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Technology-Based Music Instruction

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by

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Abstract

Many beginning band and choir students lack proficiency in basic sight-reading skills. A significant learning curve exists between the late elementary and early middle school years regarding music reading competency. This study aims to ascertain the effectiveness or ineffectiveness of music notation apps such as Prodigies, Yousician, and Noteflight. The study will use a mixed-method approach. To obtain quantitative data, the study will use an experimental approach to test the effectiveness of digital notation apps on student learning by utilizing a survey. The working hypothesis is that digital notation apps will improve sight-reading skills by using the tools present in the applications, such as visual cues, colored notation, lettering, and other auditory and visual aids, and creating individual learning opportunities tailored to student needs. These applications allow students of all learning levels to build essential music literacy skills and provide educators with options to exercise technology-based teaching strategies. To obtain qualitative data, students will complete a survey regarding their experience with digital notation apps at the end of the eight-week course. The study will also discuss the need for music educators to adopt diverse technological strategies congruent with traditional ones. Evidence of societal change involving technology is prominent in education. Therefore, developing the necessary technological pedagogical skills and techniques as educators and recognizing students' diversity and unique needs is essential if music educators hope to align more closely with modern educational paradigms.

Keywords: Scrolling Notation, Figurenotes.

Dedication

This project is dedicated to my spouse, who, throughout writing this thesis, has had to endure many long nights with little to no help with our child while also being pregnant. Her assistance managing our household and family during this time has been invaluable. Without her help, managing work and family would not have been possible.

Acknowledgments

I want to thank all the professors at Liberty for taking the time and energy to invest in me and guide my work in a biblically informed way. I am more equipped in my Christian Worldview to impact future generations as an educator because of their help. Thank you to the families who allowed me to conduct the research with their students to obtain vital data for my research project. Finally, I thank our savior, Jesus, for guiding me through these difficult years in obtaining this degree and completing all the coursework.

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Abbreviations

App - Application. Software designed to perform a group of coordinated functions, tasks, or activities for the user's benefit.

CLO - Course Learning Objectives. The specific goals that students expect to achieve by the end of the course.

DBNA - Digital Notation Apps. Software applications like Prodigies, Yousician, and Noteflight used for music education, specifically for teaching and learning music notation and sight-reading skills.

IRB - Institutional Review Board. A committee that reviews and approves research involving human subjects to ensure researchers meet ethical standards.

TPT - Technological Pedagogical Techniques. Methods and strategies employed by educators to effectively integrate technology into teaching and learning processes.

SN - Scrolling Notation. A digital method of displaying music notation that scrolls across the screen in digital notation apps.

FN - Figurenotes. A music notation system using colors and shapes to represent musical notes, making reading music more accessible.

SR - Sight-Reading. The practice of reading and performing music at first sight without prior rehearsal.

Chapter One: Introduction

Background

Figurenote and scrolling notation strategies lessen the cognitive load music reading requires by adding visual cues, colored notation, lettering, and other auditory and visual aids.[1] The foundational conceptual framework serving this applied study is reflexive, using strategies that reveal student proficiency gaps and employing discussions that create independent learners.[2] Music education methods in this theory derive from pragmatic meanings and values, defined as learning through physical action rather than an aesthetic experience.[3] Reflexivity derives from numerous social theorists; this study recognizes John and David Creswell. Pragmatic values derive from David Elliot's Praxialism philosophy.

The overall problem in the literature is that the literature has not fully addressed technology-based sight reading's effectiveness or ineffectiveness with fourth-grade students in choral and instrumental performance. Ultimately, this applied study aims to make choral and instrumental performance available to all fourth-grade students by developing a thesis through quantitative data and qualitative data and inspire educators to acquire more technological strategies and fourth-grade students to acquire sight-reading skills appropriate for beginning choral and instrumental ensembles.

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[1] Sanna Kivijarvi, "Applicability of an Applied Music Notation System: A Case Study of Figurenotes," *International Journal of Music Education* 37, no. 4 (November 2019): 14.

[2] John W. Creswell, and David J.Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, (Available from MBS Direct, (5th Edition), SAGE Publications, Inc. (US), 2017): 181.

[3] Thomas A. Regelski, "Music and Music Education: Theory and Practice for making a difference," *Educational Philosophy and Theory* 37, 1 (2005): abstract.

Finally, developing a thesis that discusses modern sight-reading strategies such as scrolling and figure-note notation will address sight-reading deficiencies among fourth-grade students, increase mastery of sight-reading skills, and establish a more equitable classroom for diverse learning styles and levels. Additionally, implementing technological notation strategies will equip music educators with more differentiated approaches to address sight-reading deficiencies by utilizing the notational systems tools such as tempo variation, color coding, and visual cues. This paper will address the first three chapters of this thesis for this applied study.

Statement of the Problem

The problem statement involves the lack of musical expertise in fourth-grade students. The overall problem in the literature is that the literature has not fully addressed technology-based sight reading's effectiveness or ineffectiveness with fourth-grade students in music education. Musical expertise among fourth-grade students varies due to numerous factors typically involving time and resources, primarily technical skills such as sight-reading. Further, brain research reveals that this age group is essential because of malleability within the first decade of life.[4] Fourth graders are at the end of this decade; therefore, educators must choose activities that appropriately stimulate the brain and develop the complex morphological functions necessary for sight-reading skills.[5] If young children experience music as a positive experience, this will positively affect their brain function and structure.[6]

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[4] Suzanne L. Burton and Cynthia Crump Taggart, *Learning from Young Children Research in Early Childhood Music*, (Lanham, Md: Rowman & Littlefield Education, 2011): 11.

[5] Burton and Taggart, 12.

[6] Ibid.

To establish a healthy music culture that influences and leads to middle school arts learning, music educators must employ engaging traditional and modern methodologies and recognize the significance of current social transitions and their effect on students.[7] American culture promotes a fast-life strategy involving reproductive tasks that prepare individuals for adult life and future professions.[8] Many curriculums experience overload, expansion, and limited space, all of which encompass numerous learning outcomes that can overwhelm students and teachers.[9] Therefore, students entering adolescence need tools that control the pace at which they learn and execute acquired skills. This applied study aims to ascertain the effectiveness of modern technology-based notation technologies in designing a thesis that addresses sight-reading deficiencies. The problem is that the literature has not fully addressed the effectiveness or ineffectiveness of technology-based sight reading with fourth-grade students in music education.

Statement of the Purpose

The need for study regards how music educators need diverse technological tools to teach sight-reading to various learning styles and levels. Data collected from a quantitative study conducted by the American Psychological Association concluded that students in individual or group ensemble training perform higher on standardized tests and select executive function tasks and also earn better grades in language arts and

[7] Jean M. Twenge, "The Decline in Adult Activities Among Us. Adolescents, 1976-2016," *Society for Research in Child Development*, 2, no. 90 (2019): 638.

[8] Ibid.

[9] OECD Ilibrary, "Curriculum Overload: A Way Forward," Last modified 2023, https://www.oecd-ilibrary.org.

math.[10] The premise of this study is that mastery of sight-reading will foster more independent learners who can continue growing in choral and instrumental performance with less assistance from their instructor.[11] Sight-reading also fosters executive skills necessary for early child development and is a topic of urgency amongst practitioners and policymakers.[12] Executive skills related to sight-reading include working memory, inhibitory control, and flexible attention.[13]

Moreover, regardless of the learning environment, skills obtained through mastery of music skills, such as sight-reading, also transfer through representations and applications in literacy.[14] Literacy requires listening, viewing, writing, and speaking, all skills supported through musical training. In one understanding, literacy is using available symbol systems fundamental to relevant social practices.[15] Indeed, developing technological literacy is imperative in modern society. Teachers must inform students of the technical aspects underpinning future choral and instrumental performances, which will involve digital variations of traditional and contemporary notation systems.[16]

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[10] Steven J. Holochwost et al, "Music Education, Academic Achievement, and Executive Functions," *Psychology of Aesthetics, Creativity, and the Arts* 11, no. 2 (2017):147.

[11] Amy L. Simmons and Sarah E. Allen, "Reports of Research in Music Education Presented at the Annual Meeting of the Texas Music Education Association," *Texas Music Education Research,* (2016): 15.

[12] Holochwost, et al. "Music Education, Academic Achievement, and Executive Functions," abstract.

[13] Ibid.

[14] Dee Hansen, Elaine Bernstorf, and Gayle M. Stuber, *The Music and Literacy Connection*. (Lanham: Rowman & Littlefield Publishers, 2014): 19.

[15] Ibid.

[16] Peter Gouzouasis and Danny Bakan, "The future of music making and music education in a transformative digital world," *Research Gate,* (2011).

Preparing educators and students in a society that expects competency in digital literacy demands that education align more closely with the goals thereof. Most curriculums now incorporate the use of technologically based instruction because of its versatility and its potential to individually tailor lessons to students in real-time and develop technological literacy, a growing aspect of being a productive member of American society and the world.[17] The pandemic revealed many gaps in modern education's ability to accommodate distance learning and in educators possessing the skill to teach and utilize distance learning platforms.[18] According to the National Skills Coalition, thirty-one percent of Americans lack essential digital literacy skills, and thirteen percent lack digital literacy skills entirely.[19] Education Districts worldwide must provide teachers with the correct professional growth opportunities to meet these demands; however, institutions lack the personnel to teach these skills, illuminating current society and education's need for development in technological literacies.

Therefore, independent learning and competence in various digital tools are crucial in a techno-centric society.[20] Fostering independent learning is vital in all educational realms since education's pivotal goal is cultivating citizens capable of employing flexible solutions to a mutable technocentric society. Achieving independent learning must incorporate relevant, meaningful activities through what Thomas Regelski calls "Action Learning," which promotes deep reflection within numerous layers,

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[17] Romina Bandura and Elena I. Mendez Leal, "The Digital Literacy Imperative," *Center for Strategic and International Studies*, (2022): 2.

[18] Ibid.

[19] Amanda B. Shilcock, "The New Landscape of Digital Literacy," *National Skills Coalition,* (2020): 4.

