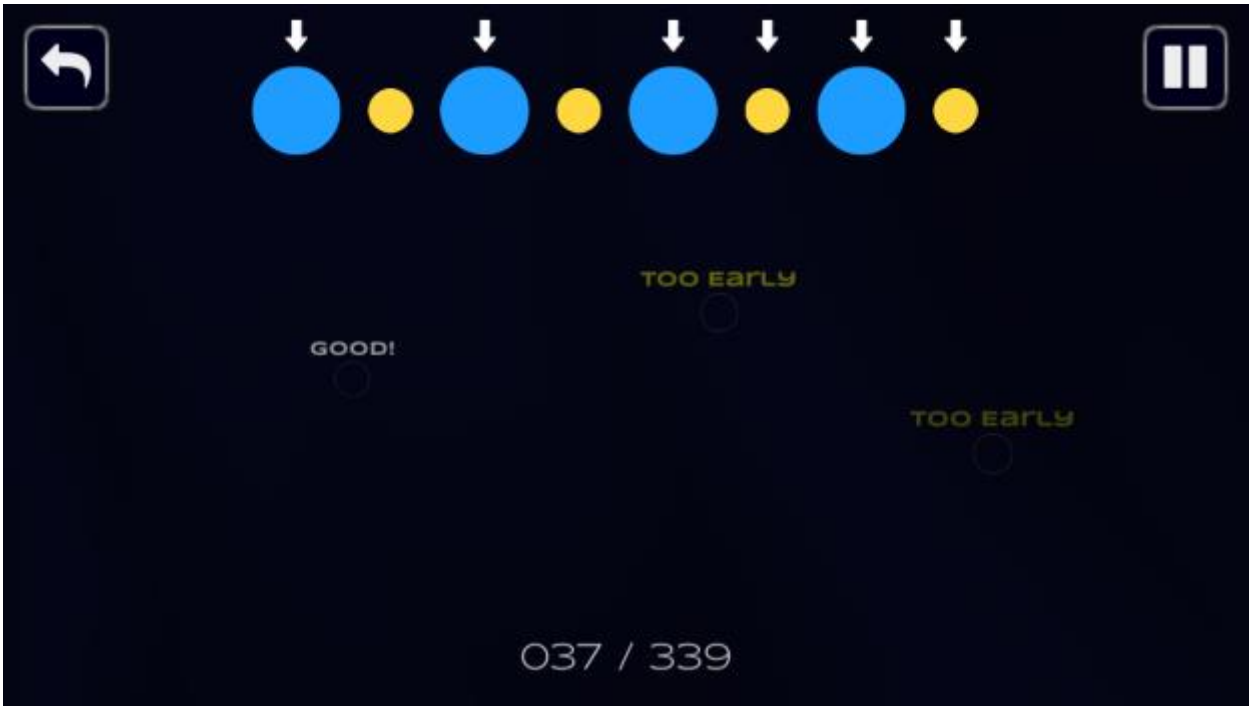

Figure 6-8: Screenshot of Module One with feedback

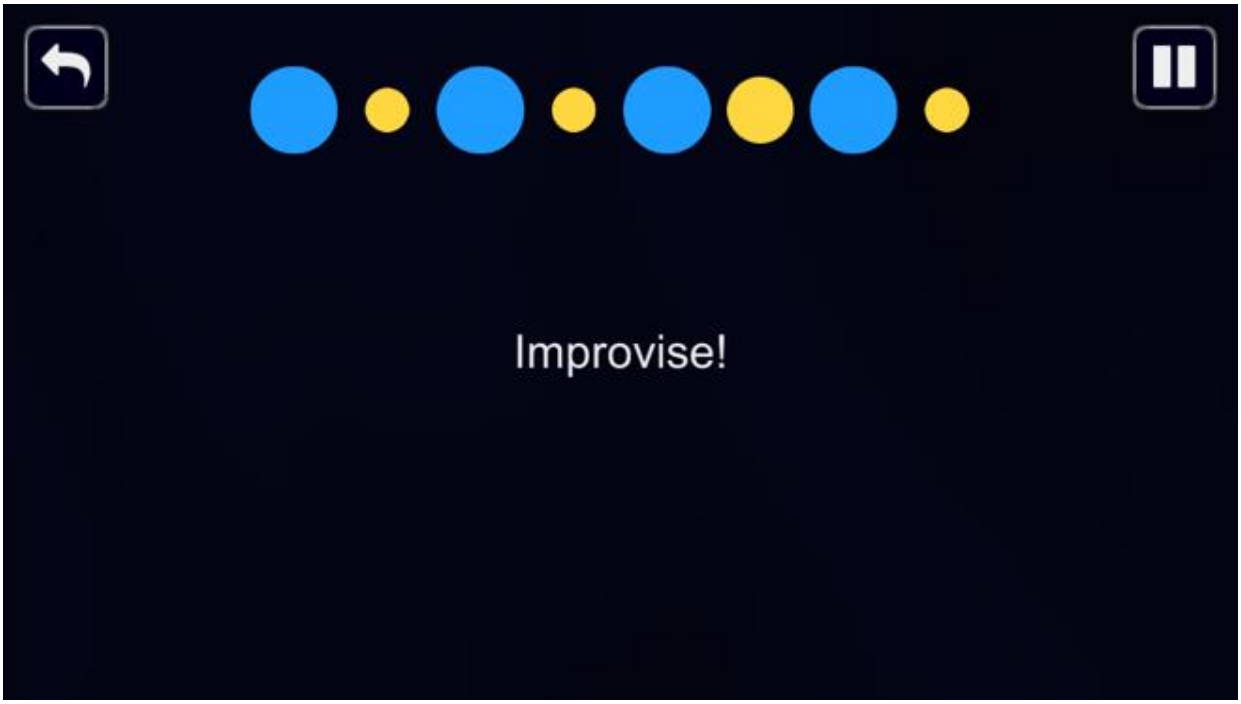

Figure 6-9: Screenshot of Module One - Improvise

At the end of Module One, the software provides a summary of results (see Figure 6-10), including cumulative accuracy, and an early/late bias that informs the player the degree to which they are typically early or late with respect to the beat. The final score represents the percentage of correct responses. Accuracy refers to the percentage of correct responses out of only those rhythmic pulses that were attempted. Early and late bias are the percentage of responses that were either early or late. The following equation was used to calculate early bias, α, based on the number of taps that were either e (early), p (perfect), or l (late):

$$\alpha = \frac{n_e}{n_e + n_p + n_l}$$

Late bias was calculated in the same manner. The data from this tracking forms the basis of the motivational gameplay, and future development could include a reward system based on these calculations.

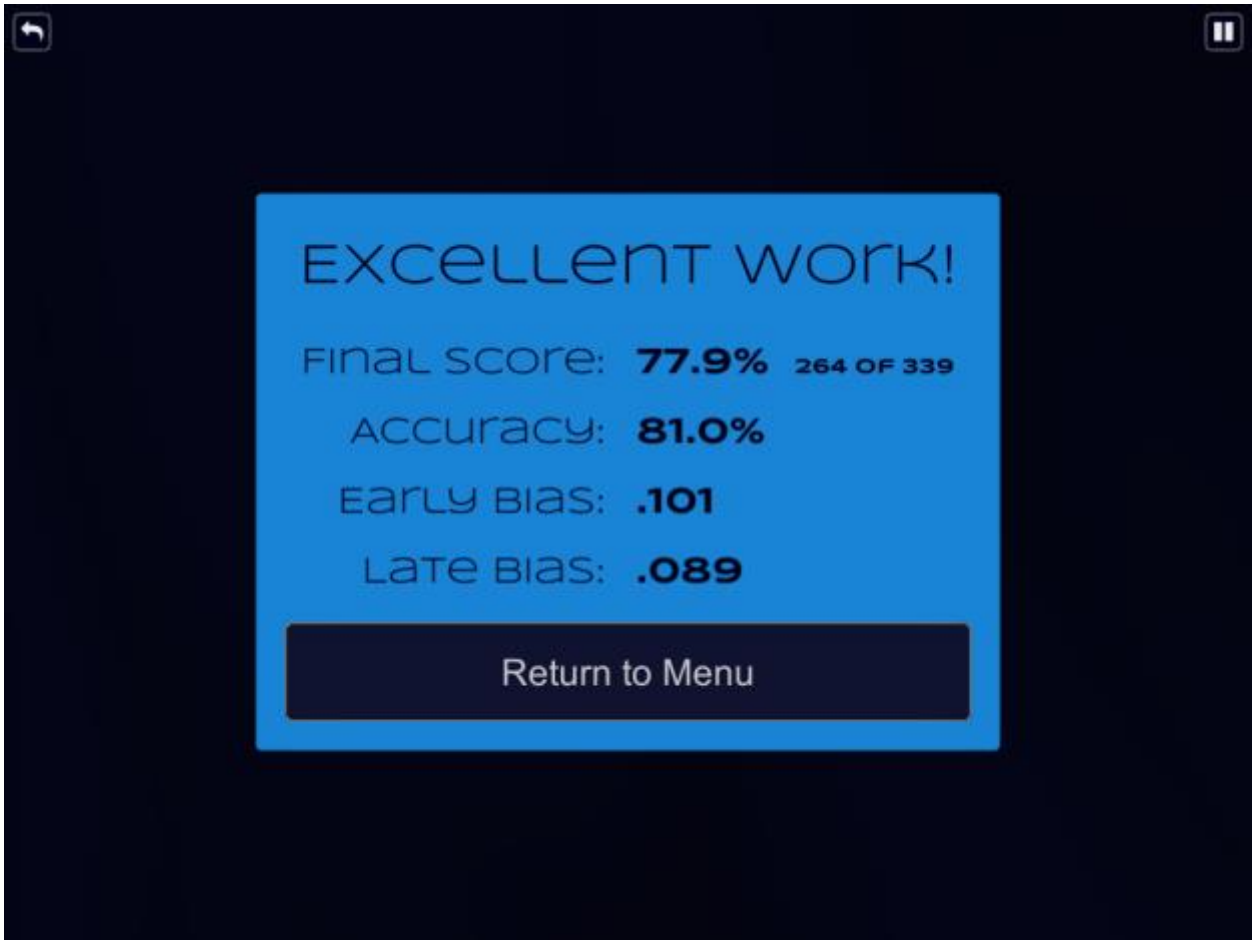

Figure 6-10: Feedback after completing Module One

Module Two – Harmony

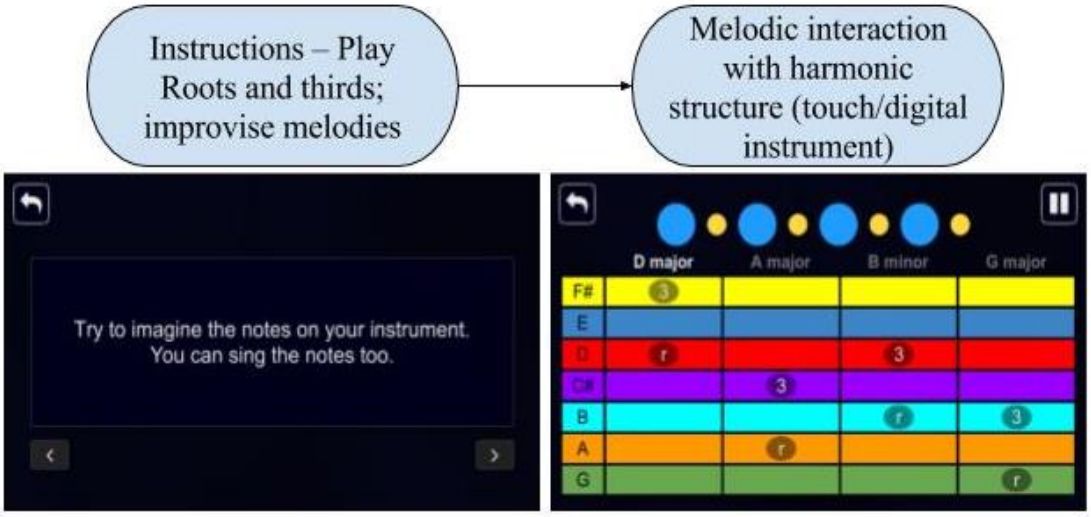

Figure 6-11: User flow Module Two

The second module of the prototype aims to teach students how to understand and interact with harmony while following the harmonic progression of the work. The interface is a dynamic representation of the notes in the corresponding key of the music, broken up in quadrants to represent the chords of the song (see Figure 6-12). At the top of the screen, the live notation from the rhythm module is shown to provide a reference of the rhythmic pulse and assist the user to correctly follow the temporal and harmonic structure of the song.

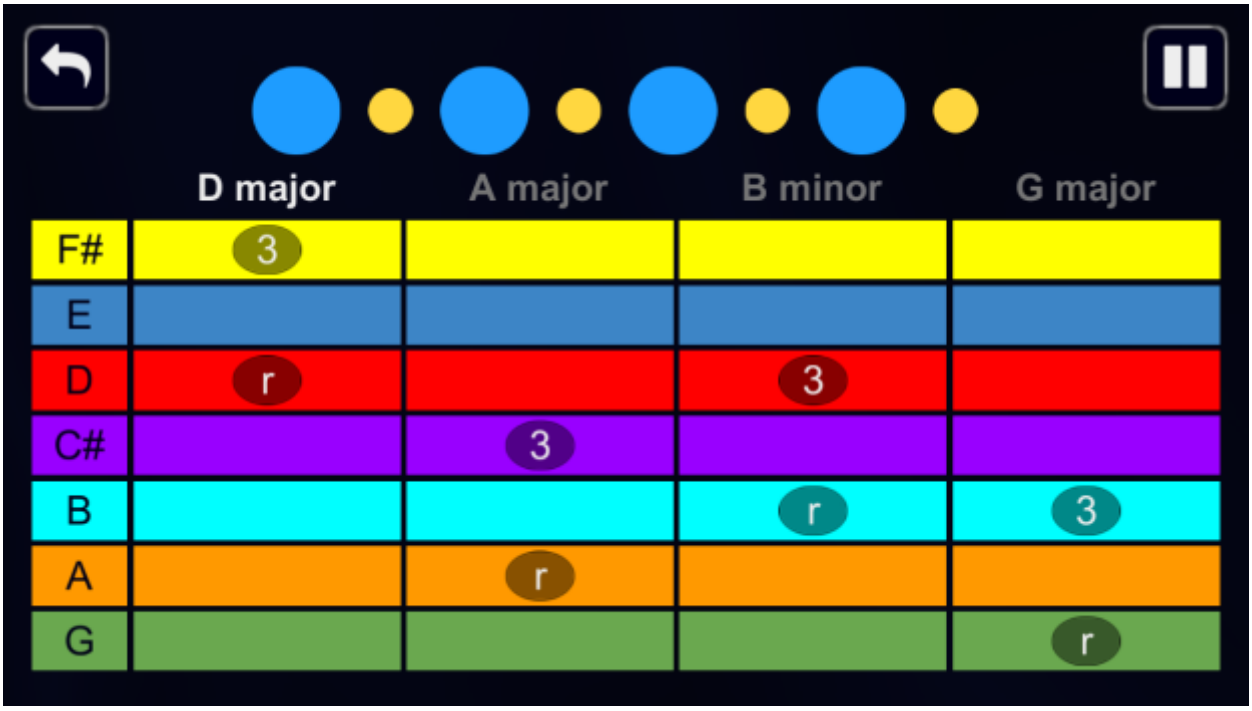

Figure 6-12: Harmony Interface for Module Two

The instructional sequence that precedes the interactive listening gives some background about the music and the harmony of the song (see Figures 6-11 and 6-13). Students are told to concentrate on learning the roots and thirds of the song, while following the song structure and form. They are also invited to add other notes as they become comfortable. When the student presses the next button on the final instruction screen, the dynamic interface is displayed and the music begins to play.

The interface acts as a digital instrument, responding to the student's touch by playing the note related to each color (indicated to the left of the interface). The samples used for the instrument are classical guitar notes G3, A3, B3, C#4, D4, E4, and F#4. On each chord quadrant, the root and the third of the chord are indicated with the letter *r* and the number *3*.

Instructional Sequence for Module Two – Harmony
This harmony module uses an electronic cover of (the song), by (another popular artist).
Harmony refers to the chords used in a song.
The harmony in this cover version is the same as the song used Module One
Both are in the key of D Major.
D Major A Major B minor G Major
For now, concentrate on learning the root (r) and the third (3) of each chord, in time with the song form.
Try to imagine the notes on your instrument. You can sing the notes too.
When you are comfortable with the root and third, play with the other notes in the chord box.
The intro has four bars resting on D Major.

Figure 6-13: Instructions, each displayed on a separate screen, for Module Two

A working understanding of form is an essential core skill to obtain for improvisation (Parisi, 2004), therefore a feedback strategy in the harmony module aims to assist students in learning the form of the song. This is accomplished by requiring users to play the notes on the interface within the chord quadrant corresponding to the chord that is sounding at any given time. Text feedback is again provided, placed at the point of touch. When the user is not playing in the correct chord quadrant, the feedback is "wrong chord". When the user is playing within the correct chord quadrant, there are three feedback messages, depending on the particular note the user is playing. The three messages are: "root" when the user plays the root of that particular chord, "third" when the user plays the third of the chord", and "good" when the user plays any other note within the correct chord quadrant. As seen in Chapter 3 of this work, harmony and melody, or chord-scale theory, forms the basis of many stylistic improvisation pedagogies. What makes this unique, is that students are given a framework for creatively interacting with these elements while listening to professional music recordings, therefore providing an interactive aural experience of music learning.

This module invites users to play any note within the scale at any time and is intended to encourage creative freedom and experimentation. By hearing the notes sound over the different chords, the user receives aural information regarding the sound of notes in relation to harmony.

Harmony and form are intertwined to allow for a better comprehension of their relationship. It is the harmonic structure of the song, or the chord progression, that defines the temporal form of the song. The harmony module is working to deepen users' understanding of not only the chord sequence and musical form, but also the specific notes that make up the chord. Due to the layout of the module design, users are guided to develop an understanding of the relationship of the notes throughout the chord progressions. Though they may be instructed to begin with the chord tones, they are free to play all notes, and even invent melodies. It is hoped that the visual breaking up of the four chords, and the necessity of staying within the chord quadrant as the music plays will increase their ability to understand the changing relationships of notes as they move between different chords. Students can experiment with the sounds of the particular note choices over the different chords and learn about note functions through autonomous play. At this time there is no score on this module, however this would be a useful development in the future.

Module Three – Play

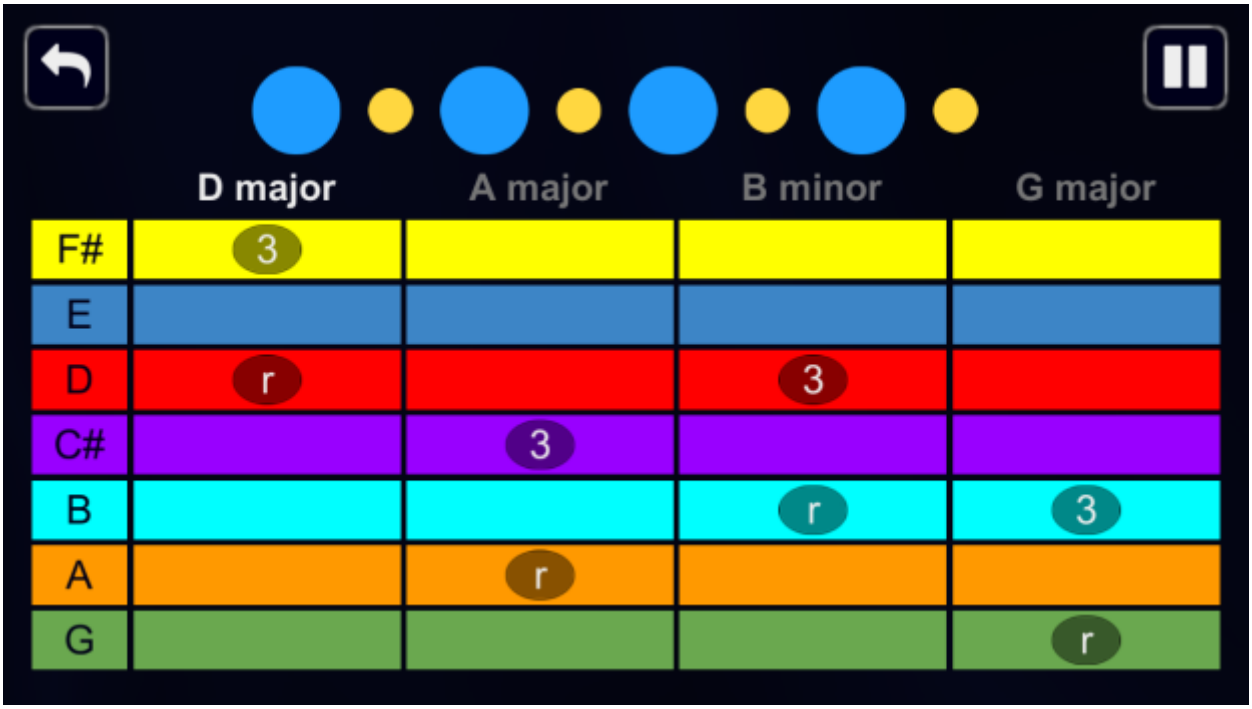

Figure 6-14: Harmony interface for Module Three

Module Three brings the dynamic interface of the harmony module into a setting devised for playing an instrument. The music used in this module is a backing track of the popular song. Live notation from the preceding modules is represented on the screen, providing guidance and supporting the transfer of knowledge from the listening modules to the student's instrument. The live notation pulses the rhythm, marking each bar in time. The chord quadrants pulse as well, indicating the chord playing at any given time. These guides are present as the student experiments on their instrument. The digital instrument is still present if the student needs a reference.