[20] Ibid., 1.

allowing students to move at a pace according to their level of readiness.[21] According to Regelski, the music classroom should envelop students in investigative activities that challenge and inspire them through critical thinking and individual, meaningful discoveries that allow an opportunity for critical judgments.[22] Digital technologies that provide opportunities for unique, significant findings and promote student-centered learning are scrolling notation apps like Yousician and Prodigies. Educators can assess students through scoring systems embedded within the apps and then adjust content according to student ability. Teachers can develop students' sight-reading skills that can aid collective choral and instrumental ensemble sight-reading ability by applying skills gained through individually tailored sight-reading activities.

Significance of the Study

Developing a thesis that discusses the importance of differentiation and equal participation is paramount. To learn musical concepts, students must possess an adequate notational reading ability. For example, just as language arts in early education require reading comprehension, music requires music reading comprehension.[23] Advanced reading comprehension skills allow students to handle incongruencies better, such as unfamiliar words or sentence structures. Students will encounter and approach notational incongruencies differently with beginning to advanced musical repertoire as they grow in

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[21] Thomas A. Regelski, *Teaching General Music in Grades 4-8,* (New York, Oxford: Oxford University Press, 2004), 61.

[22] Ibid., 2.

[23] Natalia Chitalkina et al.,Handling of Incongruences in Music Notation during Singing or Playing." *International Journal of Music Education* 39, no. 1 (February 2021): 4.

sight-reading ability, making individualized sight-reading instruction paramount for fourth-grade students as music educators prepare them for future choral and instrumental ensembles.[24]

Utilizing modern notational reading technologies such as scrolling notation and figure notes allows music reading to be less of a cognitive load, as these methodologies remove several facets of music reading from the process, including visual-spatial skills (differentiating line notes from space notes) and tempo fluctuations (following notes through scrolling notation).[25] In popular music, traditional Western notation must accommodate the growing demand for popular music repertoire. Figure notes and scrolling notation systems provide more socially relevant content, which naturally interests late elementary/early middle school students.[26] Further, applications such as Prodigies provide backing tracks that allow students to hear the correct interpretations of notes and rhythms instead of only hearing their or the ensemble's interpretation.[27] These new curriculums embody the new strategies app developers are creating to make music more accessible to various learning levels. These applications focus on user-friendly layouts (easily understandable terms, menu organization), scaffolding (how quickly app features teach actual music reading), playback capabilities (availability of instruments, scrolling notation accuracy), and many other measurements that aid in making music content more accessible to learn.[28]

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[24] Chitalkina et al., 6.

[25] Kivijärvi, "Applicability of an Applied Music Notation System: A Case Study of Figurenotes." 1.

[26] Ibid., 6.

[27] K.C Collins, *Playing with Sound : A Theory of Interacting with Sound and Music in Video Games*. (Cambridge: MIT Press. 2013) 1.

[28] Dunbar, 39.

Research Question and Sub-Questions

Central Research Question: How does figure note or colored notation affect fourth-grade students' interpretation of rhythms and identifying note names?

Revised Central Research Question: How do digital notation applications affect the development of sight-reading skills among fourth-grade students?

Developing a thesis that discusses modern sight-reading strategies such as scrolling and figure-note notation will address sight-reading deficiencies among fourth-grade students and increase mastery of sight-reading skills. Further, implementing technological notation strategies will equip music educators with more differentiated approaches to address sight-reading deficiencies by utilizing the notational systems tools such as tempo variation, color coding, and visual cues.

RQ2: How does scrolling notation affect fourth-grade students' interpretation of rhythms and identifying note names?

RQ3: Do the fourth-grade performance scores of sight-reading using traditional and technological curricula differ?

RQ4: How do scrolling notation strategies impact the cognitive load associated with music reading for fourth-grade students?

RQ5: How do visual cues, colored notation, and auditory aids in figure note and scrolling notation strategies enhance music learning and performance among fourth-grade students?

RQ6: How does using technology-based sight-reading strategies affect the development of sight-reading skills in fourth-grade students compared to traditional methods?

RQ7: What are fourth-grade students' perceptions regarding using figure note and scrolling notation strategies when learning to sight-read?

Hypothesis Section

This study investigates the potential of digital notation applications to enhance sight-reading skills among fourth-grade students. Technology integration in music education presents a promising avenue for addressing students' varied learning needs and fostering a more inclusive and engaging learning environment. The research's mixed-method approach grounds the hypothesis in quantitative and qualitative insights derived from existing literature and preliminary observations. The literature review and the identified gap in research regarding the effectiveness of technology-based sight-reading strategies for young learners inform the formulation of these hypotheses. By exploring these hypotheses, this study aims to contribute valuable insights into the pedagogical practices of music education, particularly in leveraging technology to enhance sight-reading proficiency among elementary students.

Hypothesis Statement:

Main Hypothesis: Digital notation applications, through their interactive features such as visual cues, colored notation, lettering, and auditory aids, significantly improve sight-reading skills among fourth-grade students compared to traditional sight-reading methods. This hypothesis hinges on the assumption that digital notation apps' interactive and customizable nature can cater to individual learning styles, thereby reducing the cognitive load associated with music reading and making the learning process more engaging and effective.

Sub-Hypotheses:

1: Visual and Auditory Aids Hypothesis: Using visual cues, colored notation, and auditory aids in digital notation apps enhances the music learning experience and performance among fourth-grade students by providing a multisensory approach to sight-reading.

2: Individual Learning Opportunities Hypothesis: Digital notation apps create individualized learning opportunities that allow students to progress at their own pace, leading to improved mastery of sight-reading skills.

3: Cognitive Load Hypothesis: Scrolling notation and figure-note strategies implemented through digital apps significantly reduce the cognitive load associated with music reading for fourth-grade students, thereby facilitating a smoother learning curve.

4: Student Perception Hypothesis: Fourth-grade students perceive digital notation apps as beneficial for developing sight-reading skills, recognizing their potential to make learning more accessible and enjoyable.

Definition of Terms

Scrolling Notation: Musicians and Instructors use scrolling notation apps for educational purposes and for creating/editing pieces. Scrolling notation writing software includes features for scrolling through the music and other features such as playback, transposition, and printing. More advanced software may consist of features such as a virtual keyboard, a score editor, and a playback engine. Some popular digital music notation software programs include Noteflight, Finale, and Sibelius. Education apps include interactive games, exercises, and tutorials. Some popular music education apps that use scrolling notation include Yousician, Prodigies, and Simply Piano.

Figurenotes: Figurenotes is a music notation system that uses colored symbols to represent pitches and rhythms. Kaarlo Uusitalo and Markku Kaikkonen, the figurenote notation creators, designed it to be easier to read and understand than traditional music notation, especially for people with learning disabilities.

Summary

Adopting technology is crucial because of its versatility and ability to modify lessons for students and develop technological literacy individually.[29] The advent of technology has ushered in a transformative era in music education, challenging traditional pedagogical methods and introducing innovative strategies to enhance learning outcomes. This study delves into technology-based music instruction, focusing on the efficacy of digital notation applications—such as Prodigies, Yousician, and Noteflight—in improving sight-reading skills among fourth-grade students. By employing figurenote and scrolling notation strategies, this research aims to mitigate the cognitive load associated with music reading, facilitating a more accessible and engaging learning experience for young learners.

Grounded in a reflexive conceptual framework and drawing upon the pragmatic values of David Elliot's Praxialism philosophy, this study seeks to bridge the gap in the literature regarding the effectiveness of technology-based sight reading for elementary students. The overarching goal is to democratize choral and instrumental performance by developing a thesis that leverages quantitative and qualitative data to cater to diverse learning styles and proficiency levels. By implementing modern sight-reading strategies, this research addresses sight-reading deficiencies, enhances mastery of sight-reading skills, and promotes a more equitable classroom environment.

The problem statement highlights a critical gap in music education: the variability in musical expertise among fourth-grade students and the underexplored potential of technology-based sight reading in addressing this issue. With the malleability of young learners' brains and the cultural shifts towards a fast-paced, technology-driven society, there is a pressing need for music educators to adopt innovative teaching strategies that resonate with contemporary

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[29] McDowall, Janet, and Lily Gower, "Interactive Music Video Games and Children's Musical Development," *British Journal of Music Education 29,* no.1 (2012): 91.

students. This study posits that digital notation apps can be pivotal in achieving this objective by offering individualized learning opportunities and reducing the cognitive load associated with traditional music reading methods.

The significance of this study lies in its potential to revolutionize music education by integrating technology in a manner that aligns with modern educational paradigms. By fostering independent learning and enhancing technological literacy, this research aims to equip students with the skills necessary to thrive in a technocentric society. Furthermore, the study underscores the importance of action learning and critical thinking in music education, advocating for a curriculum that encourages students to explore, reflect, and make informed judgments.

Overall, the technology of all mediums shapes various cultures in volatile ways. Therefore, in whatever occupation one resides, we must learn, grow, and adapt as musicians, respond accordingly to technological changes in music, and lead the next generation as educators, equipping students with the right tools to sight-read effectively so they may perform at high levels in numerous choral and instrumental contexts.

Chapter Two: Literature Review

Introduction

Chapter two of this applied study encompasses the literature review and theoretical or conceptual framework. This literature review outlines six categories, which are to create more individualized learning opportunities, facilitate the changing technologies' influence on music education cognitive processes related to sight-reading, re-evaluate outdated methodologies with newer, more critical approaches, and connect new gamification phenomena to music education. In the evolving landscape of music education, integrating digital tools has emerged as a pivotal factor in enhancing teaching and learning experiences. This chapter explores the literature and theoretical underpinnings that inform this study's focus on digital tools in music education, particularly their role in facilitating individualized learning and improving sight-reading skills.

The chapter's discussion centers around three foundational theoretical frameworks—Constructivism, Connectivism, and Differentiated Instruction. These theoretical frameworks guide the understanding of how digital tools can effectively leverage and support diverse learning needs and styles. Constructivism emphasizes the active role of learners in constructing knowledge through experience, Connectivism highlights the importance of digital networks in learning, and Differentiated Instruction advocates for tailoring educational approaches to meet individual learner differences.