Module Four – Improvise

The final component of the prototype is a module that allows students to practice and record playing on their instrument with the backing track. This module has no visual guidance,

calling on the student to “test” their retention of what they have learned. By pressing the “Practice” button, they may simply play the backing track and practice with the accompaniment. Pressing “Record” gives them a four count lead-in before commencing recording with the backing track.

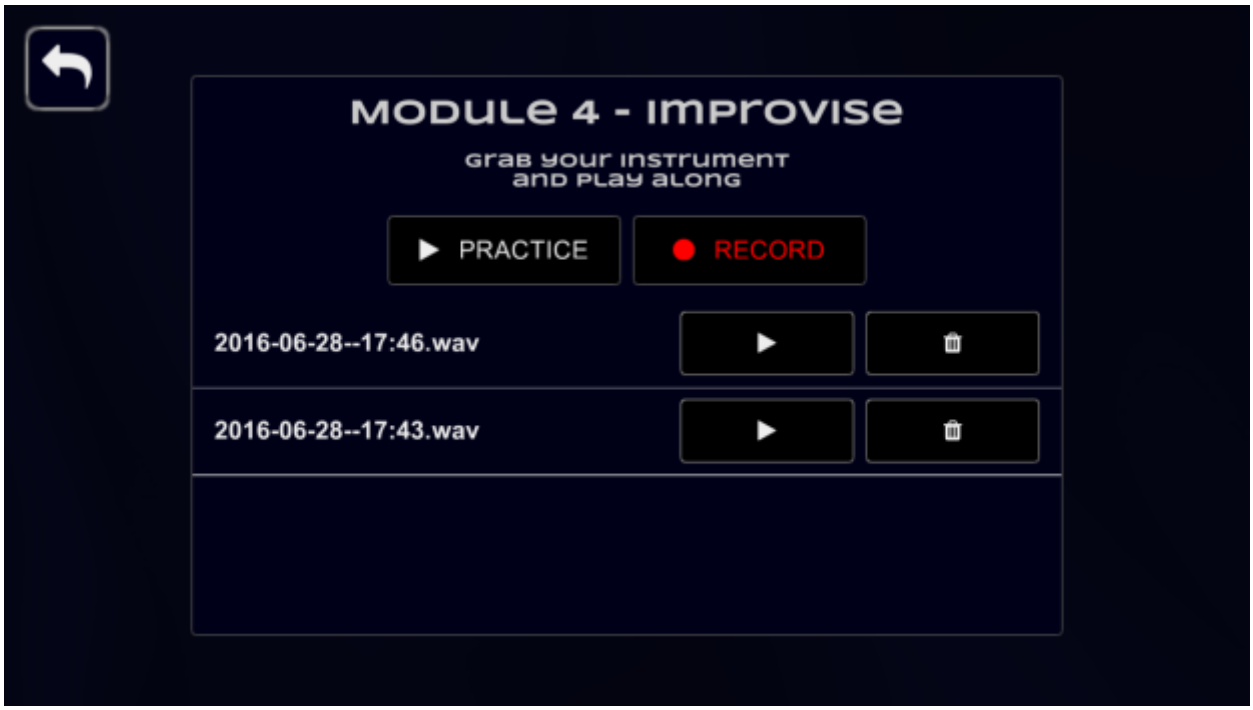

Figure 6-15: Screenshot of the interface in Module Four - Improvise

Students can playback their recorded improvisations for review and delete them if desired. Otherwise, the recordings remain in the application indefinitely.

The chapter that follows, Chapter 7, presents the user testing and case studies that influenced development and examined the effectiveness of the software prototype.

CHAPTER 7: A TWO-PART STUDY OF THE PROTOTYPE EFFECTIVENESS

Methodology of the Study

In order to test the validity of the framework and the prototype, a study was conducted with seven private instrumental music teachers considered as experts, and fourteen middle school instrumental students aged between 10 and 13 years old. The research was designed to examine the feasibility of the tool and explore the potential for the creative music learning system to be successful. As an action plan for answering a series of questions, this research design incorporates the collection and analysis of relevant data in order to arrive at a set of conclusions (Yin, 2003). By examining potential student users and teachers engaging with the prototype, the research seeks to deduce the applicability of the framework for Creative Music Learning with Technology to the field of music learning. Within the field of educational research "there is a tension between the desire for locally usable knowledge on the one hand and scientifically sound, generalizable knowledge on the other" (Sandoval & Bell, 2004, p. 199). The study was designed in order to produce both outcomes: a deep analysis of student and teacher experience using the prototype, as well as more general information about creative and autonomous music learning.

The study had four primary research questions guiding it. The first two questions correspond to the first part of the study examining one-time user testers. These participants included eight middle school instrumentalists and seven expert music teachers.

Expert teacher user testers: Research question #1:

What impressions, opinions, and evaluative responses do professional music teachers have about the prototype and the potential application for their private music studios?

Middle school instrumentalist user testers: Research question #2:

What impressions, opinions, and evaluative responses do middle school instrumental students have about the prototype and the adoption of such a tool into their musical lives?

The second part of the study involved a group of six long-term user testers, also middle school instrumentalists. These students participated in a five-week study that involved a pseudo-control week of purely listening, and four weeks of interaction at home with the prototype. There were two research questions that guided this portion of the study.

Case studies of middle school instrumentalists: Research question # 3:

How do middle school instrumentalists find the experience of using the prototype over a period of one month?

Student confidence improvising after using the prototype: Research question # 4:

Does using the prototype affect their perceived self-confidence in improvising?

Preceding the presentation and discussion of the results is a thorough description of the methodology employed in these studies. This begins with a description of the participants and the setting, as well as the recruitment process, ethical considerations, and data collection and management. This information is followed by a description of the two studies: the one-time user testing and the five-week case studies. Following a description of the research design of each

study, the data analysis is described including data reduction and the handling of emergent themes.

Participants

A total of fourteen middle school instrumentalists and seven private music teachers volunteered and participated in the study. All participants were residents of an urban city on the coast of western Canada with a population of approximately 350,000. The seven teachers and eight of the middle school students participated in one-time user testing of the prototype. Six of the fourteen students participated in the long-term study. A small sample size was elected for the case studies in order to reveal rich feedback concerning design and experience.

Setting

The study took place at the local conservatory, located in the downtown area of this city. Of the fourteen middle school instrumentalists, twelve took lessons at the conservatory, and the other two took lessons privately, outside of this institution. Four of the seven expert teachers were employed at the conservatory. The others taught in private music studios.

The conservatory, originally founded in 1964, reports attendance of 3,000 students of all ages and abilities per year. Students learn music within many genres, including classical, folk and contemporary.

Practice/teaching rooms in the conservatory were used for the individual sessions with the students and teachers. These rooms contained at least one piano and multiple music stands. Students were able to feel comfortable that no one else could hear them besides the researcher and occasionally their own observing parent.

Recruitment and Participant Specifications

All students and teachers were recruited through the conservatory by way of a letter of

invitation to participate mailed out by the Dean to the faculty and entire student body (This letter was approved by the Research Ethics Board Office of McGill University and is included as Appendix I). The letter also invited them to forward the email to anyone they thought may be interested, as studying at the conservatory was not mandatory for participation. Specifications for the music teachers required that they be instrumental music teachers with a minimum of five years of teaching experience in music.

For the student participants, the requirements included being between the ages of 11 and 14. Students of this age typically have an inclination towards technology, as well as sufficient autonomy and instrumental proficiency to engage in autodidactic music learning. This age was also chosen because studies have shown that as students approach this age their interest in music declines (Ark, Nolin, & Newman, 1980; Bowles, 1998). Because musical programs are typically electives in middle school, many students may choose not to engage in them. For those who elect to participate in school music programs, it is not assured that they will receive instruction in improvisation or composition, as research has shown that many teachers find these two skills less important than other curricular elements (Barkley, 2006; Byo, 1997; Kirkland, 1996; Louk, 2002).

Participating students were required to have studied an instrument for at least one year. This is because the app is designed for instrumentalists that know the notes on their instrument and have the necessary technique to be capable of thinking about and performing more complex aspects of the music. Though participants were not required to have experience improvising, they were aware the study involved learning to improvise with the help of an iPad app.

Students in the long-term study were not required to have an iPad at home—in these cases, a device was lent to the student for the four weeks of interaction with the prototype.

Students were also given the option of using their iPhone in place of an iPad, as the app works on either platform.

Compensation details were included in the email. One-time test users, both students and teachers, were compensated with a $10 iTunes gift card. Students in the long-term study were compensated with a $25 iTunes gift card upon completion of the five weeks.

Responses

Parents of interested students and the teachers responded directly to the researcher by email. There were more responses than anticipated, and 100% of respondents did in fact participate in the study. Students and teachers were sent a questionnaire created and managed with Survey Monkey[112] that retrieved basic information about the students and teachers as well as information about their past experience improvising and using technology (see Appendix II-students and III-teachers). The survey also asked students to indicate the day of the week and time that meeting would be most convenient for them at the conservatory. Following reception of the survey, sessions with all of the twenty-one participants were scheduled. The following two tables represent some of the survey data collected initially from the student participants. Table 7.1 is the one-time middle school user testers and Table 7.2 contains the six case study participants.

[112] www.surveymonkey.com

One-time user testers: Students

Student	Age	School grade level	Instrument	Years of study	Has an iPad	Has an iPhone	Has experience improvising	Ensembles?
Student 1	11	5	Piano	4	no	no	no	no
Student 2	11	6	Piano	6	no	no	no	Band, Strings, and Choir
Student 3	13	7	Violin, Viola	7, 1	no	no	no	Quartet
Student 4	13	7	Violin	7	no	no	no	Quartet
Student 5	12	7	Alto sax	1.8	yes	yes	Some, jazz band	Concert and Jazz band
Student 6	11	6	Piano, Viola, Flute	5, <1, <1	yes	yes	Yes, alone and with friends	no
Student 7	12	7	Trumpet	2	yes	no	Some, with friends	Concert band, Jazz band, Wind ensemble
Student 8	13	7	Voice	2	no	no	no	Choir

Table 7-1: One-time user testers: Student information

Long-term users: Case Studies

Student Name (pseudonyms)	Age	School grade level	Instrument	Years of study	Has an iPad	Has an iPhone	Has experience improvising	Ensembles?
Emma	11	6	Cello	6	Yes	Yes	No	Quartet through private studio
Steve	12	7	Piano, Saxophone	6, 2	Yes	No	Yes	School ensembles: Band, Junior Jazz, Wind ensemble
Alex	10	5	Violin	4	yes	No	Yes	Family ensemble
Kirk	11	6	Cello	2.5	Yes	No	Yes	Family ensemble
Cindy	12	7	Flute	6	No	Yes	No	School ensemble: Band
Stella	11	6	Viola, Flute, Piano	2, 1, 1	Yes	No	yes	School ensembles: Intermediate strings, Choir, Band

Table 7-2: Case study student information

Ethical Considerations and Role of the Researcher

Once the study was complete, pseudonyms were substituted for the teachers and students' actual names. This safeguard, coupled with respect for the agreements between researcher, teachers, parents, and students made in the consent forms, helped maintain ethical integrity in the study. No student or teacher dropped out of the study, and each participant completed the necessary tasks in their entirety. A relationship of mutual respect with the teachers was cultivated and akin to that of colleagues. With the students, a relationship of mutual respect, similar to that

of a typical teacher-student relationship, contributed to positive interaction between the researcher and participants.

In an attempt to deeply understand the students' perspectives and experiences, an improvisatory approach to the sessions was taken. Though guide questions existed for all of the sessions, they were only loosely pre-defined, allowing a student to direct flow and creatively participate in the user-testing session with the prototype.

Data Collection and Management

All student and teacher sessions were audio recorded from beginning to end using a specified audio recording device and the researcher took notes during the sessions. When a participant interacted with the software, a video was recorded that focused exclusively on the hands of the participant interacting with the device. No faces were video-recorded at any time. Audio recordings of improvisations were taken on a laptop computer or on the researcher's iPad. The researcher recorded personal audio journals, and wrote extensive notes between the sessions with students.

All listening logs, audio recordings, transcriptions, and videos were stored in secure, individual participant folders on Google drive. Data from the questionnaires was exported into PDF and Excel formats directly from *Survey Monkey* and stored in the appropriate student folder on Google drive as well. This Google drive folder has restricted access, available only to the researcher and her supervisor. Student and parent consent forms are stored in a locked file cabinet in the researcher's home.

One-time User Testing

The eight middle school students and seven expert music teachers each participated in a one-on-one session with the researcher at the conservatory. As previously mentioned, each

participant completed a preliminary questionnaire via *Survey Monkey* (Appendices II and III). Arrangements were made to schedule each session, and at that time, the researcher met with the participants at the conservatory. Students and teachers were requested to bring their instrument to the session.

Each session began by asking the teacher, or the student and the student's parent, to read and sign the appropriate consent forms (see Appendix IV-VIII). The project was explained to them and they were given the opportunity to ask questions.

During the one-hour session, the students and teachers were asked to interact with the prototype, asking and answering questions and engaging in conversation as different topics naturally arose from their experience. The students and teachers completed all four modules of the prototype. The first two involved interactive listening and the second two modules involved playing an instrument along with the prototype.

Data analysis

As interviews were transcribed, notes were compiled into a separate document to find emergent themes. A second reading consisted of the implementation of a labeling system according to these themes. The emergent themes that arose in the data from the teachers were: listening, rhythm module, harmony module, balance between structure and freedom, mistakes, application to students and teachers, musical styles, design ideas and concerns, instructions, and experimenting and online communities. The data analysis of students' sessions revealed the following emergent themes: rhythm module, gamification, instructions, harmony module, improvisation on an instrument, social component, and music. These emergent themes are used in the reporting of results below.

The Five-Week Case Studies

A case study approach guided the long-term user-testing portion of the study. This methodology was chosen in order to garner analytic generalization about the potential for the framework to benefit users over an extended period of time. As Yin explains:

> Case studies, like experiments, are generalizable to theoretical propositions and not to populations or universes. In this sense, the case study, like the experiment, does not represent a "sample," and in doing a case study, your goal will be to expand and generalize theories (analytic generalization) and not to enumerate frequencies (statistical generalization). (2003, p. 10)

The student participants in this phase of the study also began by completing the Survey Monkey student questionnaire (Appendix II). They then participated in a five-week guided study that included multiple components.

The first stage of the study began by sending students a set of emailed instructions (Appendix X) to be followed independently for the first week. This week was considered the pseudo-control week, as students did not yet engage with the software prototype. Students met in one-on-one sessions for one hour with the researcher at the conclusion of this week. After this initial meeting, there were four weeks in which the students interacted with the prototype. During these four weeks, the researcher met with each individual student on two more occasions, once in the middle, and once at the end. Each of these sessions was one hour and took place in a one-on-one setting at the conservatory. Below is a detailed description of the events and procedures.

Week one – Pseudo-control week

Exactly one week before each student's initial scheduled meeting with the researcher, they and their parents were emailed instructions that included a link to a Google Drive folder containing nine musical tracks. The students were instructed to download these tracks and listen to them throughout the week as much as they could, for a minimum of one hour. The audio

tracks were all the same popular song, interpreted by nine different artists (listed below). The chosen musical selection was the classic 1979 reggae song "No Woman, No Cry," written and recorded by Bob Marley and the Wailers. This song was chosen for two reasons. Firstly, because of the universal popularity of the song there were many high-quality cover versions readily available. The second reason it was selected was due to its harmonic content, primarily the I-V-vi-IV chord progression that dominates the song. This chord progression is a common progression in popular music and is identical to the song selection used in the prototype. Having this similar harmonic structure decreased the amount of variables between the two song selections, therefore increasing the potential to observe the benefits of the prototype intervention in weeks two through five.

Selected versions of "No Woman, No Cry"
Original version: • Bob Marley and the Wailers Cover versions: • Gilberto Gil • Hisham Fageeh[113] • Joan Baez • John Popper and Blues Traveler • Jonathan Butler • Nina Simone • The Fugees • Xavier Rudd

Since the prototype asks students to interact with the music as they listen, the pseudo-control week sought to have students listen to multiple versions of one song in the natural context in which they typically listen to music.

[113] "No Woman, No Drive" - A cappella parody on YouTube: https://www.youtube.com/watch?v=aZMbTFNp4wI

Students were asked to keep a listening journal whenever they listened to any of the recordings. This journal was on a private Google document, shared only between the student and the researcher. Changes students made to these online documents were automatically and instantly shared with the researcher due to the collaborative nature of Google documents. For each listening session in which they engaged, they were asked to write down the following information: date and time, length of time, location and the device used. They were also asked to share any other notes about the listening session including activities that they did as a result of listening or while listening.

Session one

Arrangements were made via email to schedule the first one-on-one session with students and parents. These sessions took place at the conservatory, and the first task was to have students and parents read and sign the appropriate consent forms (See Appendix IV and V). Then students were asked to discuss the control week and describe the experience of listening to the Bob Marley original and the eight cover versions. Their opinions and experiences were reported as well as where and when they chose to listen and what activities they were simultaneously engaged in. They were asked about musical elements in the music and any recognition they may have had while listening. This conversation typically lasted about 15 minutes. The researcher tried also to ascertain their typical listening habits to their own favorite music.

In order to provide control data for later comparison after using the prototype, students were asked to improvise on their primary instrument along with a backing track of the song[114], "No Woman, No Cry." Students were told that the song was in the key of C major, and they were invited to play a C-major scale to warm up. The researcher then set students up for recording on

[114] The backing track was purchased online from www.guitarbackingtrack.com

a laptop computer using a simple multi-track recorder, headphones, and the laptop microphone, and instructed students to improvise along with the recording. They were assured that this recording was not going to be shared with anyone, nor was it going to be graded or assessed for correctness. They listened privately on headphones to the backing track as they played their instruments and were recorded. Students played and were recorded for the entirety of the five-minute play-along track. Immediately following this, students were asked to complete a questionnaire that asked them to rate the following questions on a Likert scale of 1-10 (1 being not at all, and 10 being very much so).

- How confident were you improvising just now?
- How well did you know where you were in the song?
- To what degree were you aware of what chord you were playing over?
- How well were you able to play rhythmically with the beat of the song?
- How well did you enjoy improvising?
- How much did your experience of listening to the original and covers help you to improvise better?
- To what degree were you able to create melodies that you liked while improvising?

They were also asked at the bottom to write one sentence about their improvisation. Following the completion of the questionnaire, the students were introduced to the study and the prototype with which they would be working over the next four weeks. They were informed that they were part of the creative process of software development—that while the pedagogy had been carefully developed through research and study, the prototype was new and would require the input of student users. They were being 'brought on board' to provide feedback about their opinions and experiences with the software and were told why their input was so vital to the design of the digital tool.

The basic process of collaboration between the researcher and the computer programmer was explained to the students: the researcher was designing the tool and the computer

programmer was working closely with her to make it as near to the envisioned tool as the logistics of computer programming would allow. Students were also debriefed on the basic design of the pedagogy; they were explained that through interactive listening and playing along with backing tracks, they would be guided through a process of internalizing first rhythm, then harmony and melody within the context of one particular song.

Instructions for installing the software on their devices were covered including helping students to acquire the UDID[115] of their iPad or iPhone. The UDID is required by the developer of an app that is not yet sold on the App Store. Instructions involved typing in getudid.io in the Safari browser and following instructions that lead to the display of the device UDID. Once obtained, the UDID was then messaged or emailed to the researcher. This UDID is then included in the provisioning profile within a build of the software, therefore granting permission for the device to download and install the software. This permission was maintained as subsequent versions of the prototype were built and made available.

During the session, each student also received instructions for how to keep audio journals throughout the study. They had two options for recording the journals. The first involved using the voice memo app on an iPhone, if they had one, to simply record and then email them to the researcher. The second asked students to go to http://online-voice-recorder.com/ where they could record and share their recordings.

Next, the student watched with the researcher a musical video of Axis of Awesome "Four chords".[116] Both the control music selection from the first week and the musical selection used in the prototype are included in this comedic medley of 40 songs that use the same four chords.

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[115] The UDID of a device is the particular identification that allows developers to give permission for downloads outside of the App Store

[116] https://www.youtube.com/watch?v=oOlDewpCfZQ

Students were explained why popular music was a good first choice for learning to improvise due to the simplicity of the musical elements. The Axis of Awesome video begins by playing just the four chords and displaying the corresponding roman numerals (I-V-vi-IV). At this point the researcher paused the playback so that the 4 chords remained on the screen (and in the ear) and asked the students if they knew what these symbols represented. This was used as a teaching moment to explain what the roman numerals stood for and how they related to what musicians play. Following playback of the entire song, a discussion took place regarding the infinite number of variations one can create over the same four chords. Students were asked to talk about which songs they knew, and which ones they liked or particularly did not like. What made each song and each artist unique? Style, color, genre, rhythm, and instrumentation were some of the topics spoken about with regards to the various songs covered in "4 Chords". Finally, students were given the opportunity to try the first version of the prototype software.

In-between sessions one and two

Following session one, students received an email that included the link to download and install the app on their device (see Appendix XI). The email also included instructions for keeping the audio journal and the questions they were to answer (all journal questions are found in Appendix IX). The questions were different for the very first journal entry, in which they were to compare using the software with simply listening naturally to the "No Woman, No Cry" collection.

Session two

For the second session, students again met individually with the researcher at the conservatory for approximately one hour. The majority of the session was spent observing student interaction with the prototype and talking about their experience and the perceived

usefulness of the prototype. The sessions were conducted in a relaxed and informal manner, with the idea that if students were comfortable they would be more likely to divulge honest perceptions and opinions about the software. Each student interacted with the software, interacting with all four modules. This included playing their instrument along with Module Three and Module Four. The researcher sometimes asked them to pause in the middle of an activity in order to clarify their motive or thought process behind an observed action, or to give an opinion about a specific element. One test the researcher gave students was to cover the chord quadrants with her arm and ask the student what the four chords were, in order.

Following the session with the software, the researcher and student engaged in exploratory dialogue about the prototype for approximately ten minutes, including the social possibilities, as well as potential applications and where and how it could be used. They were asked about music they would like to see in the app and about music they would like to be able to improvise with friends. When a moment naturally arose for a teaching segment, the researcher explained a concept or demonstrated a musical device on the piano, or with the app itself.

For the last ten minutes of the session, students were given the task to improvise along with the backing track from Module Four. Students used headphones and improvised while being recorded directly into the prototype application on the researchers iPad. Following this recording, they again filled out the questionnaire as before. The only difference in the questionnaire was in question six: instead of asking if listening to the original and covers helped them improvise better, they were asked if using the prototype helped them improvise better.

In-between sessions two and three

Students were asked to use the prototype for at least one hour per week. There were two version updates that were sent to the student via email, requesting them to download the newest

version onto their device. They were again requested to keep an audio journal[117].

Session three

Session three was the final one-hour session with the students and was again conducted in a one-on-one setting at the conservatory. The students interacted with the software in its updated iteration, again providing feedback and subjective opinions. The researcher assessed the students' judgements about the software and the potential benefits it could have for them or other students. The researcher also assessed how much the students had learned with regards to the harmony of the song. Observations and interviews often revolved around the students' ability to transfer the harmonic knowledge from the prototype to their instruments.

Often the researcher would provide directives for the student to do while using the app in an attempt to judge if these directives may or may not be valid additions to the software. Students were encouraged to contribute any ideas they may have about the design or any other aspect of the software.

Students improvised and were recorded one final time. They completed the same questionnaire a third time and the session was concluded by giving students their compensatory reward.

[117] Journal prompts in Appendix IX

Student Confidence

Instead of attempting to qualify student improvisational ability through assessment measures, the present dissertation takes into consideration the inherently personal process of improvisation, choosing instead to focus on perceived self-efficacy. For this reason, the data gathered focused on student perceptions of their improvisation and of their experience using a tool that facilitates deeper comprehension through active listening and improvising.

The questionnaires the students completed are included in Appendix XII and XIII. These questionnaires provided an additional form of analysis, that benefited the overall understanding of the students' experiences. The primary motivation for the survey was to rate the perceived self-confidence of the students, and a discussion of these results concludes this chapter. One other question had important results globally as well and is discussed in the conclusion. Additional student responses are discussed in a specified section at the end of each pair of case studies.

Data Analysis: Case Studies

Following the 5-week case studies, the data from the six students was analyzed one student at a time. In accordance with accepted procedures of analyzing qualitative data, the analysis sought to uncover emerging themes, patterns, concepts, insights, and understandings (Patton, 2002). Patton describes the inherently creative process of qualitative analysis:

> A great deal of the work of qualitative analysis involves creative cutting and pasting of the data… The analysis of qualitative data is a creative process. There are no formulas, as in statistics… Because different people manage their creativity, intellectual endeavors, and hard work in different ways, there is no one right way to go about organizing, and interpreting qualitative data. (1987, p. 146)

Each audio recording of the student sessions was listened to and transcribed by the researcher, as were the audio journals. Audio recordings of student improvisations were listened

to and any important notes were added to their file. The videos of student interaction with the prototype also revealed interesting data and subsequently notes were added to student files. The researcher read over the initial questionnaires, field notes taken throughout the sessions, the week-one listening log, and the transcriptions. Through in-depth analysis of the case studies, a natural pairing structure emerged from the data involving three groups of two students each. The reporting of the case studies reflects this pairing structure, providing additional generalizable insight into potential groups of users that may exist.

The answers to the three questionnaires regarding student confidence improvising were inputted into an Excel spreadsheet for analysis. These results are reported at the end of each pair of case study results.

Data from the questionnaires and interviews underwent exploratory data analysis (EDA) and was collated and analyzed in order to generate summary findings, relationships, interpretations, and narratives.

The data was coded where possible in order to make multiple comparisons. The data from the interviews was transcribed and an emergent framework of themes was used to group the data. The text was analyzed for content and attitude and sorted into the framework, which was then used in descriptive analysis. Observations regarding participants' processes and preferences were charted illuminating key issues (positive and negative) with the various strategies and designs. A reflexive journal was used throughout the data analysis for creative interaction with the data and design.

Results

The data gathered through questionnaires, interviews and observations provided insight into the manner in which the prototype was received by the different test groups. This rich data set serves as a frame of reference for understanding the user experience and the opinions of expert teachers. It also provides interesting results applicable to autonomous music learning, creative music learning, improvisation pedagogy, and middle school learners. The reporting of results is organized as follows: First, a discussion of the prototype iterations explains the changes that were made to the prototype during the study. Next, the results from the one-time testers will be reported, starting with the expert teachers and then the eight middle school children. Following this, the six long-term user case studies are reported, including an analysis of responses from the questionnaires administered on three occasions in the study. Each of the two studies, the one-time user testers and the case studies, are concluded with a discussion of the findings.

Iterations of the Prototype

Throughout the user testing there were various iterations of the prototype. Changes were made based on testing conducted by the researcher, the user testers and the long-term users. When a user comment was part of the motivation for making an alteration to the design of the prototype, specific mention is made in the reporting of results.

The rhythm module had two principle versions. The first iteration had a large version of the live notation centered on the screen, with text instructions displayed within the interactive listening sessions at the top of the screen. Based on the conclusion that instructions during play were not favorable (see below) all text was removed and the live notation was made smaller and moved to the top of the screen.

There were three principle iterations of the harmony module, and many feature changes. The first version had four horizontal quadrants, one for each of the four chords in the song. Due to the simplistic nature of the song, with a repeated four chord progression throughout the entire piece, this simple task required little attention be paid to the actual chord names. Users were required to simply tap to the beat in the correct quadrant throughout the song. As this was found to be of limited use for transferring to users' instruments, the interface was changed to a more dynamic representation of the notes in the corresponding key of the music and the addition of a digital instrument embedded in the interface.

The third iteration also included the root and third of each of the chords. This was met with enthusiasm and, based on the comments in the sessions with students, appeared to have a positive impact on the students' ability to transfer knowledge onto their instruments in the third and fourth modules.

Results—One-Time User Testing

The procedure undertaken with the seven expert teachers and the eight middle school one-time users was almost identical. Both groups provided the preliminary information in the questionnaire, scheduled a session, met at the conservatory for the session, and spent an hour engaged in the prototype and conversation with the researchers.

Expert teachers

The one-time testing sessions with teachers were guided by the following research question:

What impressions, opinions, and evaluative responses do professional music teachers have about the prototype and the potential application for their private music studios?

The interviews allowed for these teachers to interact with the prototype, pose questions and give feedback. They were also asked a variety of questions concerning specific aspects of the

prototype and their opinions about potential application with their own students. At the time of testing, there were four modules: Rhythm, Harmony, Play-Along, and Practice/Record. Their responses were organized into the following categories: listening, rhythm module, harmony module, balance between structure and freedom, mistakes, application to students and teachers, musical styles, design ideas and concerns, instructions, experimenting and online communities.

The teachers' responses are incorporated together in the results and specific mention of the individual is only given when deemed important for understanding the context of the observation or opinion. All quotations pertaining to the reporting of the one-time users in this chapter represent exact representation of the comments from the one-time sessions. For clarity and simplicity, the first-person voice is used by the researcher.

The preliminary questionnaires completed before the meeting provided background information about these teachers (see Appendix III). This included information about their instrumental and teaching specialties, their current teaching positions as well as their experience with technology and with improvisation.

All teachers were between the ages of 39 and 59 years old, and most of them were professional performers as well as studio music teachers. The group was comprised of four pianists, one violinist, one vocalist, and one tuba player. Although there was gender equity with the students, the teacher group consisted of one man and six women.

In terms of their familiarity with mobile technology, six of the seven teachers owned an iPhone and five of these teachers owned an iPad. This high level of technology use could be because the teachers all volunteered for the study, cognizant of the fact that it concerned an app for iPad. Despite having these devices, four of the seven teacher reported being "OK at using computers and mobile devices", while the other three reported being "comfortable with

computers and mobile devices". No teacher reported being extremely comfortable with computers and mobile devices.

The one teacher who did not have an iPhone reported that she did not enjoy using technology but that she "would if she could be taught". She reported that she used no technology within her own musical practice or with students. With regards to improvisation however, she reported being a confident improviser, having learned informally within a family of improvising musicians.

Of the seven teachers, only two reported being very confident improvising while two reported not feeling at all confident improvising. Figure 7-1 graphs the teachers' reported confidence improvising.

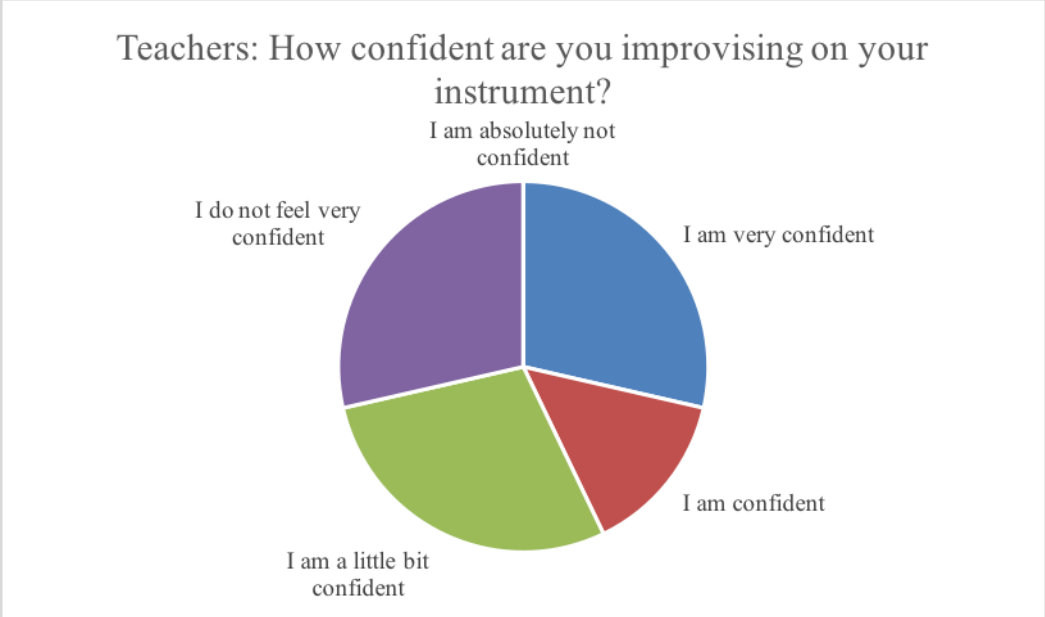

Figure 7-1: Teacher confidence pie graph

Generally, comments about the prototype were positive, with some teachers especially enthusiastic. There were frequently comments about the potential use of the application such as "It is a fun practice tool," "I'd love to learn how to do some fun improvising." "That was super fun. I would do that every day." Even for the teachers, there seemed to be an appreciation of the

creative engagement presented in the prototype. As represented in the following quote, there was a wide demographic of potential users considered by many of the teachers: “It’s an excellent start for people.” “I think this has huge potential. I’d use it and I’d use it with my little students. Adults who have never played piano before could benefit from this.”

One area of discussion was an appreciation of the manner in which the prototype helped to achieve musical fluency. A teacher commented: “Once your mind has absorbed the pattern, now your mind can stop thinking about the pattern and start being free.” Participants’ comments also addressed the benefits of the app to ear training, such as noting that it could help “to develop my ear a bit better.” With regards to children, one teacher said, “A lot of the kids play by ear very well and it might be something fun for them to do being less bound by the written note.”

Comments such as “I think it might help you loosen up a bit” specifically address the aural benefits and the idea of safe space for developing a personal voice and losing inhibition, two aspects from CMLT. There seemed to be general enthusiasm among the teachers regarding the potential application with their own students, as demonstrated in the following comment, “Even just a teacher as myself, I have students that would want to do this [improvise] but I don’t know how to engage them. This would be another great tool to add.”

One teacher addressed the possibility of having a teacher who may not be comfortable improvising use the app in order to learn along with their students. “This absolutely seems to be paving out the bumps of teachers being afraid of improv encouragement. If you give a teacher an app that they can teach with their students, they will learn with the app as a teacher first, and have a fast learning curve they can apply to their students.”

There were also comments, such as the following, addressing the benefits of musical training in the interactive listening modules: “Away from the instrument training helps to battle bad habits one can obtain over time.”

Listening

The listening component of the prototype was considered essential, as learning seems to occur within a primarily aural context. This was recognized by many of the teachers, who expounded on the importance of listening in learning music. “I think it’s great for beginners, especially the listening part. People are so concerned with making a mistake that they don’t listen. Which is something you have to do when you play with others.” One teacher likened the repeated listening to the Suzuki method’s focus on repeated listening to the repertoire being learned. As an improvisor herself, she talked about the importance of developing aural skills at a young age and how important aural skills are for improvisation:

> I think that’s why the Suzuki method is so good because you have to listen over and over. And then you’re actually developing ear training. So for young kids I really advocate that because that’s something that you can’t develop when you’re older. It only happens maybe by age 12, 13, or 14 at the latest and then after that it’s so hard. It’s like language. When you learn when you’re young you can become a native speaker. But when you learn when your 20-25, even if you spend 30 years, you’ll never be like a three- year old who spent three years [learning a language/music]. So I want to maximize that time when the kids are young to really train the ear to be able to listen and play, because even for professionals the most important thing is listening. Yes, you can think about all these different techniques but if you don’t have this ear, the listening skills, then it’s not going to work. You can’t make the music. I find that’s very important. When you learn to play by ear, improvisation will come more naturally.

Rhythm

The teachers seemed to enjoy the rhythm module: “I loved the visual and the tapping...so much fun!” Two of the teachers expressed their particular interest in using the tool as a rhythmic trainer for their own musical practice. One explained she was searching for ways to train her

rhythmic accuracy. “I thought it was super useful for training rhythm and the ability to be in time.” Another expressed the desire to train herself a little every day: “I’ve been looking for apps that help me play with rhythm for 20 mins.” She said that this would be a great option.

Explaining her process of interacting with the rhythm module, one teacher said, “I was using my sense of rhythm to play as if it was an instrument.” Another teacher commented on the live notation, suggesting that it may be beneficial to avoid standard notation: “Rhythms are not difficult. It’s how we notate them that makes them difficult. If you can say ‘do this’ and clap something for them…people can mimic it back easily.”

Some of the teachers had specific ideas about the best way to teach rhythm: “Lyrics are keys to the complex rhythms.” “It would be neat to feel duple and triple back to back and feel comfortable with that.”

When discussing the inclusion of the various rhythm patterns in the sequence, one teacher spoke about the importance of making sure all rhythms were extracted from the music being heard, in that way, upholding the premise of the prototype, to teach through the music:

> For me, it can have variations, but with the music. Because the point of improv is being able to feel the music the way it is. If we do a rhythm that doesn’t fit the music then you’re teaching them technicality, not the music. In the end, it has to be how you feel with that music and how do you want to encourage that rhythm to be felt.

Harmony module

The harmony module, in which users interact with the chords as the song plays and where the focus is specifically directed to the roots and thirds of the chords, was something most of the teachers enjoyed.

- “I felt by the time I got half way through the song, I felt I know this chord progression. I’ve never played that chord progression. You learn it and it’s fun.”
- “I think it’s really useful for that of hearing the chord tones.”

- "Sometimes my ear won't tell me what chord I'm in and I would love to develop my ear telling me what chord I'm in. So I think it's cool for that"
- "I would play this game. Good idea. Roots only."
- "I think it's very helpful for string people. We don't have bass lines. We have a line basically."
- "When I am teaching it to people the first step is to take the chord and learn the third above and the fifth above, then you can start fiddling with it. Folks need to just plug in the hours and learn how to do it."

Concerning the specific instruction on the app that directs the user to try to sing the notes, the vocal teacher said: "with the RCM (Royal Conservatory of Music) exams, having them sing the intervals is helpful to them. Singing gets a short shrift, but eventually people see it's actually really helpful." Some of the teachers talked about personal experience with a past teacher's improvisation instruction:

> Another aspect of improvising that one teacher I had talked about was that it's important to know the chord structure, it's important to know the melody, and to have some other harmonizing lines or secondary melodies that fit with the other one that act as another path through the chord changes. They see these alternate paths through a forest and can jump around on them and make their own way through.

This quote reinforces the notion discussed in Chapter 3, that many improvisation pedagogies are quite similar. At least within a context of stylistic improvisation, the need to develop an understanding of the potential path for melody to fit within chord changes is a common and useful approach. One teacher describes her experience immediately following the run through of the harmony module:

> Having it set up so that you're doing progressive teaching of the chords because you want them to learn the harmonies. So you don't just want to stay on the D or the A. I can feel it. You're just desperate to fill them in. You can hear all the chords and once you start to fill in the chords it starts to anchor just by the repetition. And the repetition isn't boring. I'm going to bring this to my adult group class.

This teacher really enjoyed the harmony module; she was engaged and making progress in her ability to interact melodically with the harmony as she completed the song. Another teacher commented on her experimentation with chord tones:

> You can get enough repetitions in that you actually learn that chord progression. And you experiment. I was experimenting with different notes and realizing which ones sounded good and which ones didn't, and which ones were easy to get to and which ones were liable to lead to a screw up. But you feel a bit of freedom in being able to get there which you don't feel when you're looking at a piano book—saying 'play this chord progression'.

This distinction between playing from a method book and playing with the prototype was important. It also relates to the use of live notation as opposed to standard notation. And while some teachers appreciated this distinction, others preferred no notation: "I found the pulsing notes distracting because I don't need them. But that could just be me". When subsequently asked if she would prefer standard notation, she replied, "I would prefer without notation. I know where the progression is going."

With regards to the play-along module, one teacher said: "What I really liked was the background track and not having the melody so it felt like I was jamming with the band."

Balance between structure and freedom

The prototype specifically allows students to play freely with the diatonic notes in the song using the embedded digital instrument. While there is an instruction that asks them to begin with roots and thirds of the corresponding chords, their only restriction is to stay within the proper chord quadrant; they can play any notes they wish. While some teachers appreciated the freedom, one thought that more structure would be beneficial: "Do what you want? Structure sequences. What does the B sound with the A etc. Some people really need that structure. I have a student that is terrified of improv. She would love structure." The balance between structure

and freedom is an important element to analyze when creating software for improvisation. As one teacher aptly said: “Limits can increase creativity sometimes.”

Mistakes

The importance of allowing for mistakes is crucial when learning to improvise, as it is a necessary and unavoidable part of the process. This teacher likened it to liberation:

> Another thing I find that’s quite crucial in improvisation is making mistakes. When you make mistakes you are opening up a whole lot of doors of possibilities. I find that very liberating as well because once you make mistakes in order to correct those mistakes you have to find a new path and that path becomes a way of making music and that ties everything together. I find it very fascinating that actually mistakes are a good thing. It’s actually necessary. Whereas in classical music mistakes are frowned upon. In improvisation mistakes can lead you to a better place. Something that can open up new doors.