This chapter will examine how these theoretical perspectives inform the design and implementation of digital tools in music education, leading to enhanced learning outcomes. We will also consider the broader implications of societal and technological changes on music education, underscoring the need for adaptive, inclusive, and forward-thinking pedagogical

strategies. This literature review and theoretical exploration aim to provide a solid foundation for understanding the potential of digital tools to enhance the development of sight-reading skills.

Learning Outcomes

The primary learning outcome of this applied study is to create more individualized learning opportunities. Music educators must consider student pacing and factors that engage learning.[1] In technology-based resources, particular sounds, colors, videos, photographs, graphics, and other multi-media factors engage learners differently than traditional classroom techniques.[2] Web-based learning provides additional activities for students struggling with particular topics, offers more in-depth material for students interested in specific topics, and more advanced content for high-achieving students.[3] Educators can differentiate their activities, pacing, and approach. It is essential not to choose methods based on familiarity but on critical thinking and factors that serve the unique sociological setting of our classroom.[4] Educators often approach content based on prior experience without questioning methodologies critically. Even if an educator's methods prove successful, the educator must ask if the method better serves them or the students, what components are necessary, and what can be taken away or altered.[5] Possessing dynamic pedagogical techniques and the humility to adapt will, in turn, reach

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[1] David A. Cook, "Web-Based Learning: Pros, Cons, and Controversies," *Clinical Medicine (London, England)* 7, no. 1 (2007): 38.

[2] Ibid.

[3] Ibid.

[4] David A. Williams, *A Different Paradigm in Music Education: Re-Examining the Profession,* (London, New York: Routledge, 2019): 3.

[5] Ibid., 4.

more students, create more individualized learning opportunities, and habitually refine the educator.

Integrating digital tools in music education can facilitate the development of dynamic pedagogical techniques and even transcend the facilitation of individualized learning opportunities, extending into the cognitive, affective, and psychomotor domains.[6] Individualized learning opportunities can accommodate diverse learning styles and foster the development of higher-order thinking skills, emotional engagement with music, and the refinement of motor skills essential for musical performance.[7]

Digital tools in music education significantly enhance cognitive outcomes by promoting critical thinking, problem-solving, and analytical skills.[8] Through interactive software that allows for composition, music theory exploration, and sight-reading practice, students are encouraged to engage in deductive reasoning and creative problem-solving. For instance, music notation apps challenge students to analyze and interpret complex musical scores, enhancing their music literacy and theoretical knowledge. This cognitive engagement supports the development of abstract thinking skills applicable in various academic and real-world contexts. Web apps such as Noteflight allow educators to create unique scores or transcribe existing scores with various written or performance-related exercises attached to the score. Students can use invaluable tools enabling them to isolate problem sections, analyze the synergistic nature of a couple or multiple sections,

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[6] Piia Naykki et al.,"Affective Learning in Digital Education—Case Studies of Social Networking Systems, Games for Learning, and Digital Fabrication," *Frontiers in Education* 4, (2019): 2.

[7] Ibid.

[8] Kelly Keane, "The Imperative of Educational Technology: Why Teachers Must Embrace it in 2023," School of Education, Loyola University Maryland, Accessed May 6, 2024, https://www.loyola.edu/school-education/blog/2023/imperative-of-educational-technology.html

and equalize the score for listening purposes, to name a few features suitable for educational avenues.

Developing motor skills necessary for musical performance is another area where digital tools offer significant benefits. Virtual instruments, rhythm training apps, and interactive tutorials allow students to practice and refine their technical skills in a supportive, feedback-rich environment. These tools often include features that track progress, offer instant feedback on technique, and adjust difficulty levels to match the learner's skill level, promoting continuous improvement. The tactile interaction with digital interfaces can also enhance hand-eye coordination and fine motor control, essential skills for playing traditional musical instruments.[9] Yousician offers features such as color coding incorrectly played notes red and correctly played notes green. The app also features two playback modes: performance and practice. Practice mode is a fail-safe mode that allows students to control the tempo and loop problem sections. However, the performance mode only allows limited incorrect notes before failing the student. If the student fails, they can revisit the concepts and refine the skills necessary to perform the song. For convenience, the app displays the lessons chronologically, with each lesson scaffolding the student's skills to prepare for performing the song.

Using digital tools can offer a holistic approach to developing well-rounded musicians.[10] Digital tools can support the learning outcomes outlined in this chapter by fostering strategies to develop technical proficiency, musical literacy, cognitive

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[9] Wangqian Fu, and Chenying Ji, "Application and Effect of Virtual Reality Technology in Motor Skill Intervention for Individuals with Developmental Disabilities: A Systematic Review," *International Journal of Environmental Research and Public Health* 20, (2023): 2.

[10] Sam Lellouche, "5 Innovative Ways to Use Technology in Music Education and Learning," Opus1.io, May 6, 2024, https://www.opus1.io/blogs/5-innovative-ways-to-use-technology-in-music-education-and-learning

flexibility, emotional depth, and motor skills that underpin artistic expression and creativity.[11] As such, the effective integration of digital tools in music education represents a forward-thinking approach that prepares students for both the challenges and opportunities of the musical world. It also empowers students to individually engage emotionally with music, a critical component of music education that digital tools can have a more significant impact than traditional methods. Students can explore vast digital music repertoires from different genres, cultures, and historical periods. Digital tools enable them to examine things apart from conventional classroom settings, utilizing digital means for greater autonomy over their exploration capabilities and creating a more personal connection with music. Platforms that allow for creating and sharing music help students express themselves creatively, fostering a sense of accomplishment and emotional investment in their musical journey.[12]

Societal Change

While music educators will continue using traditional sight-reading methodologies, technological ones will inevitably become more prominent in curriculums, especially with the No Child Left Behind Act of 2004 update. The Every Student Succeeds Act of 2015 expects educators to incorporate elements relevant to world application and college readiness.[13] Educational policies and reforms have

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[11] Lellouche, "5 Innovative Ways to Use Technology in Music Education and Learning."

[12] Aaron H. Rodwin et al.,"A Systematic Review of Music-Based Interventions to Improve Treatment Engagement and Mental Health Outcomes for Adolescents and Young Adults," *Child and Adolescent Social Work Journal,* (2022): 2.

[13] Robert E. Murillo, "The 21st Century Elementary Music Classroom and the Digital Music Curriculum: A Synergism of Technology and Traditional Pedagogy," *Texas Music Education Research,* (2017): 14.

significantly impacted music curriculum development and instructional practices in various ways. These policies prioritize accountability and standardized testing in core academic subjects but often marginalize arts education, including music.[14] As a result, many music programs have faced budget cuts, reduced instructional time, and limited access to resources. However, STEAM education (Science, Technology, Engineering, Arts, and Mathematics) highlights the importance of integrating arts, including music, into interdisciplinary learning approaches. For instance, STEAM incorporates technology in academia; therefore, students will likely experience or learn about online music applications during their professional careers.[15] For example, Platforms like Fiverr, Supreme Tracks, and Auddly make online collaboration widely available.

Students can use applications such as Smart Music to record performances they can send to their peers with feedback Smart Music provides. Educators can create unique assignments requiring one student to record while the other analyzes the performance. The student can review Smart Music's critique, then listen to their performance with a checklist of what to listen for while following the score to provide additional feedback regarding playing technique. This collaborative process can refine the students' sight-reading and critical listening skills for quality performance.[16] In comparison, In decades past, traditional assessment methods limited what an educator could critique and monitor outside the classroom and the depth of detail the instructor could provide in a single class period. Online capabilities allow music educators to stretch their influence beyond their

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[14] "A Shared Endeavor," National Art Education Association, May 6, 2024, https://www.arteducators.org/advocacy-policy/arts-education-for-america-s-students.

[15] Angela Lou, "Arts Integration in STEM," Kaleidoscope: Educator Voices and Perspectives," Accessed May 6, 2024, https://trellis.kstf.org/kaleidoscope/arts-integration-stem.

[16] "Smart Music," Description, edshelf, last modified 2023, https://edshelf.com/tool/smartmusic/.

fourth-grade year, give them tools that enable virtual practice sessions wherever they are in the world, and refine their skills more intricately independently throughout their music careers.[17]

The International Society for Technology in Education reports that all curricula significantly increased internet usage, digital music, video games, and cell phones in education.[18] According to their study, only fourteen percent of students regularly read books outside the classroom, and eighty-six percent report using the internet regularly.[19] Music education must better align with the larger field of education to remain relevant. Indeed, the internet has globalized and transformed how society exchanges musical ideas, traditions, and practices across diverse cultural contexts, enriching the musical landscape and expanding opportunities for cross-cultural learning in music education.[20] Research indicates that exposure to diverse musical traditions can enhance students' cultural awareness, empathy, and appreciation for global perspectives.[21] Music educators play a vital role in fostering cultural competence by incorporating diverse musical repertoire, teaching practices, and perspectives into their curriculum.

Educators can use new and exciting art forms to expose students to art encapsulating American and other cultures. Arts are ephemeral in our culture and other cultures; therefore,

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[17] Lellouche, "5 Innovative Ways to Use Technology in Music Education and Learning,"

[18] Danni Gilbert, "Revitalizing Music Teacher Preparation with Selected' Essential Conditions.'" *Journal of Music, Technology & Education* 9, no. 2 (2016): 161–73. doi:10.1386/jmte.9.2.161_1

[19] Gilbert, 162.

[20] Sandra E. Trehub, Judith Becker and Lian Morley, "Cross-Cultural perspectives on music and musicality," *Philosophical transactions of the Royal Society of London,* no, 370, (2015): 2.