Application to students and teachers

A Suzuki teacher with students as young as two and a half spoke of the possibilities of having young children use the tool, while acknowledging it was too advanced: “If your goal is to bring it in the studios you are definitely on the right path…but you would need to scale down for younger students.” There were concerns about using the prototype with beginners: “I think this will be a bit advanced for new beginners.”

The following quotes demonstrate the applicability of the prototype to middle school students:

- “Seems like it’s not for beginners, maybe for teens that have had piano lessons but is great for understanding chord structures.”
- “We don’t have the opportunities to practice these skills”
- “I teach group classes and one of the group classes I had 14 and they were up for a challenge. They were challenging so for me I could definitely use something like this because they were all interested in progress. They would love it. Just a bit too complicated for them”
- “It would be really interesting for children with dance background as they understand rhythm.”

A few of the teachers, as parents themselves, noted the potential for their own children to benefit from using the application. One teacher who had 13-year old twins said "this would be perfect for my kids' age." Another teacher with a 13-year old son also expressed his own hesitation in teaching improvisation, and his hope that the tool may be useful for his son:

> I think there's a lot of neat things that are possible with this kind of technology. I was mostly excited for what I could do for my son who is in his second year in jazz band (who is trying to improvise on a trumpet). I don't believe I'm the best to give him guidance on improvisation.

One of the teachers spoke about the similarities to Guitar Hero, and the possibility for this type of music learning tool to engage people in a similar manner. She brought up the potential for alternative forms of notation to one day become a standard mechanism:

> This is like Guitar Hero but they don't use any of the language and it has limited instructional value. But they can get quite good at rhythm. Had a full drum kit at the computer graphics conference. It was very interesting to watch the non-musicians, but they like it and it was very popular and a very similar idea…I think it's neat that all these things connect. Because you're all doing your own little niche but it's using a very similar visual which will then just become the language of that teaching tool.

Musical styles

There were various opinions about the ideal music to use in the app, although it was mentioned to all of them that the idea was to include a combination of classical and popular music.

- "Pop is totally the way you want to go."
- "I think it should absolutely have a classical component."
- "Something that the whole world knows like Happy Birthday, Twinkle Twinkle, Mary Had a Little Lamb."

There were also preferences about the music used in the prototype. All except one of the teachers were familiar with the pop song used in the prototype, and they all said they liked the

song. Concerning the first cover version of the pop song used however, one teacher commented, "I preferred the original version with the singing." Another teacher found one cover version too static rhythmically: "Actually this version, this rhythm was very similar from beginning to end. If there was a varying rhythm, I think it would be more fun."

Design ideas / concerns

One interesting design point concerned those who may be color blind and unable to distinguish between the colors of the notes: "It is a good thing to have, if it is color dependent, to have something else that can identify it as well for any people who are color blind, or texture layer if change in color isn't clear."

Instructions

In the design of digital media, especially an interactive mobile app, it is challenging to find the balance regarding the level of instruction given for specific tasks. On the one hand, it is important for the instructions to explain in detail what steps the learner must take and for these instructions to be as clear as possible. On the other hand, too much text will be onerous and tiresome to the student. Often, they simply skip it anyway, as they are more interested in engaging with the application. An attempt was made to include as little text instruction as possible—just enough to give a clear understanding without overloading the learner.

There was frequent discussion throughout the first user-testing sessions about the difficulty of reading text-based instructions while playing the rhythm and harmony modules. Comments such as: "I can't read" as well as observing the users while they attempted to read the instructions while simultaneously continue tapping with the prototype provided incentive to change the design. While one teacher who had a difficult time the first-time around noted that, "It's very simple if you do it a second time," this was not sufficient. Therefore, the second

iteration of the prototype removed all instructional text from the music listening sessions, and placed the instructions at the beginning instead, before commencing the interactive listening portion.

A frequent theme of discussion was the idea of making multiple difficulty levels, which would therefore imply different instructions: “Different levels of experience would require different instructions.”

We spoke about the use of the alternative forms of notation. One teacher thought it would be interesting to put the actual notation in the instructions. “You could put a picture of a quarter note and not the word. They often learn the meaning of the visual before they attach the word. Especially the little ones.” The idea of various versions was discussed with regards to notations: “Maybe you can have options. Option of turning on the notes so that they have options. Some people might prefer that or prefer this.”

It was not within the scope of this project to build instructional sequences into the prototype, however this was something discussed with teachers. Many of them felt that having more instructional content would be beneficial. “More accurate explanations would be helpful.” “I think if you can add instructional component on this one, people will love it. I know by gaming they can learn but first they need the instructions then gaming and that reinforces the gaming.” This same teacher also felt that having examples would be useful for little kids:

> You know what I think might be useful is give them an example. Show how it is done. Bap, bap, bap, bap. Each time you have an idea show them how it’s done and then let them do it. I think it’s a good learning tool for them to see. But even audio instructions that are clear. These days they have to understand quickly or they don’t bother. Everything has to be instantaneous.

Experimenting and online community

An appreciation for the potential to move outside of purely stylistic improvisation was shared with one teacher. This teacher had a 13-year old son and recognized his appreciation for experimentation. She suggested to "maybe let them do weird stuff that's outside the norm." Teachers also were receptive to the idea of having a community aspect to the application. They agreed that this could provide benefits to the teachers and the students. We spoke about using the app to create a community within private music studios. One teacher also felt this would be useful on a larger scale: "Yeah, and also put this online and share so it's making a community online as well."

Together, these teachers provided insightful observations and comments about the potential for application of the prototype to students and teachers. A summary of findings is included in the conclusion of the one-time user testers, following results from the middle school students.

Middle School Students

The one-time testing sessions with students were guided by the following research question:

What impressions, opinions, and evaluative responses do middle school instrumental students have about the prototype and the adoption of such a tool into their musical lives?

In a similar manner as the expert teacher sessions, the sessions with these eight young people invited them to play the app, ask and answer questions, and play their instrument along with the prototype. These student sessions took place at various points of the prototype iteration process. A few students were able to play an additional harmony module that was developed.

Results are again reported together, organized under the following emergent themes: rhythm module, gamification, instructions, harmony module, improvisation on an instrument, social component, and music.

The students were aged 11 (n=3), 12 (n=2), and 13, (n=3). There were four males and four females, and all students were in fifth, sixth, or seventh grade. There were two pianists, a violist, a violinist, a sax player, a trumpet player a vocalist, and one student that played piano, viola, and flute. Five of these student reported that they had studied their instrument for over four years. Five of the students had no experience improvising.

Three of the students reported being “extremely comfortable with computers and mobile devices,” three reported being “comfortable with computers and mobile devices” and two students reported being “OK with computers and mobile devices.” With regards to improvisation, the majority of students reported being “a little bit confident” improvising on their instrument. (see Figure 7.2)

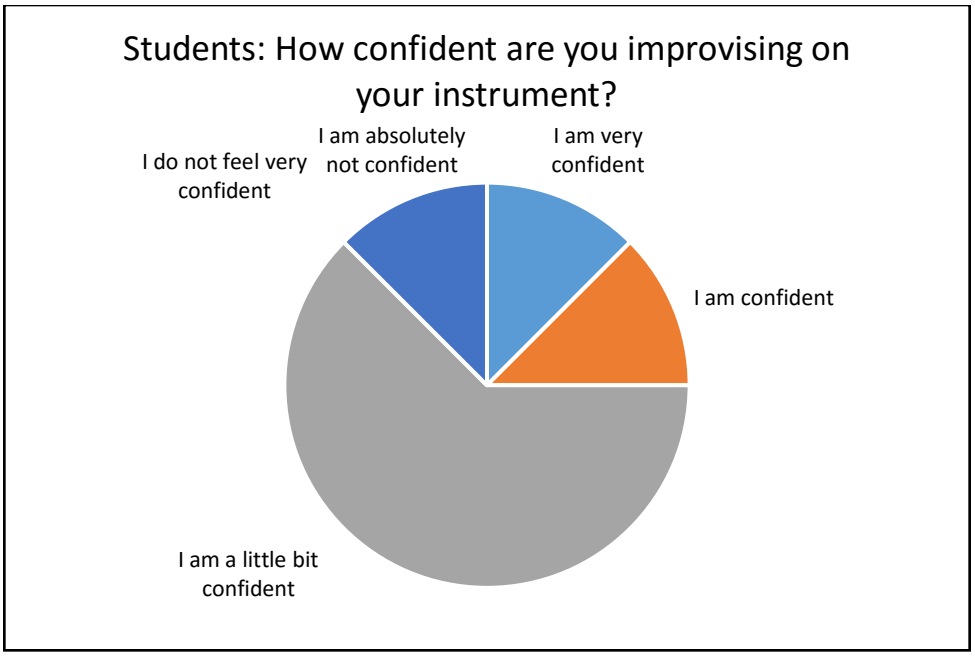

Figure 7-2: Student confidence pie chart

Rhythm module

The students commented positively on the rhythm module and the potential for it to help them hone their rhythm skills: "Learning how to stay with the beat could really help."

When one student was asked if they liked the rhythm module, he replied, "Yeah, it helped me with learning the rhythm of the song so that way I was able to play the rhythm better." It was notable that they were able to perceive the benefit of the rhythmic training, and they seemed to enjoy it: "It's just interesting, the way this works; and I could probably play around on this for hours." Another student commented that, "It was fun to do it." I asked how long they would imagine using the app in one sitting: "Half an hour, an hour, yeah." "I feel like it is training me."

When discussing the live notation, there was also enthusiasm:

> It's different. That's why I like it. Music tends to be one way. Just the notes. And the fact that you put it in a different way and you still have to listen to the music, I really like that. It's different. It's something new. Everyone can learn from it. It's just open to a variety of people.

We discussed the use of method books for learning rhythm or improvisation. One student said, "Yeah, I have some of those." When she was then asked if she would rather learn from a method book or practice with an application like the prototype, she replied, "I'd rather use this."

There was no agreement about whether tapping freely anywhere on the screen was or was not preferable to being restricted to a certain area. If they did not fully read the instructions, a frequent interaction by both teachers and students was to tap on the actual circles that make up the live notation. "Yeah, I was actually thinking that at the beginning that you actually had to tap on the dot." Some people enjoyed tapping wherever, while others preferred tapping on something specific. "I like tapping wherever I want." "I kind of like the freedom; if it were like a big area instead of just everywhere I think I'd like that better. There could be a big red button to tap on."

An important component of the prototype provides users with periods of improvisation even as they are engaged in the active listening modules (rhythm and harmony):

> It was actually really fun to just improvise. I really liked that at the end you were given that tune and then you had to stick with it and then eventually towards the end you get to change it completely and put your own mind to it. It's a really fun learning experience.

Gamification

The rhythm module is the only module that had scoring already programmed into it. Seeing their progress at the end of this module prompted discussions about the potential for including gamification. The students all liked the idea of having more gaming elements in the prototype. One student said, "Putting it into a game form could really make a big difference in the music world." We talked a lot about the scoring of the rhythm module and what would help motivate them to practice more. When asked what they would do if they only achieved 65%

accuracy, all eight students responded that they would not be satisfied. One student said specifically, "I would want to go back and do it again and better my score." Another said:

> I wouldn't be happy with that. I'd go back and get a new score. Not in a competitive way but a fun way. Just for my own benefit I would know I could do better. I know I have better skills than that.

A student who played a lot of video games said, "When I play Besiege or Jump Tree I have to get it perfect before I want to go on."

It was clear that many of these students were competitive and that they enjoy a challenge. Various ideas for including gamification were discussed. One example was: "You could just put a giant D (referring to the chord) somewhere. Or you could just take away the little blip and if the person loses where they are then they are lost. You could make up a harder mode."

Instructions

Some of these students tested the prototype before the instructions were removed from within the listening session in the rhythm module. Like the teachers, they too had difficulty reading text while playing the rhythms indicated:

> I had no choice to stop. I could not continue and still play and read it. The bigger text when there's more lines I had to stop because I had to read it. But the two line ones or the one lines ones, I can read while I'm playing.

Instructions implied to the students that the game was complicated: "More instruction must mean it's a harder game. My brain automatically went to the conclusion it would be harder." Another student also assumed it was going to be harder than it actually was:

> I think at first it took a few seconds to understand what was going on. At first I thought it was a little bit more complicated. I really thought I actually had to think about way more things than I had to. I was over-complicating it.

The apprehension from the instructions changed as they realized the pattern in the music: "When I started playing it I realized that there was a pattern which is what I started to follow and then I started to count it and then I started to follow it."

Harmony module

The harmony module allows users to play melodically over a harmonic guide that aims to teach chords. A concern was whether students were actually thinking about and learning the chords while paying, or whether they were just moving along every bar to the next chord quadrant. When asked directly what she was thinking about, one student replied positively, "I was thinking about the chords."

There was a clear need for an instructional component to teach some students about chords. I took the opportunity to teach a simple lesson about chord construction to those that required it. This was necessary in order for them to interact with the harmony module, as demonstrated by the following question from one student: "On the chord root. What does that mean?"

A student recognized that the skills being cultivated in the harmony module might in fact help him to interact better in ensembles: "Sometimes I, like, don't know where I am in a concert so sometimes that would be good if I could improvise with the part I know."

One student perceived a particular benefit relevant in his own musical life, outside of school: "I'm trying to form a band and I have no idea how to play a guitar so learning about chord progression is very useful." When asked what he learned, this student replied, "Well, I learned a good chord progression—D, A, B minor, G; and the first and thirds sound really good." He thought the harmony interface looked like a guitar, that maybe the notes were the strings on the guitar. I asked him if he had a guitar: "No, we have a guitar player in the band but I'm trying

to write music for everyone and it's not going so well with that aspect." He said this sort of tool would be great to learn how to write songs, and to learn the chord progressions and how melody fit with it. He was proud that he figured out how to harmonize the chords: "Yeah, I think I figured it out by myself, the fifths too."

One of the principle design ideas behind the harmony module is allowing students to have the freedom to figure out for themselves the manner in which different notes fit into the harmonic progression of a piece. Success of this principle was demonstrated by the following comment:

> I was also trying to test out different things. I just went to either the third or the root and also when I tried to do something and it sounded like something else that was cool. It was cool how the notes sounded different when the chords changed.

It's important for them to discover musical preferences on their own in order for this learning to have an impact on their musicianship. Comments such as: "Yeah, I liked the way it sounded with the thirds" showed that they were actively engaged in listening and making subjective observations.

The real-time feedback in this module of the prototype concerned the ability to play within the correct chord quadrant. In this way, the module required students to be aware of the harmony sounding at all times. A student brought up his frustration that he could be playing the correct note and still be given negative feedback: "One thing I found a little bit annoying is that it said I was playing the wrong chord when I was doing the right note just in the wrong box."

After each student completed the module, I put my arm in front of the chords and asked each student what the chords were. Only three of eight students answered correctly after only one play through. All of the students got at least two chords right, both chord names and quality, in the correct order. The most common problem was the order of the chords, or forgetting that the

third chord was minor. This also implied the need for an instructional component in the application that can reinforce the theory and chord structure.

Improvisation on an instrument

While transposition at sight was not an issue for the one transposing instrument played by a teacher (the tuba), this was not the case for the students playing transposing instruments. Since the prototype was limited in this respect to only concert pitch, I explained and wrote the transposed chords, roots and thirds for the students who required it for use during the improvisations with their instrument.

Following the play-along module, Module 3, I asked students if they found the previous modules useful for actually playing on their instruments. A student commented about how helpful it was to have the visuals from the harmony module carried over into the play-along module: "The notes, it was extremely helpful having these." Another student replied:

> It was very useful. I really think that the first two steps (rhythm and harmony) really helped with this. The fact that you are introduced to this first before you actually play with it, I really think was a good idea.

A student commented that they appreciated the distinction between the engagement with the prototype and playing repertoire:

> And I really think that this gets you out of the comfort zone of being used to regular music and then you're put in a totally different place and make your own sort of tune to it to another song and that's amazing.

Social component

The students were all asked what they thought of the idea of working on a particular song concurrently with other students in their private music studio, with planned group improvisation sessions held by the teacher. Would this motivate them to use the application? One student responded, "Yeah I'd practice on that." When we talked about the social component, there were

multiple ideas such as, “Yeah if you could record and stream it to them so they can hear it as well would be pretty cool. If they are in different places they can practice together.” One student spoke of their own social music-making: “Well actually, recently I’ve been doing a trio. We’re working on the same song and we get together and play it.” This was a classical piece that the trio was playing. I asked her if she would enjoy learning to improvise on that song? “Yes, definitely.”

Music

Despite not everyone knowing the popular song in the prototype, all of the students appreciated it. Most replied with positive comments such as, “Yeah, I really liked the song.” We also discussed what types of music they would like to see in this kind of an app: “I think a mix of rock, classical, pop,” “Jazz would be cool.” “I think I’d be pretty motivated by classical music ‘cause that’s mostly what I do.”

Relevancy to the students’ musical lives seemed to be a particularly vital characteristic of the music the students wanted to see: “If I knew the piece on my instrument I’d definitely learn this.” Multiple students were interested in seeing the music that they are working on: “It would be cool to load music on there.” “Your own music?” I asked. “The music your working on in school?” “Yeah. If you’re practicing and you don’t know what to do you could use that and it would be really cool.”

Discussion

Results from the one-time user testing of teachers and students showed an appreciation for the novelty of the presentation of music through interactive listening and improvisation. Their comments reflected the potential for this new form of learning to engage learners. There appeared to be genuine interest and an implied applicability of the prototype to the lives of the

teachers, their students, and the eight middle school user testers. The teachers supported the importance of listening for learning music, and appreciated the touch-screen interaction that engaged learners through the listening process. The practice of rhythm while listening to music presented a form of practice that they thought was not only fun, but helpful. There were many comments about the success of the tool to teach harmony and chord progressions, developing the ear along with theoretical understanding.

A range of teacher opinions were found concerning the live notation system and the exclusion of traditional notation from the app, with some teachers feeling this would be a beneficial addition. There were also multiple views concerning the balance of structure and freedom, although there was a great deal of enthusiasm about the freedom advantaged in this form of music learning. There were also various opinions about the relevancy to different age groups and levels, however, there was some consensus that it was appropriate for the middle school music student with some level of technical skills already established. There was also discussion about the potential for an easier version for younger children, and the applicability of the prototype to adults.

The teacher and student one-time user testers had difficulty reading text-based instruction while interacting with the listening exercises. The subsequent version was met with greater enthusiasm, however, there were still concerns about the level of instructions present. Finding a way to give explicit instructions in the simplest and clearest format is a challenge for this kind of media. The inclusion of specific instructional sequences to teach concepts such as chord construction was likewise deemed important by many participants.

The students overwhelmingly enjoyed the freedom and creative agency provided by this alternative learning tool. They were enthusiastic about gamification and displayed a propensity towards competitiveness.

The students' experimentation with melody and harmony in the harmony module appeared to teach musical concepts and provide moments of insight to the students. Furthermore, there seemed to be a desire by the students to attain these kinds of skills. Having clear teaching segments within the app may be essential if students are to understand harmonic structure without the presence of a teacher. Students did appear to be successful at transferring the knowledge and skills from the first two listening modules to their instrument in the third and fourth modules. They appreciated that the visual cues were carried over as reference while playing along with the backing track on their instrument.

Finally, both teachers and students had positive reactions to the idea of having a social component to the app that allowed for communities to work together and improvise together, based on the music they studied individually within the app.

Results—Case Studies

Case studies of middle school instrumentalists: Research question # 3:

How do middle school instrumentalists find the experience of using the prototype over a period of one month?

The six long-term user testers produced a rich qualitative collection of data that provides insight into autonomous music learning, improvisation pedagogy, student habits, and learning preferences. Three females and three males participated, each with individual contributions and unique viewpoints. During theoretical analysis of the six case studies, three groups of two

students each naturally formed. The results of the case studies are therefore organized according to these three groups: The Technology Enthusiasts, The Multi-Instrumental Improvisors, and The Classical String Players.

One of the primary reasons the case studies were carried out was to test the benefit of using the prototype over an extended period of time: the six students had the opportunity to practice with the prototype autonomously over a period of four weeks. The experience presented an alternative form of musical learning to the students and invited them to be musical in a way they had not before. It gave them a new way of thinking about and playing music. Furthermore, it facilitated the ability to test student confidence after extended use of the prototype.

Student confidence improvising after using the prototype: Research question # 4:

Does using the prototype affect their perceived self-confidence improvising?

The data reported in this section is a culmination of a variety of collection methods: interviews, observations, audio journals, and questionnaires. While the quantitative measure was not a rigorous experiment, as no control group of students was involved, the process of assessing student confidence improvising before and after using the prototype (two weeks, and four weeks) provides some insight into how efficient the prototype is at improving student confidence when improvising. These students were asked to improvise with a play-along track of approximately five minutes in length, after which they were asked to immediately complete a questionnaire (see Appendix XII). An analysis of the difference in results from these three questionnaires is included at the end of each pair of students.

As discussed in the methodology, a pseudo-control week took place before the students first met with me or were given the prototype. During this week, students were given music to listen to (nine different interpretations by nine artists of the same popular song) and asked to keep a listening journal. This control week had a few purposes: The first was to discover information regarding their listening habits. The second was to find out how they perceived listening repeatedly to the same song, but interpreted differently. Most importantly, this week provided the pseudo-control data for the confidence test. This data came from the first session with the researcher, in the form of a recorded improvisation and the completion of the first of three questionnaires. While the second and third improvisation questionnaires followed extended use of the prototype, this first questionnaire followed a week of repeated listening to multiple versions of a song. Unlike this experience with the prototype, they were not given instructional guidance for interactive listening or asked to play on their instrument, as they would be with the prototype. From an observational perspective as well, seeing and hearing the students improvise, as well as observing their attitude and confidence before and after having used the prototype, helped to ascertain the extent to which the prototype was a successful intervention.

Technical Issues

There were few technical problems throughout the testing phase. Perhaps this had to do with the professional skill level of the programmer in the initial building of the prototype. The programmer was also able to create five versions in total during the five-week study, in which he fixed bugs, made design changes that I felt were necessary, and even implemented a new module as I completed annotation of an alternate track. There were four occasions in which participants were asked to install a newer version of the prototype and only two instances where one

participant had trouble doing so. However, this student was still able to use the previous version of the prototype, therefore not causing any significant problem in the study.

The prototype managed to fulfill a need for each of the students in the long-term study. This need varied from student to student, however, a principle benefit involved having a way to be creative with music. All six of the students reported little or no instruction on improvising within their musical lives thus far. Even the one participant who was active in jazz band reported a lack of instruction from his teacher about how to go about improvising specifically, apart from being told the proper scales to use. For most of the students, working with the prototype presented the first pedagogy of improvisation they had encountered and they appreciated the fact that it differed so much from the musical material and structures to which they were accustomed. For the two advanced improvisors, the prototype actually had a different effect of forcing them to slow down and actually think about things like chord tones and musical structure. These two also reported significant benefits from recording themselves and listening back, which revealed issues such as a tendency to rush and not stay with the musical form of the piece.

The remainder of this chapter examines the six case study students, beginning with the pair of technology enthusiasts. All names have been changed to protect the anonymity of these students.

The Technology Enthusiasts

The Technology Enthusiasts consisted of two girls who described themselves as never being without their iPhones. Of the six students in the case studies, these two had the most intimate relationship with technology, constantly listening to music on their iPhone or laptop. One of these students was a cellist, Emma, with six years of experience on her instrument. The other student, Cindy, was a flute player, also with six years of experience on her instrument.

Each of the girls had experience coding but only Cindy had used music software such as Garage Band with her instrument. Both of them reported using many apps, and the social apps were especially important. Cindy was clear about her feelings for her social media choices, demonstrating the appreciation of impermanence that is popular with many young people today: "Snapchat is my favorite thing in the world. I like how it deletes within 24 hours."

Emma

Emma is a smart, relatively shy 12-year old cellist with great attention to detail. This was apparent from the outset of the study, when she read each word of the consent form. She was in the 6th grade and did not play in any ensembles at school. She had a small amount of experience jamming with friends casually and reported being "a little bit confident improvising." She had been with the same private cello teacher since she was very young, participating in a music appreciation class with her even before she started playing the cello. And while she reportedly enjoyed her teacher, in her six years studying cello, they had never done any form of improvisation.

Emma listens to music when she is walking or commuting, as well as when she is doing homework. When watching the Axis of Awesome 4 Chords video, she knew many of the popular songs. Besides music lessons, she has been dancing for many years. She takes ballet, contemporary, and "acro" dancing (a combination of gymnastics and ballet).

She was very enthusiastic about learning to improvise, and throughout the study she showed genuine interest and dedication to using the prototype. During the first session she immediately took to the format: "The pulsing circles help a lot. You kind of like get into a rhythm when you are doing it, tapping the beat—a groove, I like it." Not surprisingly, Emma had perfect rhythmic accuracy using the prototype. She was reserved throughout the first session, but

asked questions to make sure she understood. When we met her mother at the end of the session, the first thing she told her was, "that was lots of fun!"

Session #2

In the second session, Emma immediately commented about the newer version of the prototype where the text was removed and the live notation was found at the top of the screen in a smaller format: "I like this version way better, it gives you more space to play. The instruction is clearer." When asked her opinion about the rhythms being used, she said, "I like them. They started easy, then got more challenging." She was able to execute them all perfectly. She was very interested in doing the rhythm modules with variations of the same song and reported that while she was engaged in the rhythmic tapping she was listening intensely to the music. With regards to scoring, Emma said that a score of 65% would make her do it again, but 85% or higher would prompt her to move along to the next module.

Emma had had difficulties downloading the latest version on her iPhone, which had not affected the rhythm module, but meant that she had not yet seen the full harmony interface that contained notes. This provided the opportunity to observe her using this module for the first time. She had considerable difficulty understanding what to do in the beginning, indicating a need to revise the instructions and for the interface to be clearer. Once she understood that she was supposed to play the roots and thirds, and other notes as well, she found herself in a state of "flow." It appeared challenging enough that she had to concentrate, but she also seemed to be in a relaxed state of enjoyment. When asked her opinion again immediately following this first performance of Module 2 she said, "I like it. I think it's nice because its flexible and you can do whatever you want pretty much."

Emma had no previous knowledge of chords, roman numerals, or chord structures. I

instructed her in these elements, describing how they are constructed and how they function. She was very capable of understanding this information and seemed able to apply it immediately to her playing. I explained how to count in intervals such as thirds (c-e-g-b-d-a), which again she had no difficulty understanding though it had hitherto not been explained to her.

A discussion about the different sounds of the notes when played over different chords lead to a discussion of color in music, and the particular feeling that notes and chords can evoke.

When it came time to play on her instrument with the backing track, Emma had considerable difficulty keeping up with the play-along track. Her need for assistance getting through the track was an indication of the need to have support available on the application, including increased instructions and, potentially, additional constraints. It was clear that students' capabilities should not be overestimated in the design process.

When asked to play a D-major scale, she was able to play it perfectly, obviously having practiced this skill extensively in the past. She was also able to play the roots and thirds perfectly when prompted, though it had been almost impossible with the backing track. Connecting the types of skills that the student does well, such as play scales, with the exercises on the prototype will ensure the most beneficial process and outcome.

Despite a hard session in which she struggled to stay along with the backing track, Emma reported having a positive impression of the prototype. She perceived the challenge as something positive for her. When asked how it was different from what she usually does on her instrument, she responded, "It lets you make up more, and have it be your own. The music is different and unique. It's more fun than playing sheet music. You don't feel as much pressure, like to memorize and stuff."

Session #3

Emma now had a few weeks of using the prototype and was very enthusiastic. Her first comment in the final session was, "I really like it. It's super fun and when you are using it doesn't feel like work, and yet you know that you are learning. I can tell that I have gotten better at improvisation." When asked how she liked the rhythm module she replied:

> I like it. I feel like it is easy and fun, it's not too hard and not too easy. I like the fact that you can see how good you are doing at it, see what it says. Listening helps me hear things that I didn't hear first. When I am supposed to be sleeping late at night, I'll be on my phone doing it.

When asked about the harmony module she responded, "I like it because if makes you feel like you are making your own song. You are totally in control of it and you can get a whole bunch of different things from it. I know the chords now."

Since Emma was using the iPhone at home, I had her try out the iPad during the session. She perceived benefits in each of the two devices: "I like the iPad because you have more room. but with the phone, it's nice because you always have it with you."

As I observed her playing with the harmony module, she experimented with all kinds of patterns, like r-3-2 over each chord, 5-4-3-2-1, 2-3-4-3, etc. It appeared she really appreciated the straightforward guidance through the different chords, presented in time with the backing track. We talked about variations and developing options such as switching between chord names and roman numerals, as well as the ability to turn the pulsing on and off. Like most students, she thought having different options was a good idea. With regards to the types of music she would like to see in the application, she had many suggestions: Katy Perry, Adele, Taylor Swift, Ed Sheeran, classical music, folk songs, jazz standards, and Suzuki repertoire. We spoke about the classical track that would be in the next version. She commented, "I can't wait for that one to come out." Since the prototype did not yet cover melody, I asked her to try to play the melody of the song by ear. Because it is a simple song, and she had listened to it already so many times, she

was able to play the melody with no problem after two to three minutes of experimenting.

Emma made considerable improvements in her ability to improvise over the song, and by the final session, could keep up with the music perfectly, vary rhythms, and play target tones. Her improvisations were not melodically developed at this point, but she was able to sustain the music with confidence and precision, and showed a clear working understanding of the harmony and structure of the song. “I think this app is really good. At the beginning of this, 5 weeks ago, I barely knew what improvisation was, what I was doing, and now I feel way more confident.”

Cindy

Cindy is a confident, outgoing flute player. She has played the flute for six years, and reports being “a little bit confident improvising” just like Emma. She says that she sometimes jams with her best friend, but she has never been taught how to improvise. Cindy says rap is her favorite kind of music, with music like Beyoncé and Drake being the artists she most listens to.

In the first session, Cindy had the opportunity to try the prototype for the first time. She received the first module very positively: “Yay, this is fun. I could do this for hours.” She appeared to immediately take to the format and imagined ways of incorporating practice into her life. As someone who always has her iPhone, this signified imagining the ways in which she could use it in small intervals of free time, in which her phone was often a source of entertainment: “I have a basketball tournament on Sunday and this is what I’m going to do in my free time. It’s also very relaxing.”

We spoke about the scoring of the rhythm module, and she was also posed the question of how she would respond if she got 85% correct. She was adamant that she would need to repeat the module until she received a perfect score: “I would play it again until I got 100%. That’s just what I do. I would do it again until I got 100%. I would memorize it.” This opinion

was not shared by everyone; Emma, for example, would go on with a score of 85%.

Session #2

Cindy expressed how much she liked playing with the prototype between the first and second sessions. She even talked about playing with it at school, and having all of her friends play it. "I was doing it at school and my friends wanted to try it. And I was like, OK. And then they could do it, so yeah, that was fun." She elaborated:

> Well, first of all they hated the song but then my best friend was like, oh shut up, that's a great song. But that's beside the point. They had tons of fun. They were passing my phone around. They were all screaming. It was weird. Anyway, they liked it.

Cindy had an exam coming up in which she was required to play many scales. She thought the prototype was really going to improve her scales. After two weeks of working with the prototype, following the chord progression D-A-bm-G, when I asked her what scale would go with this and what the key was, she said, "Is it the A or the E?" Neither. "G?" No. "B?" No. "C, F#?" No. This prompted me to give her a small theory lesson about how the first chord of a piece is often the key as well, which lead to a discussion about key signatures and how to find out how many sharps or flats are in a key signature. She said, "This is blowing my mind. I hate scales." It appeared that she had not really been provided with much context for learning scales, and without this understanding of what they were for or how they could be used, she had a difficult time understanding them.

Her confidence and outspoken demeanor, apparent in her quick and often jovial conversational manner, was also represented in her playing. Unlike Emma who had been quite shy, and responded best to precise prompts guiding her improvisation, Cindy was able to invent and experiment with different patterns she played over the chord progression. "At first I thought, oh no, I'm screwed, but then I did it. It's actually easier than it looks. I tend to over-complicate

things."

She was able to quickly transfer the patterns she deciphered on the harmony module to her instrument:

> When I improvise I start to make patterns… At first I was doing the duuuu du du and then I did that at the end too because I ran out of things to do. And so that's what I did. And then I made patterns which would then help me in a jam session. Because then I could be like, I totally know what I'm doing.

Session #3

Between Cindy's session #2 and session #3 the harmony module changed from improvising rhythm over the correct chord to using the more complicated interface. She noted that she did the module less now that it was more complicated. I asked her if she preferred the first version that was simpler: "Yeah. Because then you can choose because it's also kind of relaxing too. The rainbow is more like a concentrating thing but then the first one is more of that you just have to tap and that's fun. I like that one."

We talked about gamification and scoring and Cindy had a few ideas: "If you had like a total, and you get to 100 and you level up and when you get to the highest level you unlock a character. Like a little brown fluffy circle with eyes. People would like that." She discussed the badges on Snapchat: "Oh, you win emoji badges." I asked her what the game was in Snapchat and she said, "Well if you send 10 snaps using the front and back camera at the same time like in a video you get a certain emoji. Like the number 10 emoji and if you screen shot 100 things then you might get the poop emoji and you have a running score. All your friends can see what your score is." She was competitive and really enjoyed this aspect of Snapchat.

When it came time to play her flute, she again had difficulty staying in the key of D. We talked about the possibility of having the flute fingerings in the app. She was adamantly opposed to seeing anything specific about the flute while doing the harmony module. She did need to go

through the fingerings first, before playing, but she seemed to appreciate the newness of the format, and having the exclusive information about the chords and scale tones, independent of her instrument. Providing students with this ability cultivates a different level of interaction with music, one which is outside of their instrumental repertoire. She explained why it was hard to play and proposed a separate practice module for the scales, without having that information available during the actual play-along module:

> Because I don't usually go with chords. I don't usually use chords in my flute life. It's harder but it would be a good thing to learn for me to work on my scales; and like if there was a module that would record and have a picture of the chart as a rehearsal and the actual thing could be this one and you have to go for whatever.

As for the music that Cindy would like to see in the app, she proposed the Arctic Monkeys, Cage the Elephant, Nirvana, and classical music.

Questionnaire Responses—Emma and Cindy

Emma showed considerable increase in confidence improvising over the course of the study. After improvisation #1, before using the prototype, Emma reported 4/10 as her response to the question: How confident were you improvising just now? After improvisation #2, she reported 8/10, and after improvisation #3, she reported 10/10. Throughout the remainder of this chapter, this data will also be reported in the following format: {4-8-10}, representing the three consecutive scores to a question. Cindy, as a more confident person in general, rated her confidence in the first two improvisations 8/10, and in the final improvisation, a 9/10, represented as scores of {8-8-9}.

Both of these girls, comfortable with technology and their instruments, but inexperienced with regards to improvisation, had a positive reception of the prototype and appreciated being taught to think of and play music in a different way than they were previously accustomed. They both made significant improvements with respect to what they were able to do in the

improvisations on their instrument. This affected their confidence in a positive way, with both showing improvements from the first to the third improvisation.

Emma answered that the week of listening to the multiple versions of Bob Marley helped her improvise better at only a rate of 4/10. In the two other sessions, she reported that the prototype helped her improvise better at a rate of 10/10. Both girls reported improvement in how well they knew where they were in the piece—Emma's scores were {6-7-8} and Cindy's scores were {1-9-5}. They also both reportedly increased their awareness of what chord they were playing over, as evidenced by their scores of—Emma {8-9-10}, and Cindy {2-5-7}. Emma reported improvements in her ability to play rhythmically with the beat of the song, scoring {5-9-10}. Both girls increased their enjoyment improvising over the course of the study—Emma reported scores of {8-10-10}, and Cindy reported scores of {5-9-9}. Emma's comments on the questionnaires showed the level of improvement that she felt she had made. Her first response was, "It was hard and I wasn't prepared but it was fun." Her response after her second improvisation was, "I feel like I did much better than last time. I felt more confident which made it more fun." Her third and final response was "I have improved a lot." All of Cindy's responses resembled one another, such as, "Even though parts of it were a little crappy, it was fun to hear what I could do with my flutey-tooter."

The Multi-Instrumental Improvisors

Stella and Steve are both natural musicians that have been playing music passionately since they were very young. Unlike Emma and Cindy, these two actually know each other, but do not consider themselves friends. It could just be that Stella is one year younger in school than Steve. But there could be more to the dynamic than that. Both are incredibly gifted musically, and are star pupils in their musical ensembles. I had the pleasure of attending the school music

end-of-the-year concert at their middle school, in which each ensemble in the school performed. It was a massive event, with at least five different ensembles performing. The two of them improvised on multiple occasions during the evening, in solo moments, with hundreds of people in attendance. They were both fearless and displayed confidence in their roles as creative musicians. These two young people exhibited a high level of freedom with their musical voices. It was clear these two participants had something unique to contribute to the research. For these two individuals, their experience with the prototype was not about gaining confidence improvising. However, it soon became clear they did not have a good understanding of what was happening harmonically in the music, and how to approach their improvisations from a place of knowing. What was observed in their experience over the four weeks with the prototype was an increase in their knowledge and understanding of music including how chords and melodies worked together in a cyclic harmonic progression. For Steve, this meant slowing down in order to hear what was being played, as well as paying attention to the particular sonorities and rhythms in the music. For Stella, this meant understanding theory and chord structures.

Collectively, the two were in almost all of the ensembles at the school. Both were in Concert Band at their grade levels—Steve had played saxophone for two years and Stella had played flute for one year. Steve was also in the Jazz Band and the Wind Ensemble, also both on saxophone, though he played the baritone saxophone in the Jazz Band. Stella, who played flute in band, also played viola for two years in the string orchestra and sang in the choir as an alto.

However, the two middle schoolers differed greatly in one aspect—their musical upbringing. Steve was raised in a family that encouraged music from a young age, with classical piano lessons starting at age 6, though his parents did not play much music themselves. Stella came from a musical family in which her mother and father modeled and exposed her to music

day in and day out. Stella was encouraged to be creative with music, independently, from a very young age. Instead of curated listening, Stella listened almost exclusively to the radio: "I listen only to the radio—top 40. Cool FM is new music, and it's all I listen to. My dad does not like it at all." She spoke about her parents' musical preferences: "My parents listen to a lot of music. They are more into jazz and classical." Stella did not start taking music lessons formally until she was nine though she cited her constant playing around on the piano and making up her own music. She had been singing in choir since the age of eight.

Both of these students had a family iPad they could access, but only on a limited basis. Neither had unrestricted access to the technology, but were each allowed to play for small amounts of time when their parents gave them the iPad. They both were enthusiastic about the technology however, and very excited to get to use it for the study.

Both of them really liked listening to the multiple versions of the Bob Marley song, noting especially how interesting it was to hear so many different people's interpretation of the same song. This was not something either of them had ever done before.

Stella

Stella had a very different relationship to music than Emma and Cindy: "I never walk and listen. But I turn on music in my bedroom to draw or read. Music inspires my drawing."

When asked what she sings as she bikes to school, she answered, "I sing whatever comes out of my head, not other people songs." Her musical upbringing is very apparent in her comment:

> I have always been taught to just play what I want to play, even though I should be practicing as well. So when I sit down at the piano, I'll say - you know what - these few notes sound good together, I wonder what else I can do. And then I'll play a few pieces, and then I'll go back and now what. Some people have been taught to just play what's in front of them, and that just dumbs their creativity.

In the concert mentioned above, Stella told me beforehand that she would be improvising the Boogie Man Blues on the viola. Her teacher had told her and the four other volunteers to improvise over a D-major scale for the song. They were apparently given no more instruction than this. Most students in the orchestra were not interested in improvising and it was not something their teacher taught. And yet, these students were interested and willing to participate. "Our concerts don't usually have improvisations. This is an exception; this year there are a lot of changes." She was also scat soloing in the choir performance, again, explaining that it was completely her thing, that she was not being taught by the choir teacher:

> I have a natural born talent for making harmony. Give me a song and I can make harmony. I was born with perfect pitch. I can tell if something is not in tune. My dad sang with choir till I was born, and my mom is still in choir. My dad takes voice lessons. He has an electric guitar but hasn't played it in 5 years. My mom plays guitar and teaches little kids music.

Stella suggested that the changes at her school were not solely with regards to music, but also with technology: "Our school is becoming more tech-oriented. I need a computer now; all of my homework is online. I hope I get one for my birthday."

Despite an improvisational aptitude with music, at the time of the research her engagement required her to do more study than improvisation: "I am more encouraged now to practice than to improvise." She recognized that studying music was important, and was happy to be doing it: "I consider myself pretty good in music, but there is always room for improving. I haven't met anyone who has mastered everything."

Session #2

When Stella interacted with Module 1, her improvised rhythms were very musical and creative. She found different grooves in the music that she explored and followed. Unlike some of the other testers that indicated a desire to be told where to tap, Stella enjoyed the ability to tap

anywhere: “I like the freedom. I like to switch fingers. When I play something more complicated, it’s nice to not think about where I have to put them.” Stella used her two thumbs generally when tapping along on the iPad. Most other testers used one or two index fingers. After completing the rhythm module, she said, “Yeah, I am trying to really listen to it. ‘Cause if you can find the pulse, it is much easier to improvise with the pulse.” She feels quite confident in her abilities, as is obvious in the following quote:

> I can feel the pulse. I am a gifted musician, I don’t want to brag, but I am different from others. The problem, when I was scatting, I was like - oh, I’m done now, and I don’t even know what I said. I am not thinking about anything. I am not thinking about what I am saying. I could have said a swear word and I wouldn’t know it.