[21] Joel Maki, "The Intersection of Music Education and Cultural Diversity," Harbor Day School, May 7, 2024, https://www.harborday.org/.

musicians, educators, and other multidisciplinary art occupations must grow in their craft and incorporate technological elements that keep their work pertinent. In particular, the proliferation of digital technologies revolutionized music education by offering new avenues for learning, collaboration, and creative expression. Studies have shown that technology integration in music education can enhance student engagement, motivation, and learning outcomes.[22] Platforms with interactive music software, virtual instruments, and online learning resources allow students to explore music innovatively and develop digital literacy skills essential for success in the 21st century.[23]

Evidence from research studies and case studies underscore the transformative impact of digital teaching tools on improving learning outcomes across diverse educational settings, demonstrating positive correlations between integrating digital tools and enhanced student achievement, engagement, and overall academic performance. For instance, a comprehensive meta-analysis published by the Stanford University Educational Evaluation and Policy Analysis journal synthesized findings from dozens of studies. It concluded that classrooms leveraging digital resources exhibited statistically significant improvements in student learning outcomes compared to traditional instructional methods.[24] Thus, students exposed to digital tools can demonstrate higher comprehension, retention, and critical thinking skills across various subjects and grade levels when using digital tools effectively. Furthermore, longitudinal studies tracking the implementation of digital teaching tools in schools yield promising results. Data collected

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[22] Naykki et al., 5.

[23] Keane, "The Imperative of Educational Technology: Why Teachers Must Embrace it in 2023."

[24] Dorottya Demszky, Jing Liu, and Chris Piech, "Can Automated Feedback Improve Teachers' Uptake of Student Ideas? Evidence From a Randomized Controlled Trial in a Large-Scale Online Course," *Educational Evaluation and Policy Analysis* (2023): 3.

from blended learning programs documented a significant increase in standardized test scores among students following the adoption of a digital learning platform designed to personalize instruction and provide real-time feedback in conjunction with a requirement of attending one day of in-person learning.[25] Notably, students from grades K-12 demonstrated significant gains, highlighting the potential of digital tools to mitigate achievement gaps and foster equity in education.

Moreover, research has shown that digital tools enhance student engagement by catering to diverse learning styles and preferences. A study detailing the impact of gamification on how student personalities affected their gamified learning experience found that various interactive multimedia presentations captured mainly introverted students' and less extroverted students' attention and fostered intrinsic motivation and a sense of ownership over their learning process.[26] As a result, students exhibited higher levels of participation, enthusiasm, and self-directed learning behaviors, leading to improved academic outcomes. Additionally, a case study of schools implementing project-based learning initiatives supported by digital collaboration platforms documents significant gains in students' critical thinking, problem-solving, and collaboration abilities.[27] Employers increasingly value these skills, which are crucial for navigating an ever-changing global landscape.

The Department of Education adds that implementing assistive technology solutions for students with disabilities can demonstrate remarkable improvements in access to curriculum

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[25] Heather Staker, "The Rise of K-12 Blended Learning," U.S Department of Education, May 7, 2024, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://files.eric.ed.gov/fulltext/ED535181.pdf.

[26] Rodrigo Smiderle et al.,"The impact of gamification on students' learning, engagement and behavior based on their personality traits," *Smart Learning Environments,* no.7 (3), (2020): 2.

[27] Lu Zhang and Yan Ma, "A study of the impact of project-based learning on student learning effects: a meta-analysis study," *Frontiers in Psychology,* 14 (2023): 2.

materials, participation in classroom activities, and overall academic performance and that apps must account for these students rather than just being an added feature.[28] By removing barriers to learning, digital tools can empower all students to reach their full potential and contribute meaningfully to the music performance and learning community.

Students can learn of diverse art forms through digital media and carefully crafted curriculums; nearly all art embodies syncretism of varied typologies, putting a greater demand on social, cultural, and historical underpinnings behind each product.[29] Viewers perceiving artwork often miss the intent of the artist's aesthetic intentions because of a lack of these social, cultural, and historical foundations. Similarly, advanced sight-reading skills require the performer to interpret musical technicalities correctly and characteristically execute the composer's and the art or design-related collaborators' intentions; the performer must adopt the lens of those who created a piece to perform that piece effectively.[30] Interactive sight-reading apps like Prodigies inform students of the non-technical aspects of music reading by utilizing immersive visuals that concisely portray the musical work's intent.

Artists in the 21st century also produce and distribute content much differently, influencing how people and students consume their content and its ancillaries.[31] The commercial music industry no longer monopolizes the distribution, production, and value standards governing music. Modern production is democratized, placing producers and even performers in

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[28] "Guiding Principles for Use of Technology with Early Learners," Department of Education, May 7, 2024, https://tech.ed.gov/earlylearning/principles.

[29] Gillian M. Moriss-Kay, "The Evolution of Human Artisitc Creativity," *Journal of Anatomy 216,* no. 2 (2010): 158.

[30] Ibid., 171.

[31] James R. Bodiford, "Sharing Sounds: Musical Innovation, Collaboration, and Ideological Expression in the Chilean Netlabel Movement," (PhD diss., University of Michigan, 2017.) 11.

lofty positions over musical products.[32] Lawrence Lessig, the co-founder of the Creative Commons licensing platform, suggested more of a collaborative collective in a prolific technological age rather than an "all rights reserved" copyright culture, which provides endless opportunities for amateur artists and students to have access to an even more extensive repertoire of works to learn than before and expand upon.[33] Music curriculums involving technological resources diverge into traditional and contemporary works, all conglomerating traditional and avant-garde methods of performance, each potentially possessing unconventional approaches to music reading.[34] Music educators must have the pedagogical techniques and strategies to meet these growing changes in music education and performance.

Today's music industry also continues to ramify at an extensive pace, influencing society's culture.[35] For example, music streaming services significantly impacted consumer culture, allowing people to access vast libraries of content without the label-centric mediaries.[36] Students can easily access digital content, permitting them to listen, share, and collaborate. Record labels dominated the music industry during the twentieth century, making distribution challenging for independent artists. However, streaming services like SoundCloud democratized music, which trailblazed advertisement, production, and distribution methods in the new digital

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[32] Ibid.

[33] Ibid., 13.

[34] Tim Cain, "Theory, Technology and the Music Curriculum," *British Journal of Music Education,* 21, no. 2, (2004): 217.

[35] Diane Hughes et al., *The New Music Industries: Disruption and Discovery,* (Cham, Switzerland: Palgrave Macmillan, 2016): 1.

[36] Hughes et al., 1.

era.[37] Record labels now have less control over how, when, where, and how much people and students consume. Music educators can expose students to streaming services and countless other sources to learn and consume music literature by organizing activities on online platforms that display assignments, rubrics, deadlines, and discussions.[38] Conducting checks for understanding through student response systems in these platforms quickly informs the teacher where they must provide remedial instruction.[39]

With diverse technological strategies, music educators can assist elementary-age students from numerous cultures, utilize online applications to provide opportunities and resources to learn high-level sight reading skills, and ultimately foster cross-culture relationships and performance skills that will contribute to the evolving digital performing canvas.[40] In cross-cultural cohorts, language barriers can hinder effective communication between peers. However, learning platforms utilize translation tools to resolve these barriers, allowing teachers and students to communicate regardless of location, language, or time restrictions.[41]

Artists now use online platforms to connect with their audiences, profoundly altering relationships between fans and audiences.[42] Teachers can guide students to discover or learn about their favorite artists by accessing platforms like YouTube or

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[37] David Hesmondhalgh, Jones, Ellis, and Andreas Rauh, "SoundCloud and BandCamp as Alternative Music Platforms," Sage Journals 5, no.4 (2019): 5-6.

[38] Abid Haleem, Mohd Javaid, Mohd A. Qadri, and Rajiv Suman, "Understanding the Role of Digital Technologies in Education: A Review," *Sustainable Operations and Computers* 3, (2022): 275.

[39] Ibid., 276.

[40] Svetlana Karkina et al., "Performance Practice in a Pandemic: Training Ensemble Skills Using E-Tivities in Music Teacher Education," *Frontiers in Education,* no. 7 (2022): 13.

[41] Karkina et al., "Performance Practice in a Pandemic," 14.

[42] Ibid., 16.

Spotify to create playlists and collaborate with other students by sharing their findings. Likewise, information through the internet alone is already exuberantly abundant with many topics; social media increased this diversity of information outlets through individual platforms, which fostered the creation of online fan communities, all of which uniquely consume and distribute music and music experiences.[43] Instructors can incorporate fandom-related online activities to educate students on diversity within music, fan, and performance cultures. They can expose students to several genres, and they may gain valuable insight into relating vocal and instrumental nuances that are otherwise difficult to understand without experiencing them visually.

In short, societal changes, including globalization, digitalization, and cultural diversity, have reshaped the landscape of music education, presenting both challenges and opportunities for educators. By embracing cultural diversity, integrating technology, and advocating for equitable access to music education, educators can prepare students to thrive in an increasingly interconnected and diverse world. Furthermore, policy advocacy and collaboration with stakeholders are essential for ensuring that music education remains vital to a well-rounded music education for all students.

What Makes a Digital Teaching Tool Effective?

Each student is unique, with a distinct learning style. Using Figurenotes, Yousician or Prodigies provides teachers with various pedagogical approaches, techniques, and equitable music education for multiple learning styles.[44] These are apps representing the new curriculums

[43] Anindya Widita, "The Evolving Media Consumer Behavior: Fan Culture in Online Community," *J-MKLI* 2, no.1 (2018): 45.

[44] Kivijarvi, 10.

that embody the new strategies app developers create to make music more accessible to various learning levels. Apps such as these focus on user-friendly layouts (easily understandable terms, menu organization), scaffolding (how quickly can app features teach actual music reading?), and playback capabilities (availability of instruments, scrolling notation accuracy).[45] This section delves into the factors contributing to digital teaching tools' effectiveness. It explores how these tools can support theoretical frameworks such as constructivist pedagogy and connectivism, ultimately illustrating their impact on student learning and instructional practices.

Digital teaching tools can support a constructivist pedagogy, which posits that learning is an active, constructive process. Educators should investigate digital tools that facilitate experiential learning opportunities, enabling students to construct knowledge through exploration, experimentation, and interaction with digital content. For instance, the music notation app of choice should allow students to flexibly engage individually with musical concepts, experimenting with different notes and rhythms to see immediate auditory and visual feedback, thereby constructing their understanding of music theory through active learning. Digital tools must excel in providing differentiated instruction and creating tailored educational experiences to meet individual learner needs. Adaptive learning technologies can meet differentiated teaching criteria and automatically adjust the complexity of tasks based on the learner's performance, offering a personalized learning journey.[46]

In developing sight-reading strategies or activities, the apps should present notation exercises at varying difficulty levels, ensuring that students are neither bored with tasks that are

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[45] Dunbar, 39.