Despite her confidence, she admits not really thinking about the music when she improvises. I asked her if she thought that the app was helping her and she said, “Yes, I know the song much better now.”

One of the most beneficial aspects of using the prototype for Steve and Stella was the record and playback feature. Stella did not have a favorable perception of her recordings, and was unsure if the recording reflected reality: “When I listen to myself, a recording, I hear it and it sounds awful and I don’t know if that’s how I really sound or not.”

Session #3

Stella had never heard of using the roman numerals to represent chords and did not know what constituted a chord. She also did not know that the harmonies she naturally sings are thirds and fifths. Following this quote, she sang the thirds perfectly: “I don’t know the thirds by heart, I just know the sounds they are. I only go by what sounds good. I use my amazing ear.”

When she uses the harmony module for the first time, she interacts musically with the notes and is able to play the roots and thirds. When she was playing and thinking about the notes however, she did not have the rhythmic accuracy that she demonstrated in the rhythm module,

and was consistently behind the music. However, she was actually thinking about the harmony and the chord progression for the first time, receiving new information to inform a process that she had been executing "naturally" for perhaps many years. Despite the rhythmic imprecision she was completely confident in her melodic experiments which indeed sounded very musical. She also really enjoyed the new interface and the musical capabilities: "The exploration possible with this new module is great. You can hear what an E sounds like over all of the chords."

Stella and I played with the harmony module once the music stopped, taking turns playing chords and melody. We used the interface as a group instrument and improvised for 3 minutes together. "This is really cool. We should be able to do this."

Rather than having her improvise on the piano, Stella improvised vocally with Module 4. "With singing, I am not even thinking about the chords. I have gotten much better improvising these last five weeks. I have been doing it with the app, and now I don't have to think about it anymore when I record." Her improvisation was very well executed; it sounded like a popular song, with melodic shape and structurally perfect.

I ask her if she was tired of listening to the song used in the prototype. "No, I like this song. There are plenty of songs, pop songs, I notice now, that just repeat four chords. And even these four chords I hear them now."

I allowed her try the prototype out on the iPhone but she said she prefers the iPad because she liked the space. We discussed the music she would like to see and she mentioned that rock, pop and Top 40 are the best kinds of music to use.

Steve

On Steve's first interaction with the rhythm module he rushed significantly, getting more "too early" feedbacks than "good". His first comment was, "I think it's pretty cool." He felt the

instructions and the interface were clear. I asked him if he would rather see it in musical notation. “I would rather see it in notation, just being me. I would personally rather read it in notation.” When asked why, he responded, “because I’m used to it.” Steve is a very fast sight reader who has been playing piano from a young age. He also suggested that he would prefer being told exactly where to tap, as opposed to having the freedom to tap anywhere.

Session #2

By the second session, after having played with the prototype for two weeks, Steve played the rhythm module perfectly. His improvisation on his instrument, however, was very rushed. He had a hard time staying with the recording, which must have seemed too slow to him.

Steve had the same reaction to listening to his recordings as Stella. He also clearly articulated the benefit of having to record. “When I improvise I don’t record myself but when I do I think it’s horrible and I delete it right away. But this app forces me to listen to it and what I’m doing wrong or doing right. What I need to work on.” I asked him if this was useful, to which he replied, “Yeah.” He did not however find the rhythm module as useful: “Well tapping the beats personally because I’m that advanced I don’t find it useful to me. I’m sure it is helping kids find where to play. To me it doesn’t really have that much use but it’s fun.” Despite his perception, based on his tendency to rush, it may be that it had more use to him than he thought.

It may also have been that he simply needed more challenging music to listen to. He reversed his previous statement by saying, “That actually does help because I’m working on a song Flight of the Bumblebee.” I ask him if he thought doing this module with Flight of the Bumblebee would be helpful, and he responded, “Yeah, that would be fun. You should do that!”

We talked about the live notation: “I haven’t seen anything like this app. It’s pretty neat.” I asked him why. “Because it’s new and when things are new and people go on crazes for them

and get addicted to it. I like the pulses."

On piano, Steve was a fast and confident improvisor, easily incorporating harmonic support in the left hand with melodic motion in the right hand. While he struggled to stay in time with the music, most often rushing throughout the piece, he was never short of material or energy.

Session #3

At the outset of the session I asked Steve how it was going with the prototype, to which he responded, "Good, I really like it." When asked why he liked it, he responded "It's fun and it's new." He was asked what instruments he played with the prototype: "I played the piano, the saxophone and the melodica." When asked which instrument he liked the most, he answered a different instrument altogether: "The drums." When asked for his second favorite instrument to use with the prototype, he responded: "I just liked playing it on the iPad a lot."

When I asked him if it was boring he said, "Well at the beginning it was a little bit but then it changed and then it got fun." He was referring to the more complex harmony module that included the digital instrument. I asked him to tell me what was more fun about it and he said "Well, you're like getting used to something and it's like a daily routine but then it gets switched up. And you update and then people are like what is the new update? What is the new update?"

I asked him which instrument had benefited most by using the prototype and he answered "I think you'd be surprised to hear this actually, the drums." I asked him why this was: "Because then I know I'm not on time a lot of the time." For Steve, the experience of listening to himself in the recordings provided information that he did not previously have, and this in turn affected his performance on the drums. Having the feedback about his performance was a useful tool. I asked him what was the second most beneficial instrument to work on and he said "Piano and

melodica, because they are actually the same thing. Melodica is nice because you focus on the melody." What specifically did you get better at on these instruments? "Just in general, because I'm used to the saxophone I'm used to improvising with the blues scale. That's kind of all we improvise with. And all the songs are in the same key usually. You kind of helped me a lot."

Steve reported that he only did the rhythm module twice, but did the harmony and play module many times. He expressed being a bit bored with the rhythm module, and we talked about how it could be more interesting. He said he would like to be told where to tap: "Like a little white dot that appears and goes away like boom."

We talked about his perceived usefulness of the app. "Say you're behind on your learning I think this could help." Tell me about playing this app versus doing your music for school? "I'd way rather do [the prototype]." When asked why he said, "Because it's fun." I asked if he thought he was actually playing music and he said, "Oh yeah". I asked if he thought it was benefitting his musicianship and he said, "Yeah."

Steve brought up the fact that the app does not teach instrument-specific technique and may not be appropriate for beginners: "If you did it by yourself and you already knew how to do it and you're just on vacation and you can't practice this is really awesome. But if you don't know how to do it and you want to learn an instrument it might not be the best way to go."

We talked about the potential of developing a social component that worked within a particular musical community, like a middle school or private music studio: "That would make it way more appealing to other kids. It does help us to play with other people. It will serve to bring people together."

Questionnaire Responses—Stella and Steve

For Stella and Steve, the pop song selection was too easy for them. They could have both

used a more advanced song, with a more complicated harmonic progression. However, at the same time, both of these students benefitted from the slower process that involved thinking about the harmonies and understanding the chord tones as target notes. Both of them began the study as confident improvisors, and finished the study as confident improvisors. Steve rated his confidence in the first improvisation as a 9.5 and his last improvisation as a 10. The middle improvisation he rated his confidence as 6, perhaps because he was less confident after having heard himself improvise in a recording. This could have also just been because he had not felt he had executed a good improvisation on that occasion. Stella started the study rating herself a 9 in confidence. Her middle and last improvisations were both rated a 9.5. While both of these students improved by a small margin of .5, the benefits to their musicianship were substantial, and the prototype successfully guided them in a more holistic understanding of their improvisational processes as well as providing more realistic feedback about their performances through record and playback.

Stella responded that listening to the Bob Marley songs helped her improvise better at a rate of 5/10, while the subsequent sessions after using the prototype demonstrated a rating of 8 and subsequently 9.5 for this question. She also showed improvement in her awareness of the chords over which she was playing as evidenced by her scores of {2-5-7}. Not surprisingly, both of these students rated their enjoyment of improvising with scores of {10-10-10}.

Classical String Players

The final pair of students in the case studies were two brothers, Alex, aged 10, and Kirk aged 11. These two boys were home schooled by their mother, a professional pianist and gifted improvisor. She spent lots of time helping the boys with music in their daily life, and while she was supportive of the boys improvising when they wanted to, she did not teach them

improvisation, nor had their teachers. Alex was in the fifth grade and had played the violin for four years. Kirk had played the cello for two and a half years and was in the sixth grade. They have one younger brother who played the viola as well. The only ensemble experience the boys had was playing with their family. These boys had an extremely high level of musicianship for their age, and both played their instruments beautifully. As home schoolers, they had the benefit of playing their instruments for three to four hours per day.

In terms of their listening practice, they said they listened to music in the car and watched lots of YouTube videos of music with their mother or father. They had a family iPad and computer and used both of these for educational purposes almost daily. They played math games, reading games, and learned science online.

Their mother is primarily a classical pianist, and refers to her style of improvisation as compositional improvisation.

Kirk

When I asked Kirk to play a C-major scale as a warm up to his first improvisation he immediately played a perfect four octave c major scale on the cello. After his improvisation he commented that it was really hard, and that he was used to just playing the bass part when he improvised with his brothers.

Kirk reported that he is learning to code with JavaScript and is very interested in learning to make software. He visits Khan academy online and learns about programming. He said he has not yet learned to make games.

Kirk knew what the roman numeral chord symbols were and was able to infer that the vi meant that it was a minor chord. Kirk was the only student of the six that knew what the roman numerals stood for. When asked what he thought about the rhythm module he replied, “It’s kind

of cool ‘cause it shows the beats.” While a soft-spoken person, Kirk’s reaction as he played showed that he was enjoying himself. He seemed to appreciate how music was presented in a novel way.

Session #2

Like Steve in the last pair of students, Kirk was advanced and preferred to go straight to the harmony module when he played with the prototype. He did not play with his instrument very much but preferred to just use the digital instrument built into the prototype. When I asked him to tell me what the chords were, he knew them instantly but had a bit of trouble remembering the thirds of the chords. Kirk was connecting the notes with the melody of the song. When I asked him what he had learned using the app he said, “Maybe figuring out the basic notes in the song. If I was improvising to the song I could know what I need to do and I can use the notes that are used most of the time in the song and make something else out of it.” We talked about the benefits of knowing the chords in the song and understanding the progression. “If you know the chords then you also kind of know what you need to play and also the chords can help you because sometimes you play the wrong notes if you play in different keys.”

I asked him if he saw any benefit to using the rhythm module and he talked about rhythmic variation: “Because it’s not that fun; because if everything is quarter notes and eight notes, you want something else to add to it. Some new and different rhythms so it’s not boring and it’s more interesting.”

When I asked him what he liked most about the rhythm module he said “at the end where it says make up your own, that kind of helped a bit because you made up your own part. The rhythms. You can just make it up.” When I asked him what he liked to make up he said, “I tried

to make up different ones to test it." I asked him what exactly he meant by testing and he said "Like, umm, checking out which ones are the best and which ones would work really well and stuff like that."

I asked him if he was paying attention to the feedback as he played: "Well most of the time I would look at the colors and memorize them because gold is too early and red is too late and I also looked at the bar at the bottom to check sometimes." When asked if there were particular rhythms that were harder than others for him, he responded, "Yeah, the one with the.. it was like 1…wait…123. That one was the hardest."

I asked Kirk about how he would respond if he only received 85% accuracy and he said he would go back and do it again, "Yeah, to get the best score." He expressed interest in having multiple rhythm modules that had a wide variety of rhythms: "Yeah, because I'd want to learn lots of rhythms."

Session #3

In session #3, Kirk played the newest harmony module that used a performance of two cellos covering the popular song. After playing with the module I asked him what he was thinking about, and he responded "To make up new things."

We discussed having the freedom to improvise versus having more concrete tasks to accomplish and Kirk said, "Maybe both would be good." Kirk still felt challenged by the rhythm module: "yeah, some of them are harder." In his improvisations he liked to play the arpeggios, and showed a very good ability to play the roots and thirds of the chords. He had learned the chord progression well.

Kirk expressed an interest in learning to play music from *Star Wars* on the app. I asked him if he likes doing one song at a time, as we have been doing in the study, or if he would rather

do multiple songs at the same time. He answered, “I think I would like more than one song at a time because I don’t want to have only one that I am good at and one that I am not good at.” I asked him how the prototype is different from his normal practice with repertoire. Kirk responded, “When I practice, there is more of a set thing I have to practice. With the app, I can do this, I can do that, and it’s not like practicing a piece, it’s more making something up.” I asked if he thinks he improved and he said “Yeah.” And did you enjoy it, I asked? “Yeah, it’s more creation and less stressful.”

Alex

Alex was the youngest participant in the study, younger than the call for participants suggested. However, since his brother was in the study, his mother spoke to me about the fact that Alex was a very gifted violin player and liked to experiment with improvisation. He was only a few months younger than some other participants in the study and therefore was brought in to participate. Alex really enjoyed himself in the first improvisation. Before starting, he asked, almost in disbelief, “I can play anything? Can I come in anytime I want?” After a great performance he said “It felt cool.”

After trying the rhythm module, I asked him what he thought, and Alex said “Well, I like it because I like doing beats because I always think drumming is cool. And it’s kind of like drumming. And you make a beat.” Alex was quickly able to name the four chords of the song in the correct order.

Session #2

Alex enjoyed playing the rhythm module and was accurate most of the time. He was very experimental in the improvisation sections, inventing complicated rhythms. “The circles actually kind of help when they like pulse and also the arrows show which ones are going and you can

listen to the drums to see how he's doing it and then you follow what he's doing but it's still really hard." Alex responded that only 100% accuracy would be OK for him; he would continue to do it until he got that score.

In the harmony module he liked to make clusters, sometimes playing all of the notes he could manage at the same time. Alex expressed that he did not yet know the chords and instead, "I just tried different notes." He discovered that playing the indicated notes, the roots and thirds created more sonority: "They always sounded good." Alex also really enjoyed making patterns and using them over all of the chords.

Session #3

Alex said he enjoyed the rhythm module the most because it was the most fun. He still recognized the value of the harmony module and showed determination to improve: "Except this one gets me to concentrate more, the other one is kind of more the fun one, this one is the one where I'm trying to get better at it. I have to do this one well."

Alex knew the four chords when asked, and could name the thirds as well. He expressed that he had been having a lot of fun with the app. I asked him how it differed from the other practice he was doing on his violin:

> Because when you play on your violin it's more like a test because you have to play the notes and hear the rhythm in your head and play the notes to a rhythm and it's slow to get to one and fast to another. This one has the beat for you, and the song is practically going for you which makes it more fun and easier.

Alex enjoyed the freedom that the prototype offered him: "I kind of like playing anything to start off with but then maybe when I get more experience improvising I can be told what to do. Because I don't really know a lot about improvising right now." I asked him if he thought he knew more than at the beginning of the study. He said, "Yeah, we got to practice lots of it and also learn rhythms. It was more new than right now it is."

Alex was interested in the idea of having an online community to share with. This is something both boys do as part of their homeschooling; they participate in online educational communities. Alex liked the idea of being able to share his music online: "Yeah, I could show my friends and be, like, look at me!"

Questionnaire Responses—Kirk and Alex

Kirk gave himself a 3/10 in confidence in his first improvisation. After two weeks working with the prototype, this increased to a 6/10, and after the entire four weeks, he reported an 8/10.

Alex also saw considerable improvements in his perceived self-confidence, rating his confidence with a score of {4-6-9}.

While neither of them felt that the control week helped them much to improvise better, both rated the experience of using the prototype as beneficial to their improvisation, as evidenced by their scores—Kirk {1-8-10}, and Alex {3-8-9}. They also both made improvement in how well they knew where they were in the piece, with scores of—Kirk {3-8-10} and Alex {5-5-7}. With regards to knowing what chord they were playing over, only Kirk displayed improvement with scores of {3-7-8}. Kirk reported an increase in how well he was able to play rhythmically with the beat of the song, scoring {5-5-9}, while Alex reported a small decline with scores of {7-5-6}. Both boys reported an increase in how well they enjoyed improvisation as evidenced by their scores—Kirk {7-8-9} and Alex {9-10-10}. They also increased their abilities to play melodies that they enjoyed while improvising with scores of— Kirk {3-4-9} and Alex {1-9-4}.

Kirk's comment regarding his improvisation on the first occasion was "it was hard making the melody." His final comment was simply "more confident." Alex reported that "improvising was very fun because you can play any chord you want and do any beats you like"

displaying his appreciation of the sense of agency that improvisation allowed him.

Discussion

The combined data collection methods that informed the case studies create an interesting and multi-faceted array of data for examining the application of the prototype to the lives of 21st-century learners. The general enthusiasm and appreciation of the novelty and agency in working with the prototype as opposed to working on repertoire or technique shows that there may be a need for this kind of software. Furthermore, the positive results from the interviews and questionnaires display the efficacy of an autonomous tool for creative music learning with regards to student confidence, understanding music, and enjoying improvisation.

When the case study questionnaires are considered together, two of the questions provided particularly interesting results. The first is the students' report of confidence while improvising (see Figure 7.3).

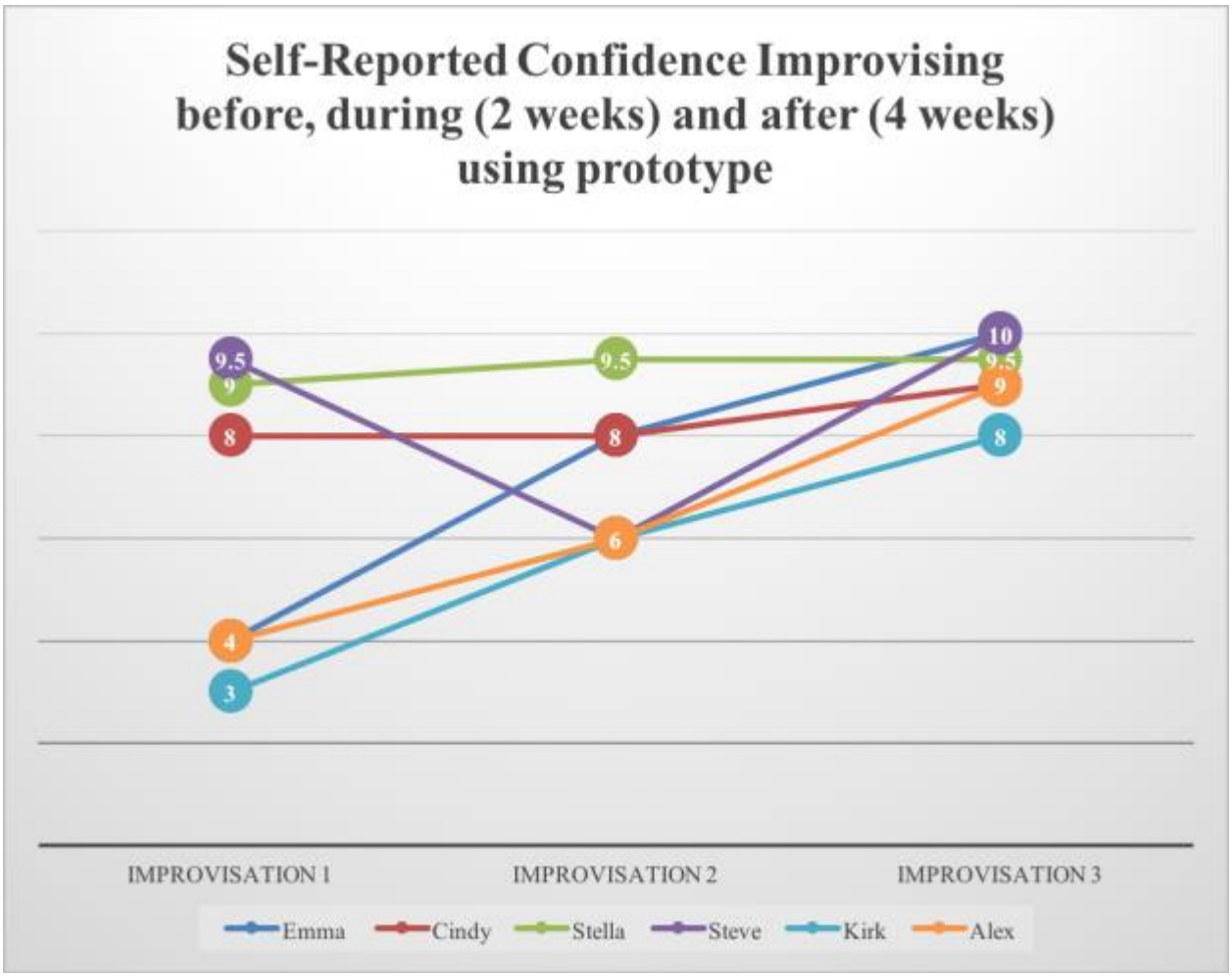

Figure 7-3: Confidence before, during and after using the prototype

While three of the students began the study with high levels of confidence, all six students did in fact report at least some degree of improvement. The three students who began the study with low confidence showed significant gains in their confidence after using the prototype. The increase in the mean scores of all participants between the first improvisation (M=6.25) and the final improvisation (M=9.25) showed a 48% increase in confidence following four weeks of working with the prototype.

The second interesting result across participants was the response to the question about whether the interventions helped students to improvise better (see Figure 7.4). Following the first improvisation, students were asked:

- How much did listening to the original and covers help you to improvise better?

Following the second and third improvisations, the question changed to:

- How much did your experience with the app help you to improvise better?

The mean score to the first question, regarding the first improvisation was (M=5.33). The second question in the subsequent improvisation garnered mean scores of (M=9) and (M=9.58) respectively. The increase between the first and third mean scores was 80%, demonstrating a significant increase.

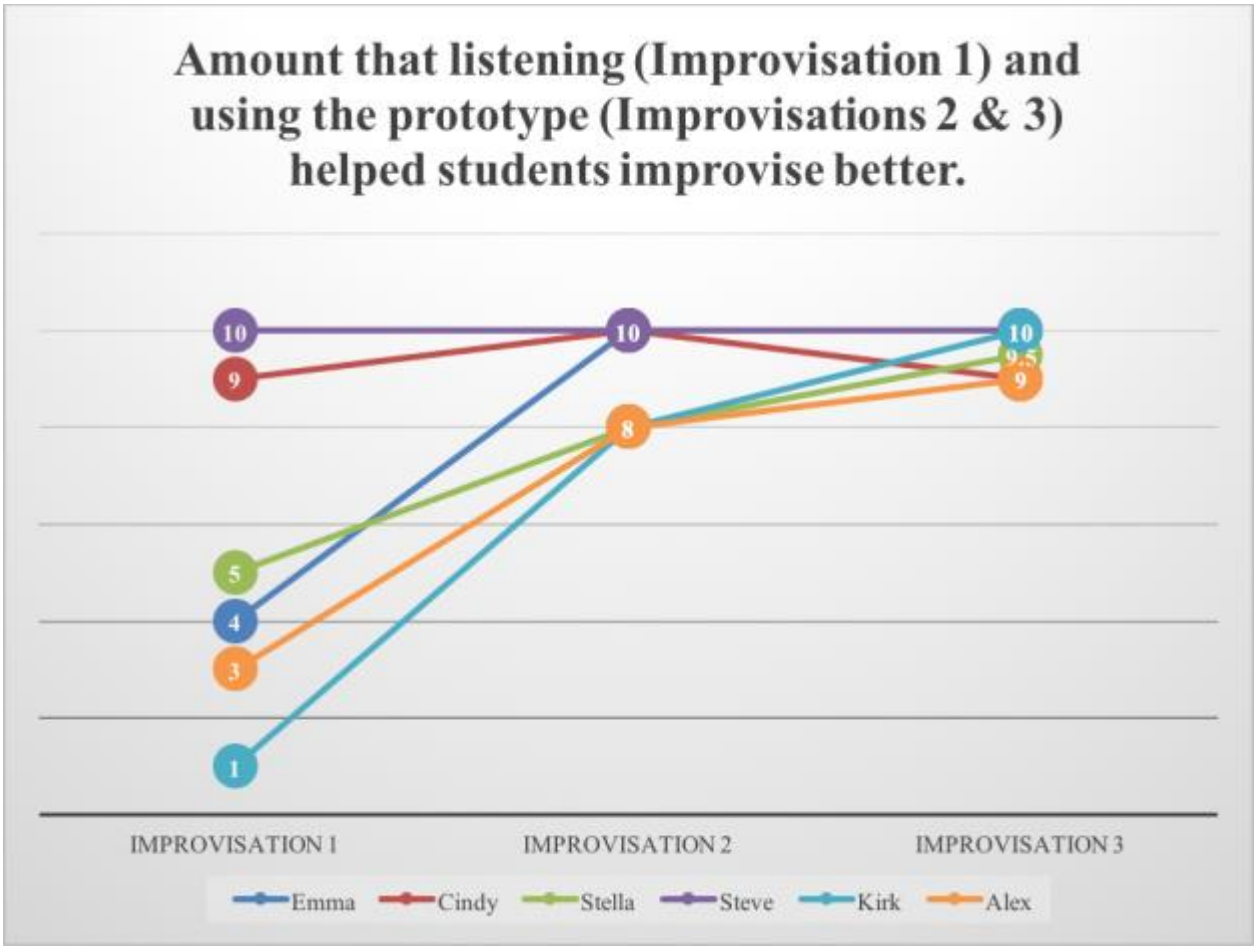

Figure 7-4: How much the prototype helped students improvise better

Across the participants there was agreement that students would want to use the prototype for 20-30 minutes at a time, or complete four to six modules. At the conclusion of the

study, I asked all of the case study students about the song, and if they were tired of listening to and playing the same song. All students responded that they were not tired of it; they still liked it and were happy to continue working with it. The chosen song was a high-quality pop song, that achieved a position of #1 in the charts when it came out in the 1990s. The song quality may have been one reason why they still liked it after having studied and played it for four weeks. Potentially also helpful in this regard was the inclusion of the alternative interpretations in some modules of the prototype. Or maybe their sustained interest in the music was due to the process of discovery, learning, and creative participation cultivated by the prototype. The many layers of exploration invited them to go deeper into the music, informing their understanding of rhythm and harmony, and providing an opportunity to practice these concepts in a creative musical context.

CHAPTER 8: POSTLUDE: CONCLUSIONS AND FUTURE RESEARCH

> Music is no longer made to be represented or stockpiled, but for participation in collective play, in an ongoing quest for new, immediate communication, without ritual and always unstable. It becomes nonreproducible, irreversible. Jacques Attali, 1977 (cited in Lewis, 2009, p. 4)

As eluded to in the words of Jacques Attali, the musical processes in recent times have shifted and altered to such an extent that music learners may not be most aptly served by a focus on repertoire performance. The design and implementation of learning mechanisms that challenge learners to become fluent in the language of music may serve to enhance their understanding and capacity to interact musically. This can provide students with the creative agency to interact within a fluid musical landscape. In a process of renewal, improvisation emerges as a key musical process, poised to advance musical experiences in the 21st century by creating a disposition for communicative and creative musicianship. While musical literacy (the ability to read music) endures as a critical component of music learning, musical fluency (the ability to interact creatively with music) deserves equal emphasis.

At the same time, recent technological innovations may enable constructionist-inspired learning environments that facilitate an active and creative approach to music learning, while simultaneously making it more widely accessible. Discovering the potential for teaching music creatively with the aid of these technologies is a principle aim of this work. The capacity to embed learning within listening, while aided by touch screen interaction and mobile technology, stands to advance music learning considerably. The framework for CMLT is a guide for the

development of this kind of technology, incorporating long-standing knowledge about music learning and improvisation with recent technological innovations.

Methodology

The use of a research-creation methodology in this work was essential for providing creative iteration and advancement in the field. The preliminary research and analysis therefore operates as part of the process of creative design, informing and substantiating the development of the framework for CMLT and the software application.

As stated by Natalie Loveless, "research-creation not only hybridizes artistic and scholarly methodologies, it also legitimizes hybrid outputs" (2015a, p. 41). The framework for Creative Music Learning with Technology and the subsequent software application break away from traditional results in music education research. While the qualitative study involving user testing provides insight and evaluation of the efficacy and potential use of the software, the framework, and software prototype, along with the preliminary research are paramount to the overall work.

Contributions

The framework for CMLT was created in order to contribute to the advancement of music learning in the 21st century, such that anyone learning or playing music may be given the opportunity to create spontaneously from a place of understanding and through a process of doing. This project was guided by research questions that emerged throughout a creative methodological process beginning with the initial research question:

> How can the literature, methodologies, and experiments conducted within the field of improvisation pedagogy inform the creation of a technology-assisted teaching framework for providing instrumental music students with creative agency through a dialogic approach to learning repertoire and improvising?

This question situates the creative development of the framework and prototype within the existing body of knowledge and pedagogies of improvisation, and served as the starting point for subsequent theoretical work. In the present context, dialogic is meant to signify a communicative facility with the musical language, such that a musician can participate in an improvisatory musical interaction, both with existing musical works, and with other artists—musicians and otherwise.

A theoretical analysis of improvisation pedagogy began with a discussion of improvisation as a more democratic and embodied form of music making than one with a sole focus on performance of repertoire. Following this discussion lies an historical overview of improvisation pedagogies in western classical music and jazz, a review of important educators and scholars in the field, and a selection of models, classifications, important publications, and research studies. Similarities between pedagogical approaches to improvisation are apparent. Some important elements include an emphasis on listening, on internalizing and understanding harmony, and in the development of patterns. Freedom, embodiment, and a safe space were also found to be important.

Constructionism, or learning by making, is used as an inspiration for an examination of media for improvisation pedagogy. A history of media for improvisation pedagogy precedes an evaluative survey of existing iOS applications for learning to improvise. This survey describes a range of tools that can assist music learners with improvisation, however it also clarifies the need for software that has pedagogical depth and widespread application for various music learners. Additionally, none of the apps surveyed took advantage of the ability to embed music learning within music listening.

An assimilation of the previous research was used in the development of a framework designed to cultivate a creative and dialogic disposition to music. The framework simultaneously incorporates aspects from existing knowledge and tools while exploring the capacities of technology and creative design to further assist in creative music learning. CMLT was developed with five core principles that may be adapted for other creative music learning scenarios, and was subsequently elaborated specifically for teaching musical fluency and improvisation.

The first principle places learning within interactive listening, facilitated by touch-based interaction. Musical study is focused on one work at a time, and the use of multiple interpretations of the work is therefore beneficial. The process of learning through multiple sessions of interactive listening facilitates the construction of a cognitive model of the song form, while simultaneously teaching students to interact creatively with the music.

The second principle of the framework is sequential pedagogy, referring to not only the scaffolding of learning based on student advancement through interactive tasks, but also on the specific pedagogical sequence that presents rhythm before harmony, followed by melody. The study of rhythm, harmony and melody are likewise used to develop an understanding of form.

The third principle is concerned with the transfer of knowledge and skills from the interactive listening sequences directly to one's instrument. Accompaniment tracks are used to mimic the song structure, rhythm, tempo and key of the original work. Students are prepared by having to continuously improvise with the musical components in the interactive listening module, thus musical memory may transfer internalized principles directly to their instrument.

The fourth principle is continuous creative engagement. For students to learn to be creative with the musical language, they must be encouraged to be creative throughout the learning process. The sequential pedagogy permits students to improvise with simple, attainable

tasks in order to increase confidence and nurture their ability to be musically creative. Creative agency is further cultivated in the safe space of autonomous music learning so that improvisational skills may be developed within a criticism-free environment. The cultivation of confidence in one's musical skills will ideally transfer to collaborative performances with other musicians.

The final principle of the CMLT framework involves the use of assessment and tracking components to provide a more complex instructional environment, capable of real-time feedback and tracking of user engagement and progress. Motivational gameplay can make use of the feedback mechanisms to enhance the student experience. Additionally, students can record and playback their improvisations for self-evaluation.

The next phase of the research-creation methodology concerned the creation of a physical manifestation of the framework in order to test it with music students and teachers. A prototype was developed for iOS devices and a subsequent study examined fourteen middle school instrumentalists and seven expert teachers using the prototype. This two-phased study examined prototype effectiveness and student confidence improvising following extended use. Results revealed a positive reception of the prototype as a tool for learning to improvise. Students and teachers reported an ability to improve rhythmic performance, aural skills, and understanding of harmony and demonstrated the ability to transfer these skills to playing their instrument with accompaniment. The freedom and creative agency supported in learning were appreciated for being distinct from typical music learning contexts. Students reported that using the prototype allowed them to experience music-making in a way that invited personal input and creativity, considered a substantial departure from the musical activities to which they were accustomed.

An important aim of this study that emerged through the process of research-creation was the evaluation of students' confidence in improvising after having used the software for an extended period of time. The results of this portion of the study were positive, and all six of the long-term users reported an increased confidence in improvising after using the prototype for four weeks. Furthermore, the three students who began the study with low levels of confidence increased their confidence substantially. Considering the considerable research that shows the correlation of confidence to successful improvisation, these results suggest the potential for the framework and prototype to assist 21st-century music learners in attaining this skill.

Limitations

In order to support creative design and innovation, this work took a broader approach than is most often undertaken in doctoral work. Due to a choice of favoring breadth over depth, the theoretical analysis unfortunately omits important scholarly work from the fields of music learning, improvisation, technology, listening, and educational game development. Additionally, the survey of software for learning to improvise is limited to those available on iOS devices.

Initially, a more complex and elaborate software prototype was designed including a module on melody and an additional complete lesson based on a classical work. Furthermore, elements such as a reward system, enhanced instructional sequences, a social component, instrument transposition, and various difficulty levels were envisioned for the software, but the complexity of programming these features was not practical for the study and therefore the software prototype is limited in scope in many ways. Essential components in the process of learning to improvise idiomatically such as voice leading, motivic development, variation, cadential patterns, embellishment, and guide tones are not included. Furthermore, exploration of elements of musical expression such as dynamics, timbre, texture, color, phrasing, intensity,

energy, relation to breath, emotions, feelings, sentiment, articulation, communication, accents, and nuance, integral to the development of artistic freedom and one's own musical voice, are not included. These expressive elements can and should be introduced in the early stages of improvisation.

Limitations in the study likewise bear mention. Because the iterative design of the prototype was an important objective, interaction with student participants was carried out in a positive and open approach. My own knowledge of the prototype and its aims were not concealed, but rather worked to inform and strengthen student interactions with the prototype, and may have affected results. Participants were all sampled from a similar population and results are therefore limited. The sample size of long-term users was small, and there was no control group, making this study more exploratory than experimental. To increase generalizability, a larger and more diverse sampling should be tested, and a control group would provide experimental validity.

Future Research

The findings in the theoretical analysis of improvisation pedagogy revealed many similarities between approaches to learning to improvise. It was not within the scope of this work to perform an in-depth, comparative analysis of these methodologies and traditions, however such a study could be instrumental for future advancement in the field. Likewise, the examination of technologies for autonomous music learning could be made more in-depth by investigating the research that has been conducted in educational technology and mobile-learning. The considerable body of literature in game design, motivational design, and gamification would further enhance the development of a tool.

Further testing of the framework for CMLT is imperative in order to further understand its applicability to 21st-century music learners. One avenue for future study would be more rigorous testing of student confidence through use of the framework. Testing students from diverse populations would also strengthen the results by providing a wider demographic. The prototype created for this study could be further developed and subsequently tested with the inclusion of features such as those mentioned, including melodic tasks, expressive tasks, increased instructional features, and a social component. An experiment with the software that employs an instrument for assessing improvisation achievement, aural abilities, creativity, or other factors would likewise produce interesting results. The relationship between confidence and gender present another interesting avenue for further research. Previous experiments have shown that females are less confident improvisors than males (Wehr-Flowers, 2006), which leads to the question—is a tool like the developed prototype a potentially disruptive device for affecting differences between the confidence of male and female musicians? These types of questions are important in order to understand the full potential and signification of CMLT for 21st-century learners.

Final Thoughts

In a moment when curricular reform is occurring in music learning and education, improvisation and composition, as creative musical processes, are being brought to the forefront as key educational objectives. Improvisation emerges as a legitimate and constructive means of fostering a renewal of creative agency for contemporary music students. Critical and progressive works in the field of music education are an essential measure in order to begin to re-imagine the place and importance of improvisation for music students of today. Such works may contribute to the emerging field of critical studies in improvisation, as well as arts education, educational

reform, and creativity studies, by furthering the importance of creative student contribution within the process of learning and participating in the arts.

As music educators grapple with the best ways to incorporate improvisation in their teaching, research that presents new approaches and tools can be immensely useful, both for potential adoption of these tools, and as informative contributions to instructional designers and developers. It is clear that mobile learning will only become more pervasive, and studies that examine not only their efficacy, but also explore their potential applications, stand to influence and define future developments.

Technologically enhanced listening accompanied by gestural feedback may become a tool of great significance for learners in the 21st century. Existing between the acts of musical study, practice, performing, and listening, such software may provide students with an intimate perception and feeling for music that can transfer into performance, listening, improvisation, composition, and any activity that involves a developed aural sense. The practice of actively listening can be enhanced and work in tandem with practices such as those developed by R. Murray Shafer, Pauline Oliveros, John Stevens, and Butch Morris.

Creative freedom should be at the core of music education. Existing pedagogical systems that place these skills prominently, such as those developed by Dalcroze, Orff, Gordon, Sarath, Azzara, and Molina are praiseworthy for their focus on developing fluid musicians capable of communicating in the language of music. Unfortunately, the values inherent in these methodologies, such as developing an improvisational capacity in students, have not yet become principle objectives in music learning. This signifies the importance of perseverance in the advancement of creative music learning.

Furthermore, the prototype testing from this study provides insight into 21st-century music learners, with their unique set of skills, needs, interests, and learning preferences. It is from an informed understanding of our teaching tools and our students that we can begin to imagine the disruption of a canon-centered practice. By doing so, we give students an enhanced ability to interact with traditional forms, and we ensure that they are not afraid to move outside of them and chart their own course.

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APPENDIX I: INVITATION TO PARTICIPATE

Dear students and faculty of the Conservatory of Music,

Music education researchers from McGill University are presently looking for volunteer participants for a study involving iPads, music listening, and improvisation. We are seeking faculty and instrumental students between the ages of 12-14. Our goal is to determine user preferences for a software prototype for learning to improvise. Your participation will help to advance creative music technologies for music improvisation. There are two options to participate:

Study #1: Are you an instrumental student aged 11-14? Or an instrumental teacher?

Receive a $10 iTunes gift card for a one-hour session

This study consists of an hour long one-on-one session with the researcher scheduled at your convenience in May, 2016. During this hour you will be asked to interact with a software prototype for listening and improvising. No instrument is needed for this session. We want your honest and valuable opinions and to see you interact with the software. The session will be video-recorded only for the researchers. Your confidentiality is assured.

Study #2: Are you an instrumental student aged 11-14?

Receive a $25 iTunes gift card for completing the five-week study

This study has students work with the software at home for an hour a week for five weeks starting in May, 2016. Students will be supplied an iPad or the software will be installed on their families' iPad. Students will listen to professional recordings of popular and classical music and be guided in various listening tasks. They will be asked to keep a journal (written or audio). Students will be asked to record an improvisation on their instrument one time per week using the software. This will be recorded on the iPad, and shared only with the researchers, in confidence. The performance will not be assessed, rather, it is the students' perception of success that will be measured.

Requirements
Students and faculty can be of any instrument and no improvisation experience is required (but is OK, too). Faculty should have a minimum of 5 years teaching experience. Students should have a minimum of one-year experience playing their instrument.

Results
The results will be used in a PhD dissertation and potentially published in music education journals. This study has been certified by the review ethics board of McGill University and is supervised by Prof. Lisa Lorenzino of the Schulich School of Music, and Prof. Ichiro Fujinaga of the Centre for Interdisciplinary Research in Music Media and Technology (CIRMMT), McGill University. No risks are associated with this research.

Confidentiality
Your identity will not be revealed and your confidentiality will be protected.

Please forward this along to anyone you know who may be interested. It is not mandatory that they be students of the conservatory.

Thank you and feel free to contact me with any questions.

Stephanie Khoury
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Schulich School of Music - McGill University
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APPENDIX II: STUDENT PARTICIPANT SURVEY QUESTIONS (via SurveyMonkey)

1. Full name:
2. Age:
3. Grade level in school:
4. Instrument:
5. How long have you played this instrument?
6. Do you play any other instruments?
7. If yes, which ones?
8. If yes, how long?
9. Are you or have you ever been in an ensemble? Please explain.
10. Do you have an iPad at home?
11. Do you have an iPhone at home that you can access?
12. Do you have any experience improvising? Please explain.
    a. Experience with a teacher
    b. Experience on your own (jam with friends, noodle on your instrument, etc.)
    c. Experience in an ensemble
13. How confident are you improvising?
    a. I am very confident improvising.
    b. I am confident improvising.
    c. I am a little bit confident improvising.
    d. I do not feel very confident improvising.
    e. I am absolutely not confident improvising.
14. What is your experience using technology?
    a. What devices do you sue and how often?
    b. Do you enjoy it?
    c. Have you used any software for learning or supporting your instrument playing?
    d. What software and how often do you use it?
15. How would you rate your ease with technology?
    a. I am extremely comfortable using computers and mobile devices.
    b. I am comfortable using computers and mobile devices.
    c. I am OK at using computers and mobile devices.
    d. I am a little bit uncomfortable using computers and mobile devices.
    e. I am uncomfortable using computers and mobile devices.
16. How and where do you listen to music?
    a. Do you listen to music at home?
    b. Do you listen to music when walking, taking the bus, etc.? Please explain.
    c. What devices do you use to listen to music?
    d. Do you use headphones/earbuds? Please explain.