[46] Lou Pugliese, "Adaptive Learning Systems: Surviving the Storm," The Voice of the Higher Education Technology Community: Educause Review, May 8, 2024, https://er.educause.edu/articles/2016/10/adaptive-learning-systems-surviving-the-storm.

too easy nor frustrated with those that are too difficult. This approach can support the diverse learning styles and paces found in a classroom, ensuring that each student can access content in a way that best suits their learning needs. Gratifyingly, digital technologies can enable personalized approaches that predicate sophisticated algorithms and data analytics that assess a student's current knowledge level, learning pace, and preferences to adjust tasks' content, difficulty, and style in real-time, giving educators tangible data evidencing student achievement or failures.[47] By doing so, adaptive learning technologies can inform the educator on ensuring that each student is engaged in an optimally challenging learning environment that maximizes their potential without leading to frustration or disengagement. Educators can review the app's student assessments as well as view how students interact and perform within the apps. The systems can identify patterns in a student's responses or performances, pinpoint areas of strength and weakness, and conglomerate data in potentially less time than traditional pencil-paper grading methodologies.

Along with dynamically adjusting subsequent content, educators can partner with app suggestions, presenting students with tasks they feel are personal and appropriate for each student. This real-time adaptation by the technology as well as the educator can help maintain a 'zone of proximal development,' where students are consistently challenged beyond their current capabilities, or intrigued, fostering growth and learning.[48] Research in educational technology consistently highlights the effectiveness of adaptive learning systems in improving student outcomes. Studies have shown that students using adaptive learning platforms perform better on

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[47] Pugliese, "Rules-Based Adaptive Systems."

[48] "Math Learning in the Zone of Proximal Development," Dreambox Learning, May 8, 2024, https://www.dreambox.com/resources/blogs/math-learning-zone-proximal-development.

assessments, demonstrate higher engagement levels, and report greater satisfaction with their learning experience than traditional learning methods.[49] Therefore, educators should incorporate apps with adaptive learning technologies to improve students' sight-reading abilities, musical comprehension, and overall performance skills.

Digital tools can also support a connectivism pedagogy by facilitating access to a vast network of resources, collaboration with peers and experts worldwide, and learning from diverse perspectives. Educators should seek apps capable of collaborating on compositions, sharing performances with a global audience, and receiving feedback from peers and professionals. This interconnected learning environment can foster a deeper understanding of music as a worldwide language and prepare students for the collaborative nature of modern music performance in various settings.[50] By incorporating these contemporary pedagogical theories in app selection, educators can employ a multifaceted approach to education that emphasizes active, student-centered learning, accommodates individual differences, and leverages the power of networks. Ultimately, apps that fit these pedagogical approaches have the potential to transform music education, making learning more engaging, personalized, and connected.

Apps such as Prodigies teach notation by incorporating several visual elements, including shapes, colors, and letters, at the beginning of their curriculum. Students can control video playback, which allows tempo control, and a set of virtual hand bells underneath each video that they may touch to play with the material they learn. Prodigies

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[49] Kimberly Daugherty et al.,"Adjusting the Future of Adaptive Learning Technologies via a SWOT Analysis," *Intersection: A Journal at the Intersection of Assessment and Learning* 3 no. 2 (2022): 4.

[50] Guozhong Zhang, Jian Sun and Ying Sun, " Mapping Interdisciplinary Collaboration in Music Education: Analysis of models in higher education across North America, Europe, Oceania, and Asia," *Frontiers in Psychology* 14, (2023): 3

begins to mimic black-and-white, traditional notation throughout the curriculum by using fewer visual aids as students progress through content. Yousician features the same tools but gives students greater freedom to manipulate their content to fit their learning style. Students can change notation systems from colored shapes with letters to note heads with letters, colors, and other variants. Yousician also listens to student performance, marking timing, and pitch mistakes students can review after each performance. After reviewing feedback, students can work on the challenging sections and transitions to refine instrumental or vocal skills. According to a study on a similar app, Tonara, student practice time increased by sixty-eight percent due to its AI capabilities and detailed feedback.[51] These versatile tools can reveal what learning style suits a student best by using a proprietary scoring system, creating more independent learners who can practice at a more efficient pace.[52]

Perhaps the most vital components to assess in ascertaining the effectiveness of digital tools, especially in younger students, are engagement and motivation. The multimedia learning principle, as proposed by Richard E. Mayer, posits that people learn better from words and pictures than from words alone. This principle underscores the importance of well-designed multimedia content in education, which can significantly improve learning outcomes by catering to diverse learning styles and maintaining high student interest and motivation levels.[53] Therefore, educators should seek digital tools that incorporate an assortment of multimedia elements—such as video tutorials,

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[51] "How To Engage Students Utilizing Music Education Tools & Technology," Online Master of Music in Music Education, last updated August 1, 2021, https://musiceducation.arts.ufl.edu/.

[52] Ibid., "Music Education Tools Overview."

[53] Andrew DeBell, "How to Use Mayer's 12 Principles of Multimedia," Water Bear Learning, May 8, 2024, https://waterbearlearning.com/mayers-principles-multimedia-learning/.

interactive scores, and auditory feedback—which can enhance the learning experience. For instance, the aforementioned music notation apps often combine visual representations of musical notes with the corresponding sounds, enabling students to make connections between what they see and what they hear. This multisensory approach can cater to auditory and visual learners and enhance kinesthetic learners' engagement by allowing them to interact directly with the musical content through touchscreens or digital instruments.

Educators must consider digital tools that offer opportunities for personalization, allowing students to choose their learning paths, pace, and even the type of content they engage with. This level of personalization can foster intrinsic motivation as students feel more in control of their learning process. For example, students struggling with rhythm notation can spend more time on targeted exercises within an app, receiving immediate feedback and gradually increasing the difficulty level as their skills improve. This personalized approach ensures that students remain engaged and motivated, as they can see tangible progress in their learning journey.

Apps chosen should also mitigate the cognitive load that comes with music reading, which requires the simultaneous use of several mental processes. Music educators should select apps that support scaffolding pedagogical strategies by developing these processes separately, thereby easing the initial cognitive load.[54] According to a study on semiotics in linguistics for young children, verbal descriptions, in conjunction with enriching visuals, develop children's interpretation of semiotic

[54] Kivijärvi, 15.

relationships between text and verbal expressions.[55] The findings suggest that picture books guide students into social and cultural multimodalities.[56] Prodigies utilizes enriching visuals incorporating foods and their syllables to teach rhythm. The foods visually correspond with traditional rhythms; a pair of cherries represents a pair of eighth notes, a beet represents a quarter note, and four avocados represent sixteenth notes—other visuals within the Prodigies curriculum support musical context, such as backgrounds and kinesthetic movements.

Elementary students can also benefit from their learning experience embodying gamification. Gamification transforms traditional lessons into enhanced online experiences that allow students to explore and choose content to invest in, earning various status achievements and creating intrinsic motivation.[57] Creating student-centered environments for students is paramount. Brain research reveals that the first decade of life is crucial in learning and development because of the brain's malleability.[58] Educators can cultivate musical development through child-like spontaneity, vitality, and inventiveness. Children must play and discover the intricacies of sight-reading and all its technical facets through gamification. In comparison, adults naturally lose aspects of child-like curiosities and creativity.[59] Therefore, music educators need to understand the cognitive

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[55] Ika L. Damayanti, Nicke Y. Moecharam, and Firly Asyifa, "Unfolding Layers of Meanings: Visual-Verbal relations in Just Ask--a Children's Picture Book, Indonesian Journal of Applied Linguistics 11, no. 2 (2021): 372.

[56] Ibid., 373.

[57] John McCarthy, "Using Gamification to Ignite Student Learning," Edutopia, Accessed December 13, 2023, https://www.edutopia.org/article/using-gamification-ignite-student-learning.

[58] Burton, and Taggart, 10.

[59] Ibid.

processes behind gamification in music pedagogy to effectively observe and facilitate natural play among children, particularly in the context of sight-reading.

Educators should also consider the cost-effective aspects digital tools can offer. Apps should be cost-effective and scalable within educational institutions. Unlike traditional methods, which can incur significant costs for procurement of physical resources, storage, and periodic updates for those resources, digital alternatives present a more sustainable and economical solution.[60] The apps chosen by the educator should update digital content regularly and ensure that students and educators can access the latest information, research findings, and educational materials. Naturally, this alternative can resolve some issues typical of traditional methods, such as frequent textbook replacement, storage, and updates.

Moreover, educators should investigate the scalability of their digital teaching tools to mitigate the constraints of physical resources, allowing schools to accommodate growing student populations and evolving curriculum requirements more efficiently.[61] The digital content should be easily replicated and distributed across multiple devices, classrooms, and geographic locations, facilitating widespread access to high-quality learning materials. Facilitating resources can disencumber educators from purchasing unnecessary items and focus their budgets on the utmost quality of items, such as instruments or performance opportunities.

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[60] Mohsen Pakdaman et al., " Evaluation of the Cost-Effectiveness of Virtual and Traditional Education Models in Higher Education: A Systematic Review," *Health Technology Assessment in Action* 3, no. 1 (2019): 4.

[61] Emma Jones, "Personalized Learning For All: Meeting The Scalability Challenge in Online Education," eLearning Industry, May 9, 2024, https://elearningindustry.com/personalized-learning-for-all-meeting-the-scalability-challenge-in-online-education.

Digital tools should also accommodate remote and distance learning environments. Recent global events have necessitated the potential emergency transition to online education in case of another crisis, and digital resources have proven indispensable in ensuring the continuity of learning despite any physical constraint.[62] Educators should seek apps that leverage cloud-based technologies to deliver educational content seamlessly to students regardless of location, enhancing inclusivity and accessibility.