17. Please tell me about the kind of music in your life.
    a. What kind of music do you like best?
    b. Name a few favorite bands/musicians.
    c. What music do you play on your instrument (you can name a few pieces)?
18. If so, for how long have you used it?
19. How many hours per week do you use it?
20. What apps do you use?
21. What musical apps have you used?
22. Do you use a computer at home?
23. If so, how many hours per week?
24. What do you do on the computer?
25. Do you listen to music?
26. If so, how many hours per week?
27. What music do you listen to?
28. On what device or devices do you listen to music?

APPENDIX III: TEACHER PARTICIPANT SURVEY (via SurveyMonkey)

1. Full Name
2. Age
3. Teaching specialty
4. Primary instrument
5. Secondary instruments (if any)
6. Current teaching position(s)
7. Do you own an iPad?
8. Do you own a different tablet device?
9. Do you have an iPhone?
10. Do you have experience improvising? Please explain:
    a. Institutional training
    b. Autonomous training
    c. Informal training
    d. Improvise in an ensemble
    e. Other
11. How confident are you improvising on your instrument?
    a. I am very confident improvising.
    b. I am confident improvising.
    c. I am a little bit confident improvising.
    d. I do not feel very confident improvising.
    e. I am absolutely not confident improvising.
12. Do you teach any improvisation? If so, briefly explain.
13. What is your experience using technology?
    a. What devices do you use? How often?
    b. Do you enjoy it?
    c. Have you used any software for learning or supporting your instrument playing?
    d. What software and how often do you use it?
    e. Do you use any software with your students? Please explain.
14. How would you rate your ease with technology? (choose one)
    a. I am extremely comfortable using computers and mobile devices.
    b. I am comfortable using computers and mobile devices.
    c. I am OK at using computers and mobile devices.
    d. I am a little bit uncomfortable using computers and mobile devices.
    e. I am uncomfortable using computers and mobile devices.

APPENDIX IV: STUDENT CONSENT FORM
One-time user testing

Project Title: Constructionism, improvisation and music education: Research-creation of software to facilitate the learning of improvisation
Investigator: Stephanie Khoury

We are doing a research study about **listening to music and improvising with the help of iPads**. A research study is a way to learn more about something. If you decide that you want to be part of this study, you will be asked to meet one time with the researcher for 45 minutes to an hour. During that time you will play with software on the iPad and give feedback about your experience and observations.

If you agree, some of the session will be video recorded. It will not be shared publicly, it is for the researcher. Your feedback is very important and will help software developers understand what young people prefer.

When we are finished with this study we will write a report about what was learned. This report will not include your name or that you were in the study.

You do not have to be in this study if you do not want to be. If you decide to stop after we begin, that's okay too. I will destroy any data collected up until that time, unless you agree that I may keep it. Your parents know about the study too.

You will be given a $10 iTunes gift card in appreciation of your contribution.

If you decide you want to be in this study, and agree to have the session video recorded, please sign your name.

I, _____, want to be in this research study.

_____ _____
(Sign your name here) (Date)

APPENDIX V: PARENTAL CONSENT FORM
One-time user testing

Researchers: Stephanie Khoury, PhD Candidate in Music Education at McGill University, Montreal
Supervisors: Lisa Lorenzino and Ichiro Fujinaga
Title of Project: Constructionism, improvisation and music education: Research-creation of software to facilitate the learning of improvisation

This is an invitation for your child to participate in the study entitled "Constructionism, improvisation and music education: Research-creation of software to facilitate the learning of improvisation." As a PhD student in music education at McGill University in Montreal, my research focuses on pedagogies of improvisation and technological tools. The present research is exploring the design of a prototype for listening to music and improvising.

Your child's participation entails providing feedback about the initial design of the prototype. We will meet in a one-on-one setting for approximately 45 minutes. They will interact with the software on an iPad and give feedback about positive and negative observations. If you and they consent, this will be video recorded. This video will be primarily for the researcher and the written report. If at a later time there is an interest in sharing this video at an academic conference, your permission and that of your child will be sought. Otherwise, your child's participation will remain completely confidential and anonymity will be assured.

Please feel free to discuss with me any concerns you may have before signing, or at any point during the research. Your child's participation in this study is voluntary and they may withdraw from the study at any time. If they withdraw, any data collected up until that time will be destroyed unless they agree that I may keep what has been collected up to that point. They may also refuse to answer any question. There are no anticipated risks associated with participation in this study.

The results of this study will be used in my doctoral dissertation, and possibly in another academic publication, such as an article in an international music education journal or a presentation at a music education conference. Your child's contribution is important to this study. The field of music education technology will benefit from their perspective as a young music student.

As compensation, the researcher will offer your child a $10 iTunes gift card in appreciation of their contribution to this study.

Interview

Do you consent to your child being interviewed by the researcher?

Yes_____ No _____

Do you consent to having this interview audio recorded?

Yes_____ No _____

Do you consent to having parts of this interview video recorded?

Yes_____ No _____

Anonymity and confidentiality
The data collected will be kept in password-encrypted files and will only be accessible to the researcher and her supervisor. After seven years, most data will be destroyed including all identifying data.

If you have any questions or concerns regarding the study, you are welcome to communicate with the researcher at any time. The following contact information may be used: Stephanie Khoury, xxx-xxx-xxxx, xxxxxxxx@xxxxx.

You are also welcome to communicate with the project supervisor, Lisa Lorenzino at the following email xxxxxxxx@xxxxx or at xxx-xxx-xxxx.

If you have any questions or concerns regarding your rights or welfare as a participant in this research study, please contact the McGill Ethics Officer at xxx-xxx-xxxx or xxxxxxxx@xxxxx.

By signing below, I certify that I have read and understood the foregoing terms and conditions, and that I agree to have my child _____ participate in the manner in which I have specified above, in the above-named study.

_____
PARTICIPANT NAME

_____ _____
PARENT SIGNATURE DATE

_____ _____
INVESTIGATOR SIGNATURE DATE

APPENDIX VI: TEACHER CONSENT FORM
One-time user testing

Researchers: Stephanie Khoury, PhD Candidate in Music Education at McGill University, Montreal
Supervisors: Lisa Lorenzino and Ichiro Fujinaga
Title of Project: Constructionism, improvisation and music education: Research-creation of software to facilitate the learning of improvisation

This is an invitation to participate in the study entitled "Constructionism, improvisation and music education: Research-creation of software to facilitate the learning of improvisation." As a PhD student in music education at McGill University in Montreal, Québec, my research focuses on pedagogies of improvisation and technological tools. The present research is exploring the design of a prototype for listening to music and improvising.

Your participation entails providing feedback about the initial design of the prototype. We will meet in a one-on-one setting for approximately 45 minutes to an hour. You will interact with the software on an iPad and give feedback about positive and negative observations. If you consent, this will be video or audio recorded.

Please feel free to discuss with me any concerns you may have before signing, or at any point during the research. Your participation in this study is voluntary and you may withdraw from the study at any time. If you withdraw, any data collected up until that time will be destroyed unless you agree that I may keep what has been collected up to that point. You may also refuse to answer any question. There are no anticipated risks associated with participation in this study.

The results of this study will be used in my doctoral dissertation, and possibly in another academic publication, such as an article in an international music education journal or a presentation at a music education conference. Your contribution is vital to this study. The field of music education technology will benefit from your perspective as expert teacher.

As compensation, the researcher will give you a $10 iTunes gift card in appreciation of your contribution to this study.

Interview

Do you consent to an interview with the researcher?

Yes_____ No _____

Do you consent to having this interview audio recorded?

Yes_____ No _____

Do you consent to having some of this interview video recorded?

Yes_____ No _____

Anonymity and confidentiality
The data collected will be kept in password-encrypted files and will only be accessible to the researcher and her supervisor. After seven years, most data will be destroyed including all identifying data.

When publications are made of this research, including the dissertation and any other articles, the researcher may want to speak about a professor specifically, to refer to the interview or a class observation. You may choose to have your true name published or to have a pseudonym.

If necessary, do you consent to have your name used in publication?

Yes_____ No _____

If you have any questions or concerns regarding the study, you are welcome to communicate with the researcher at any time. The following contact information may be used: Stephanie Khoury, xxx-xxx-xxxx, xxxxxxxx@xxxxx

You are also welcome to communicate with the project supervisor, Lisa Lorenzino at the following email xxxxxxxx@xxxxx or at xxx-xxx-xxxx.

If you have any questions or concerns regarding your rights or welfare as a participant in this research study, please contact the McGill Ethics Officer at xxx-xxx-xxxx or xxxxxxxx@xxxxx.

By signing below, I certify that I have read and understood the foregoing terms and conditions, and that I agree to participate in the manner in which I have specified above, in the above-named study.

PARTICIPANT NAME_____

_____ _____
PARTICIPANT SIGNATURE DATE

_____ _____
INVESTIGATOR SIGNATURE DATE

APPENDIX VII: STUDENT CONSENT FORM
Long-term study

Project Title: Constructionism, improvisation and music education: Research-creation of software to facilitate the learning of improvisation
Investigator: Stephanie Khoury

We are doing a research study about ***listening to music and improvising with the help of iPads***. A research study is a way to learn more about something. The first week in this study, you will be asked to listen to a few recordings of a song, and at the end of the week, improvise with the song. After that, for the next four weeks you get to use a new iPad app to help you listen. The app will ask you to tap the screen as you listen to music. The study asks that you use this app for at least an hour and a half a week, for four weeks, and that you make notes about how often, and what you noticed about the software (what you liked or didn't like, etc.). At the end of each week, you will be asked to improvise on your instrument playing along with a backing track on the app, then fill out a questionnaire. The improvisation will be recorded by the app so you and the researcher can listen to it if you want, but it will not be judged or graded. The study is interested in how you feel about your improvisation after using the prototype, not in how well you improvise.

If you decide that you want to be part of this study, you will meet with the researcher three times. If you agree, these sessions will be audio or video recorded.

Your feedback is very important and will help software developers understand what young people prefer.

When we are finished with this study we will write a report about what was learned. This report will not include your name or that you were in the study.

You do not have to be in this study if you do not want to be. If you decide to stop after we begin, that's okay too. If they stop the study, any data collected up until that time will be destroyed unless you agree that I may keep what has been collected up to that point. Your parents know about the study too.

You will be given a $25 iTunes gift card for completing the study as appreciation for your contribution to this research.

If you decide you want to be in this study, and agree to have the sessions video recorded, and your improvisations audio recorded, please sign your name.

I, _____, want to be in this research study.

_____ _____
(Sign your name here) (Date)

APPENDIX VIII: PARENTAL CONSENT FORM

Long-term **study**

Researchers: Stephanie Khoury, PhD Candidate in Music Education at McGill University, Montreal
Supervisors: Lisa Lorenzino and Ichiro Fujinaga
Title of Project: Constructionism, improvisation and music education: Research-creation of software to facilitate the learning of improvisation

This is an invitation for your child to participate in the study entitled "Constructionism, improvisation and music education: Research-creation of software to facilitate the learning of improvisation." As a PhD student in music education at McGill University in Montreal, Québec, my research focuses on pedagogies of improvisation and technological tools. The present research is exploring the design of a prototype for listening to music and improvising.

The present study will last five weeks, and will take your child approximately 1 ½ hours per week of independent time. This time will be spent listening to music, interacting with the music via touchscreen, playing their instrument along with the app, and writing notes in a provided journal or keeping an audio journal. On top of this, students may meet with the researcher on three occasions: 1. After week one. This session will be one-on-one and will be audio recorded. This session will inform them about the process to follow. 2. The researcher may schedule a meeting during the five-week study to work with the software and the student. 3. At the end of week five. This session will also be one-on-one and will be audio or video recorded.

Please feel free to discuss with me any concerns you may have before signing, or at any point during the research. Your child's participation in this study is voluntary and they may withdraw from the study at any time. If they withdraw, any data collected up until that time will be destroyed unless they agree that I may keep what has been collected up to that point. They may also refuse to answer any question. There are no anticipated risks associated with participation in this study.

The results of this study will be used in the researcher's doctoral dissertation, and possibly in another academic publication, such as an article in an international music education journal or a presentation at a music education conference. Your child's contribution is important to this study. The field of music education technology will benefit from their perspectives as young music students.

Your child will be given a $25 iTunes gift card for completing the study as appreciation for their contribution to this research.

Do you consent to your child's participation in this study?

Yes_____ No _____

Do you consent to sessions with the researcher being video and/or audio recorded?

Yes_____ No _____

Anonymity and confidentiality
The data collected will be kept in password-encrypted files and will only be accessible to the researcher and her supervisor. After seven years, most data will be destroyed including all identifying data.

If you have any questions or concerns regarding the study, you are welcome to communicate with the researcher at any time. The following contact information may be used: Stephanie Khoury, xxx-xxx-xxxx, xxxxxxxx@xxxxx

You are also welcome to communicate with the project supervisor, Lisa Lorenzino, at the following email xxxxxxxx@xxxxx or at xxx-xxx-xxxx.

If you have any questions or concerns regarding your rights or welfare as a participant in this research study, please contact the McGill Ethics Officer at xxx-xxx-xxxx or xxxxxxxx@xxxxx. By signing below, I certify that I have read and understood the foregoing terms and conditions, and that I agree for my child _____ to participate in the manner in which I have specified above, in the above-named study.

_____
PARTICIPANT NAME

_____ _____
PARENT SIGNATURE DATE

_____ _____
INVESTIGATOR SIGNATURE DATE

APPENDIX IX: JOURNAL PROMPTS FOR LONG-TERM STUDY

Questions for the audio journal one:

Think about listening to "No Woman, No cry". Did using the prototype cause you to listen more attentively to this week's song?
Did you pay more attention to the rhythm?
Did you pay more attention to harmony?
Were you more motivated to listen?

How do you like Module 1-Rhythm?
Did you do it more than once? If so, how many times? Why?
Was it easy to understand the rhythms from the pulsing circles?
Did you have any problems?
Were you concentrating on being accurate with the beat?
Did you read the feedback next to your fingers?

How do you like Module 2-Harmony?
Did you do it more than once? If so, how many times? Why?
What did you think of this cover version?
Were the instructions clear?
Do you remember the four chords, and their order?
Did you imagine the roots of the chord on your instrument?
Did you imagine the thirds as well?
Did you encounter any bugs? Crashes, etc.?

Questions for audio journals two and three:

How much time have you spent using the software?
Was it fun?
Did you encounter any bugs? Crashes, etc.?
What problems did you have?
What do you like most?
What do you not like?

Questions for audio journals four and five:

Tell me about a typical week's schedule of practicing your instrument (not using the prototype):

How many times a week? For how long each session?

What do you do during those practice sessions?

How does working with the prototype differ from your typical instrument practice?

How do you feel about your prototype sessions?

Do you enjoy them? Why or why not?

Do you usually listen to recordings of pieces that you are playing?

If so, how often?

Does your teacher ask you to listen to them?

Do you think the rhythmic practice in the prototype has or could improve your rhythm on your instrument? Why or why not?

What have you learned about harmony and chords?

Are you more confident improvising now than you were 3 weeks ago? Why or why not?

Questions for audio journal six:

Module 1

Were the instructions clear? Did you know what to do?
Did you like the new format? Why or why not?
How well were you able to play the rhythms?
What score do you think you would get for your accuracy?
Would you want to repeat it to get a higher score?
Any other comments?

Module 2

What do you think of the new interface?
Do you understand roots and thirds?
Did you enjoy it?
Did you think of the notes on your instrument?
Would you play it again to learn the notes and chords better?
What do you think of the way the notes are presented (not the typical staff)?
Any other comments?

Module 3

Was the view of the rhythm and the harmony useful for playing your instrument?
Were you successful at playing the roots? the thirds?
Were you able to stay with the chord changes?
Describe your improvisation.
Rate your confidence improvising, from 1 - not at all, to 10 very confident.
Did you enjoy it?
Any other comments?

Module 4

Were you successful at playing the roots? the thirds?
Were you able to stay with the chord changes?
Describe your improvisation.
Rate your confidence improvising, from 1 - not at all, to 10 very confident.
Did you enjoy it?
Any other comments?

APPENDIX X: WEEK ONE INSTRUCTIONS

First of all — Thank you! I am so happy to have you all on board. For your information, there are six of you participating in this study. Maybe we can all get together and jam once the study is done!

This first week of the study is a 'control' week. Like any good research experiment, having a control and then a variable will allow me to judge the effect of the study. So for this control week, you won't interact with the software at all. I want you to listen to the music I am providing you, in whatever listening context you are used to - on your iPod, phone, laptop, iPad, etc... I would also like for you to keep a listening log.

LISTENING: I will ask you during this week to spend at least an hour (hopefully more) listening to the music that I have included in the No Woman, No Cry folder. You guessed it, you are listening to Bob Marley's "No Woman, No Cry" - the original version from the Legend album, and 8 cover versions. I put all nine tracks into the folder. Each of the covers is quite different as you will see, but you don't have to listen to all of them. If you really don't like a version, by all means, don't torture yourself. And if you would like to listen to other cover versions you have or find, be my guest. Please make sure you listen to the original Bob Marley version. It is a classic!

I don't really mind in which format you listen, you can download the mp3s from the folder and put them on your iPod, phone, or iPad. Or just on your desktop. You can also listen to them directly from the Google folder, though this is less efficient. If you have any trouble, please feel free to email me or even call. I am happy to help.

LISTENING LOG: In your journal folder is a document named Listening Log. I would like for you to keep track of the amount of time you spend listening to the mp3s I have provided you with. Please tell me how long you listened, where you were, and on what device. Also, if listening leads you to do any other activities (like look up info about the artists, watch YouTube videos, play your instrument, etc.) please make note of these details as well. If you are not near your computer when you listen, you can just jot down the info, and write it in the log later. Just make sure to have it complete by the time we meet.

I look forward to our first session next week! Have fun listening. And thank you!

Contact me: Stephanie [contact info]

APPENDIX XI: SECOND INSTRUCTIONS
sent via email following Session #1, long-term study

Link to download the app on your provisioned device (updated June 2):
https://build.cloud.unity3d.com/share/xxxxxxxxxx/

I have sent it in the email as well. This is because you will want to open that email on your iPad or iPhone and click the link there. This will help you install it on your device.

Do all four modules of lesson one. It's best to do all in one sitting if you can. And if you would like to go back and repeat one in the session, this is ok too. Notice in module four, you can either record, or just practice along with the backing track.

Each time you finish using it, make a note of how long you were using the software. Please send at least two audio journals per week, more if you want (instructions below).

Your accuracy tapping the rhythms and chords is being checked by the software. In the future, we will have your accuracy appear at the end of the module, for now, you just have to read the immediate feedback to get a sense of how spot on the rhythm you are (module 1), and if you are tapping the right chords (module 2).

For the first two modules, you can either use the speaker on the device or use headphones. For the 3 and 4, headphones will help tremendously, so keep that in mind.

Audio Journal Instructions

You have two options for the audio journal.

Option One - iPhone
One option is to use the voice memo app on an iPhone in your house. Simply open the app, tap the red circle, and begin talking. Press the circle again when you are done, then hit done. It will ask you to save it. Just use the date. Then push share button (a square with an arrow going up) and choose email. You can email it to xxxxxxx@gmail.com. Go ahead and just email immediately so you don't forget!

Option Two - browser
http://online-voice-recorder.com/
This simple website allows you to record audio from your laptop or desktop (as long as there is a microphone). Hit the record button and talk. Then the stop button, followed by the save button. You can just save it on your desktop. Then email it to me at xxxxxxx@gmail.com. Go ahead and just email immediately so you don't forget!

APPENDIX XII: POST-IMPROVISATION QUESTIONNAIRE
Improvisation #1

Name: _____

Date: _____

Song title: No Woman, No Cry

Please rate your answers to the following questions on a scale of 1 to 10, 1 (not at all) to 10 (very much so):
How confident were you improvising just now? _____

How well did you know where you were in the piece? _____

How much were you aware of what chord you were playing over? _____

How well were you able to play rhythmically with the beat of the song? _____

Did you enjoy improvising? _____

Did your week of listening to the original and the covers help you to improvise

better? _____

Were you able to create any melodies that you liked while improvising? _____

Please write at least one sentence about your experience improvising.

APPENDIX XIII: POST-IMPROVISATION QUESTIONNAIRE
Improvisation #2 (and #3)

Name: _____

Date: _____

Please rate your answers to the following questions on a scale of 1 to 10:
1 (not at all) to 10 (very much so)

How confident were you improvising just now? _____

How well did you know where you were in the piece? _____

How much were you aware of what chord you were playing over? _____

How well were you able to play rhythmically with the beat of the song? _____

How well did you enjoy improvising? _____

How much did your experience with the [prototype] help you to improvise

better? _____

To what degree were you able to create melodies that you liked while

improvising? _____

Please write at least one sentence about your experience improvising.