The cost-effectiveness of the chosen digital teaching tools should extend beyond initial implementation to encompass long-term savings in operational expenses. By reducing reliance on physical infrastructure, such as printing and distribution costs associated with traditional textbooks, schools can reallocate resources toward enhancing teaching quality, investing in professional development initiatives, and addressing other pressing educational needs.

The criteria to ascertain the effectiveness of digital teaching tools extends far beyond their technological capabilities; it lies in their ability to align with contemporary pedagogical theories to meet the diverse needs of learners. From adaptive learning platforms to gamified experiences, digital tools should provide personalized instruction, collaboration, and engagement opportunities. Digital tools should enhance learning outcomes and promote inclusivity, scalability, and cost-effectiveness within educational institutions. All teaching warrants careful consideration; therefore, educators should leverage their full potential by creating transformative learning experiences that empower students to succeed in the digital age.

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[62] Panos Photopoulos et al., "Remote and In-Person Learning: Utility Versus Social Experience," *SN Computer Science* 4, no. 2 (2023): 116.

What is the Importance of Sight-Reading?

Sight-reading stimulates many brain functions, including fixations, saccades, perception, attention, memory, and audiation.[63] Within audiation processes lies sub-categories relating closer to sight-reading ability, including momentary retention, imitation, tonality, tonal and rhythmic patterns and their organization, and prediction.[64] Fixations and saccades are the motor functions in the eyes that track one object to the next.[65] This function is essential because of the need to track individual notes. Understanding these cognitive functions will provide the researcher with research that creates better research instruments.

Further, among all these processes, audiation is perhaps the most important. Audiation is how sounds are perceived and how the body reacts to those sounds.[66] An essential facet of audiation is how much this cognitive process is stimulated, especially in new sight-reading technologies. These new technologies also replicate many new gaming platforms, which may connect students more to content than traditional strategies.[67] Yousician aids in student perception of pitch and rhythm accuracy by providing colored, written feedback in real-time that may help refine students' audiation. These new technological advancements allow students additional opportunities to advance their music comprehension through sight reading.

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[63] Sarah I. Houghton, "Finding the Right Note: The Strategy Use of Eighth Grade Choral Students during Vocal Sight-Reading," (PhD diss., Boston University College of Fine Arts, 2018), 15.

[64] Ibid.

[65] Natalia Chitalkina et al.,“Handling of Incongruences in Music Notation during Singing or Playing," *International Journal of Music Education* 39, no. 1 (February 2021): 5.

[66] Chitalkina et al., "Handling of Incongruences," 5.

[67] McDowall, Gower, "Interactive Music Video Games and Children's Musical Development," 92.

Sight-reading is essential for developing musical literacy, akin to the role of reading in language acquisition. Just as literacy in language allows individuals to access a vast array of information and cultural knowledge, musical literacy, facilitated by sight-reading skills, opens the world of music to learners.[68] Fluent sight-reading can enable students to explore a broad repertoire, understand musical structures, and appreciate the nuances of different genres and styles. Proficient sight-readers can quickly interpret musical scores and deliver performances with accuracy and expression.[69] This skill is precious in ensemble settings, where musicians must often perform new pieces with limited preparation time.[70] Naturally, sight-reading can foster independence among musicians, allowing them to learn and practice new pieces independently, accelerating their learning process and expanding their repertoire.

Besides developing musicianship, research shows that music engages multiple cognitive processes, including visual perception, pattern recognition, motor coordination, and memory.[71] These cognitive demands stimulate brain development and enhance neural connectivity. Sight-reading, which requires simultaneous pitch, rhythm, dynamics, and articulation processing, can improve attention, multitasking, and problem-solving skills.[72]

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[68] Arild Stenberg and Iam Cross, "White spaces, music notation and the facilitation of sight-reading," *Scientific Reports* 9, no. 1 (2019): 1.

[69] Scott Dirkse, "A Survey of the Development of Sight-Reading Skills in Instructional Piano Methods For Average-Age Beginners and Sample Primer-Level Sight-Reading Curriculum," (Master's Thesis, University of South Carolina, 2009): 1.

[70] Ibid., 2.

[71] Muriel T. Zaatar, et al., "The transformative power of music: Insights into neuroplasticity, health, and disease," *Brain, Behavior, & Immunity-health,* 35, (2023): 1.

[72] Ibid., 2.

These cognitive benefits can extend beyond music, contributing to learners' overall intellectual growth.

For aspiring professional musicians, sight-reading is an indispensable skill. Auditions for orchestras, bands, and other musical ensembles often include sight-reading components to assess candidates' ability to adapt to new music quickly.[73] Furthermore, studio musicians, accompanists, and music teachers frequently encounter situations requiring proficient sight-reading. Thus, mastering this skill is critical for success in various musical careers. Sight-reading can encourage a mindset of lifelong learning and curiosity.[74] Musicians with solid sight-reading skills are more likely to explore unfamiliar musical territories and continue their musical education throughout their lives. This exploratory approach may enrich their musical experience, promote continuous improvement, and nurture a lasting passion for music.

Given the importance of sight-reading, music educators must prioritize its development from the early stages of instruction. Incorporating sight-reading exercises into daily practice, using technology-based tools for interactive learning, and creating opportunities for ensemble sight-reading can significantly enhance students' proficiency. Educators should also emphasize the connection between sight-reading and broader musical skills, ensuring students appreciate its value and remain motivated to improve.

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[73] Dirkse, "A Survey of the Development of Sight-Reading Skills in Instructional Piano Methods For Average-Age Beginners and Sample Primer-Level Sight-Reading Curriculum," 3.

[74] Ibid., 4.

Connecting With The Current Generations

New gamification educational strategies are an excellent way of connecting with a generation that values video games and understanding video games' role as a vital element in child youth culture.[75] As educators, we must present content in a culturally contextual, relevant manner. Presenting content in a game-like format will spark intrinsic motivation, nurture curiosity, and provide a sense of autonomy over a student's learning.[76] Many enjoy the emotions film scores bring to a movie; however, movies miss the crucial interactive component. Video games with compelling scores connect the players more with the content, and the scores and sounds may vary depending on player interaction.[77] These same components lie in musicianship, our ability to manipulate, understand, blend, and be a part of the sound.

Cinematics can also prime individuals to elicit particular emotions.[78] Students who have not experienced specific genres or music may have difficulty analyzing and developing an opinion on unfamiliar music. Cinematics may aid in informing emotional aspects of performing during sight-reading. Cinematics engenders vibrant contexts, evokes distinct emotions, and elongates the maintenance of subjective and psychological changes using stimuli adjacent to real life.[79] Instructors may assess prior knowledge or experience with specific sounds, teach music theory concepts through meaningful

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[75] Dirkse, "A Survey of the Development of Sight-Reading Skills in Instructional Piano Methods For Average-Age Beginners and Sample Primer-Level Sight-Reading Curriculum," 4.

[76] Ibid.

[77] Collins, 19.

[78] Luz Fernandez-Aguilar et al., "How effective are films in inducing positive and negative emotional states? A meta-analysis," *PLoS One* 14, no. 11 (2019): 2.

[79] Ibid.

listening activities, and guide or use preconceived notions about the role of particular sounds from personally experienced pop culture media to better connect students to the repertoire they sight read.[80] Various social media mediums are often an extension of young students' offline lives, filling the innate need for connections with friends; students connect, learn, and generate their perceptions of music by reading shared posts, blogs, and videos.[81]

Music alone can already create distinct moods that emanate particular periods. While students may superficially comprehend historical periods, combining cinematic and conducive musical elements possible through digital means can bring insight into ineffable historical events to a more understanding.[82] Cinematic elements can engage students in cross-cultural music cognition, a multimodal phenomenon in which students' cultural relationships and comprehensions of specific tonalities vary.[83] For instance, minor tonalities may not reflect what Western culture deems somber or lamentable. Each culture uniquely defines words, behaviors, and situations with varying degrees of intensity.[84] Instructors can teach varying forms of instrumental and vocal performance during sight-reading by showing students clips supporting the piece's overall tone. The instructor can also incorporate discussions that reveal students' cultural biases and teach

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[80] Garvin Brod, "Toward an understanding of when prior knowledge helps or hinders learning," *Science of Learning* 6, no. 24 (2021): 1.

[81] Gwenn Schurgin et al., "Clinical Report---The Impact of Social Media on Children, Adolescents, and Families," *American Academy of Pediatrics* 127, no.4 (2011): 804.

[82] Alyssa d'Artenay, "The Influence of Film Music on Emotion" (Capstone Projects and Master's Theses, California State University Music and Performing Arts, 2019): 4.

[83] Ibid., 6.

[84] Ibid.

critical thinking skills that compel students to make appropriate technical decisions when sight-reading.

Visuals ultimately draw an audience in. However, music keeps us attentive to the content; audiences subconsciously connect to the visuals with musical support.[85] Orchestral instrumentalists during the 1920s performed during silent films to provide the emotional content necessary to support the movie plot.[86] Any musician performing movie scores must understand the importance of emotion and how instrumental and vocal music evoke specific emotions to support a story. Regardless of the repertoire students sight-read, cinematics can connect them in a way that situates a piece's historical, emotional, and social aspects.

Instructors can also incorporate pop culture media and historical elements in sight-reading activities that can promote inclusivity and provide relatable, more digestible content that students from various backgrounds can get excited about and perhaps identify with to develop curiosity and excitement.[87] Digital tools catalyze transformative shifts in modern education, offering multifaceted benefits that empower teachers and students alike.[88] By facilitating meaningful engagement with content, digital tools can revolutionize instructional strategies and elevate learning experiences to new heights. Educators can tailor instruction to meet every student's diverse needs and interests

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[85] Ibid., 10.

[86] Ibid., 8.

[87] James Stanfield, "What Can You Teach With Pop Culture?" Pop Culture in The Classroom: How & Where to Incorporate It, last modified 2024, https://stanfield.com/pop-culture-in-the-classroom-how-where-to-incorporate-it/.

[88] Shengnan Wu, "Application of multimedia technology to innovative vocational education on learning satisfaction in China," *PloS one* 19 no. 2 (2024): 2.

through customizable learning platforms, adaptive software, and interactive multimedia resources.

For example, ELL students or students who struggle to learn language arts concepts may need assistive technology when learning a new language. Educators can use apps such as Book Creator, Flip, Seesaw, and many others in English class, each of which exemplifies how digital tools foster personalized connections with students.[89] These apps transcend traditional modes of expression by allowing students to create and share multimedia narratives, incorporating text, images, audio, and video elements. Students who may struggle with conventional written assignments can find solace in digital art and audio recordings. In contrast, others may discover newfound enthusiasm for storytelling, drawing inspiration from their favorite books and movies. Teachers can forge deeper connections with students through this personalized approach, fostering trust, rapport, and a sense of belonging in the classroom.

Moreover, digital tools facilitate ongoing professional development for educators, enriching teaching practices and promoting a culture of innovation.[90] Online courses, webinars, and collaborative platforms can provide opportunities for teachers to enhance their skills, stay abreast of educational trends, and exchange ideas with colleagues globally. By continuously refining their craft, educators can better meet the evolving needs of their students and embrace the limitless potential of technology in education.

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[89] Jeff Knutson, "How to Use Technology to Support ELLs in Your Classroom," Common Sense Education, Accessed May 10, 2024, https://www.commonsense.org/education/articles/how-to-use-technology-to-support-ells-in-your-classroom.

[90] A. E. Adeshina, "The Transformative Role of Digital Resources in Teaching and Learning," *Open Journal of Education and Development,* 5(1), (2024): 6.

In addition to empowering teachers, digital tools facilitate collaboration and communication among students, educators, and parents, creating a seamless ecosystem of support and feedback. Peer-to-peer interaction, facilitated by forums, shared workspaces, and peer review systems, enhances learning outcomes by exposing teachers and students to diverse perspectives and building essential communication skills.[91] Real-time collaboration tools, including Digital Audio Workstations (DAWs), can mimic the collaborative nature of the modern workplace, preparing students for future professional environments where teamwork and remote collaboration are increasingly common.

For instance, in music education, students can collaborate on composing a piece of music using a DAW that simultaneously supports multiple users. This real-time collaboration enhances students' musical understanding and performance skills and can foster a deeper appreciation for the collaborative nature of music-making. By leveraging digital tools like DAWs, educators can create dynamic learning experiences that inspire creativity, foster collaboration, and empower students to thrive in an increasingly interconnected world. In essence, the empowerment of teachers and students through digital tools represents a paradigm shift in education, transcending traditional boundaries and embracing the transformative potential of technology.

Many digital teaching tools incorporate gamification elements, which can tap into students' natural desire for achievement and recognition, making the learning process a more game-like and enjoyable experience. Gamification has emerged as a powerful strategy in education, harnessing the intrinsic motivation of students to enhance learning outcomes.[92]

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[91] Adeshina, "The Transformative Role of Digital Resources in Teaching and Learning," 4.

[92] Michael Sailer et al., "How gamification motivates: An experimental study of the effects of specific game design elements on psychological need satisfaction," *Computers in Human Behavior* 69, (2017): 371.

Educators can create immersive learning experiences that captivate students' attention and drive their enthusiasm for learning by integrating elements such as points, badges, and leaderboards into digital teaching tools. These gamified elements make the learning process more enjoyable and instill a sense of accomplishment and progression, mirroring the dynamics of popular video games.

In music education, gamification holds immense potential to transform how students approach learning and practicing music. By incorporating gamified elements into music learning platforms and applications, educators can incentivize students to engage in regular practice sessions, tackle challenging pieces, and strive to master musical concepts and skills. For instance, students could earn points or badges for reaching certain milestones, such as learning a difficult passage or performing in front of an audience. Leaderboards could showcase students' progress and achievements, fostering a spirit of healthy competition and camaraderie among peers.

Research in the field of education has consistently demonstrated the positive impact of gamification on student engagement and motivation levels. Studies have shown that students who participate in gamified learning experiences exhibit higher levels of intrinsic motivation, persistence, and enthusiasm for learning. Gamification can be a powerful tool for motivating students to overcome challenges, develop their musical abilities, and cultivate a lifelong passion for music.

Integrating gamification elements into digital teaching tools is a promising avenue for enhancing student engagement in music education, motivation, and learning outcomes. By leveraging gamification principles, educators can create dynamic and immersive learning experiences that inspire students to explore, create, and excel in their

musical pursuits. As technology continues to evolve, the potential for gamification to revolutionize music education and cultivate a new generation of passionate musicians is boundless.

Summary

Chapter Two presents a literature review and exploration of theoretical frameworks that underpin the study's focus on leveraging digital tools to enhance sight-reading. This chapter discusses five key categories: exploring the various learning outcomes through digital tools, how societal change impacts what strategies are most pertinent in today's educational climate, essential facets to consider when considering using digital tools, why sight-reading is vital in music education, and how digital tools can help connect with current generations.

Constructivism, Connectivism, and Differentiated Instruction are foundational theories that inform the highlighted strategies in this literature review. Constructivism emphasizes experiential learning, where students actively engage in music-making and reflection. Connectivism highlights the importance of digital networks and technology in facilitating personalized learning experiences. Differentiated Instruction focuses on tailoring educational approaches to meet diverse student needs, abilities, and interests, ensuring that every learner can access and engage with music education meaningfully.

Beyond merely providing individualized learning opportunities, digital tools can enhance cognitive, affective, and psychomotor domains. These tools support critical thinking, creative problem-solving, emotional engagement with music, and the development of fine motor skills necessary for musical performance. Integrating digital

tools in music education can cater to diverse learning styles, promote higher-order thinking skills, and foster a deep, emotional connection to music.

Societal changes concerning technological advancements and cultural shifts necessitate an evolution in music education practices. The impact of educational policies, the importance of STEAM education, and the role of technology in preparing students for future music careers all warrant revised strategies in the music classroom. Digital tools can bridge gaps between traditional music education methodologies and the demands of the contemporary music world, facilitating cross-cultural learning and enhancing digital literacy among students.

To assess the effectiveness of digital teaching tools, educators should investigate user-friendly designs, adaptive learning technologies, and multimedia elements that engage students and support diverse learning styles. These elements highlight the theoretical frameworks, illustrating how digital tools embody constructivist, connectivist, and differentiated instructional principles in practice.

Finally, gamification strategies can engage contemporary students, who are digital natives accustomed to interactive and multimedia-rich environments. Digital tools can make music education more relevant, engaging, and effective for today's learners by incorporating elements of popular culture, fostering collaborative learning, and utilizing cinematic techniques to enhance emotional and cultural understanding of music. The role of digital tools is to modernize music education to meet the needs of diverse learners. By integrating theoretical insights with practical applications, digital tools can transform music education, making it more accessible, engaging, and aligned with contemporary societal and educational contexts.

Chapter Three: Methods

Introduction

Chapter three incorporates the research design, hypothesis, participants and setting, description of intervention, and data collection procedures. Each component centers around an observational approach where the researcher gathers information and conducts regular informal assessments with participants. The researcher will not conduct research from a fixed position but will allow participants to be fully aware of the research methods, potentially providing more authentic data.

Design

The research design guiding this study is experimental, a method of conducting an experiment that allows the researcher to control the study variables and make causal inferences about the relationship between the independent and dependent variables.[1] This study will utilize a mixed-method approach to assess the effectiveness of digital notation apps on student learning in music education. This design allows for the manipulation of independent variables (the use of music notation apps) to observe their effect on dependent variables (students' sight-reading skills) while also collecting qualitative data through surveys to gain insights into students' experiences and perceptions.

The rationale for choosing an experimental design with a mixed-method approach is to establish a causal relationship between using digital notation apps and improving sight-reading skills among fourth-grade students. This design combines the rigor of quantitative methods to test hypotheses and measure outcomes with the depth of qualitative methods to explore the

[1] Ronald A. Fisher, *Experimental Design: A Complete Guide* (New York: Hafner, 1971), 3.

nuances of students' learning experiences and perceptions. The experimental component allows for a controlled investigation of the apps' effectiveness, providing strong evidence of causality. At the same time, the qualitative component should enrich the findings by capturing the complexity of students' interactions with technology and its impact on their learning processes.

Participants

The sample for the study is twenty-fourth-grade students from demographics of 52% White, 30% Hispanic, 8% Black, 6% two more races, and 2% Pacific Islanders.[2] The gender ratio is 52% Male and 48% female. This study will represent a sample of twenty Black, White, and Hispanic students, 50% male and 50% female.[3] This school resides in Surprise, Arizona, within Maricopa County. The Surprise region's demographics are 63% White, 7% Black, 25% Hispanic, 2% Asian, and 2% with two or more races.[4] Surprise is a large suburban municipality with 85.5% land, is twenty miles from the significant capital (Phoenix), and is roughly twenty-five miles from the White Tank Mountains. [5] Western Peaks Elementary is a public school with 868 students and serves Kindergarten through fourth-grade students. Academically, 53% of fourth-grade Students meet the standard for language arts, and 37% meet the standard for Math.[6] Western Peaks overall ranks #341 in elementary schools.

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[2] "Western Peaks Elementary," School Digger, last modified 2024, https://www.schooldigger.com/go/AZ/schools/0269002679/school.aspx, 1.

[3] Ibid.

[4] "City of Surprise Demographics," Surpriseaz.gov, last modified July 1, 2023, https://www.surpriseaz.gov/491/Demographics, 1.

[5] Ibid.

[6] "Western Peaks Elementary," School Digger.

Setting

This applied study will occur in a suburban area in the Dysart district with a population of fourth-grade students with various male and female participants. Western Peaks Elementary School's average ratio from teacher to student is one to thirty. Additionally, Western Peaks is an STC school with ongoing cases determining which students need special services as they progress through kindergarten to first grade. Students who did not start at Western Peaks may need these additional services, so the total sum of students needing services is unknown.

Instrumentation/Data Collection Method

This applied studies instrumentation will utilize a thesis. After students complete all coursework from the curriculum, students will complete a six-question survey. The survey will ask questions that will gauge students' interest, engagement, and possible issues with the digital notation systems. Additionally, students can provide qualitative insights into their experience with the curriculum. In the survey listed in Appendix B, question six states, "Provide additional comments about your experience with digital notation apps, such as what else you have enjoyed or disliked about using them this year." Question six allowed students to write qualitative insights documented in the data analysis tables.

Procedures

The scales of measurement will be a six-question multiple-choice pre-assessment requiring students to reflect on their performance of the passage at the top of the page, which will comprise of quarter and half rhythms and pitches C, D, and E. Students will sight read traditionally, then use Noteflight to input the passage from their pre-assessment, listen to the passage on Noteflight, perform with Noteflight's scrolling mode, then re-attempt the pre-

assessment traditionally. The instructor will base scoring procedures on students' ability to recognize timing and pitch errors. The assessment will be a pass-fail assessment, failing to indicate students cannot differentiate their performance from what they hear in Noteflight, and passing means the student can recognize one to several of their mistakes and use Noteflight effectively to customize their practice session. Students will complete the pre-assessment during the first to second day of their class's monthly rotation in music the study begins, which will take roughly twenty to thirty minutes. Fourth-grade students at Western Peaks have five days of music each month, and therefore, the pre-assessment data needs a month to accrue. The instructor will conduct the post-assessment in a like manner, encompassing all identical components after students receive training from the curriculum.

The instructor conducted the study through four of the nine months of a school year. The first month of the school year encompassed the data collection month for the pre-assessment. Before the assessment, the instructor obtained parent consent and IRB approvals from Liberty and Dysart District. The instructor implemented the technological sight-reading curriculum to train students and use traditional assessment strategies. The instructor implemented technological strategies through experimental methods. Once all fourth-grade students complete the pre-assessment, students began learning rhythms and note names on Orff instruments first through the Prodigies curriculum. Students simultaneously learned solfege and mallet techniques. Each Orff instrument followed the same color scheme as the Prodigies curriculum. Each colored and guided exercise had a corresponding black-and-white, traditional exercise. The curriculum will start with simple whole, half, and quarter note rhythms, then progress to more complicated rhythms throughout the year. Families also created an account for the Yousician curriculum to provide individual practice time and individual feedback. Yousician is one of the many new

curriculums that embody app developers' new strategies to make music more accessible to various learning levels. Apps such as these focus on user-friendly layouts, easily understandable terms, menu organization, scaffolding- how quickly app features can teach actual music reading, playback capabilities, availability of instruments, scrolling notation accuracy and many other measurements that aid in making music content more accessible to learn.[7]

Researcher Positionality

Before presenting the findings and illicit self-reflexivity, it is essential to note the author's educational, cultural, and social background. Technology became the prominent vehicle for educational provisions in 2014. From then on, students required proficiency in various applications to complete assignments. College education became saturated with different academic platforms to facilitate access to instructors, assignments, and supplementary digital resources beneficial for future careers. Concurrently, social media has become ubiquitous, and numerous businesses and entertainment outlets communicated through it, naturally influencing how academic and professional endeavors were managed. Thus, individuals were encultured to act within the confines of digital workspaces in personal and social settings. The author acknowledges the inculcation technology plays on this researcher's bias. However, this study includes aspects of both the technological as well as traditional methods of educational tools in favorable settings for each, allowing the students to assess the difference and complete the survey objectively and appropriately.

[7] Laura Dunbar, "Free Notation Apps: What is Out there?" *General Music Today (Online)* 29, no. 2 (2016): 39.

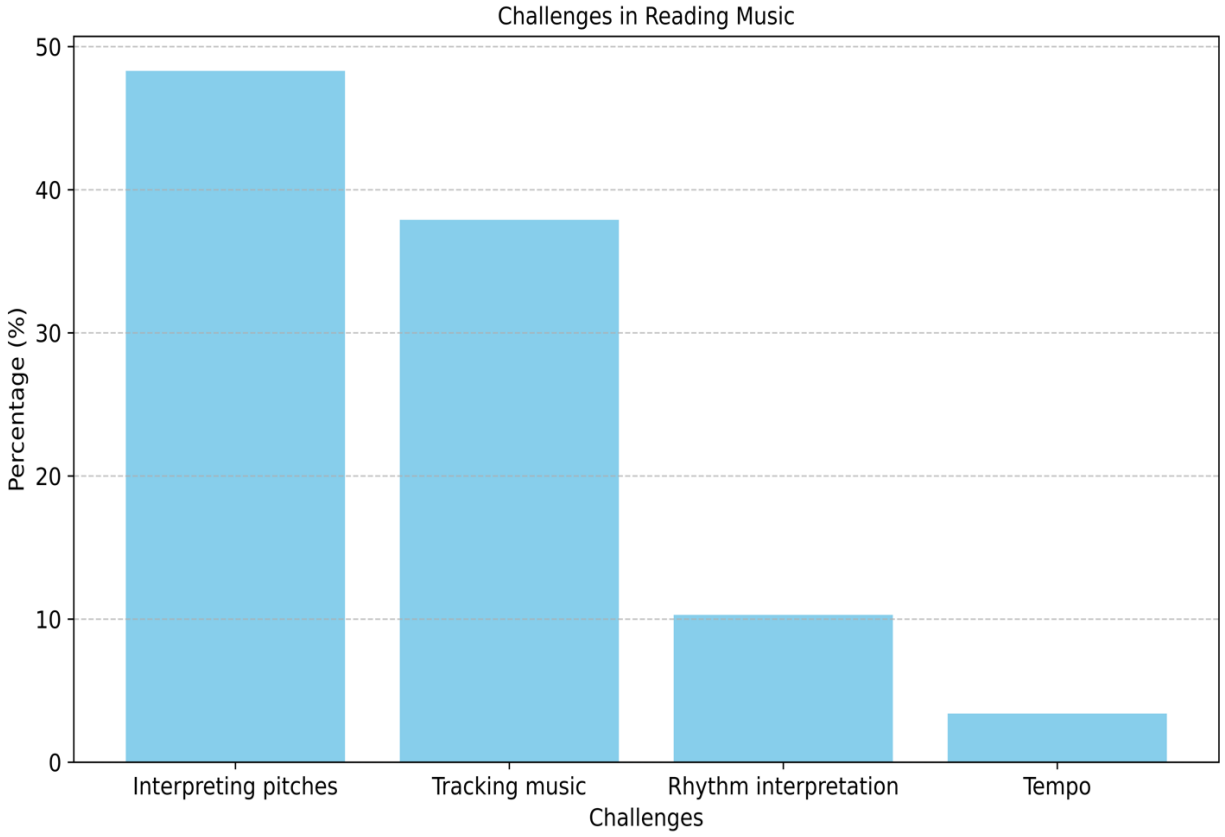
Data Analysis

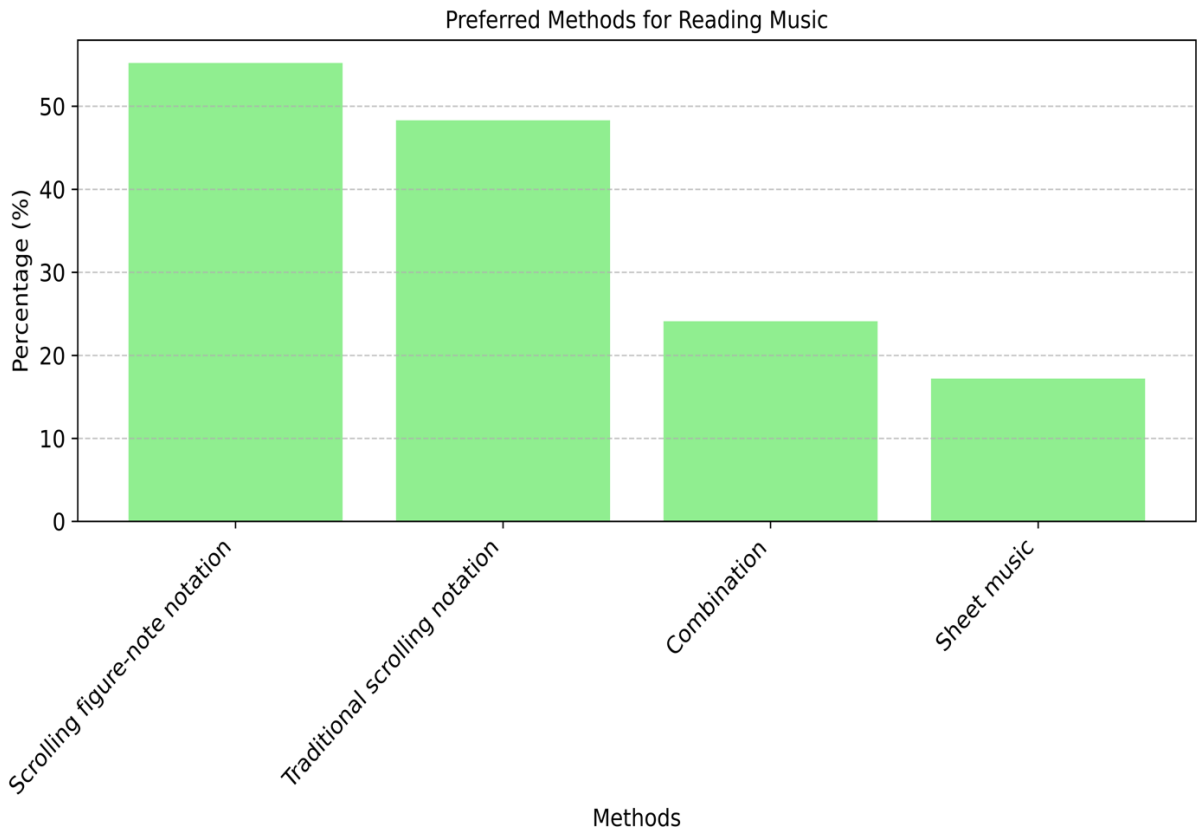
Each iteration of the research project provided unique results in some facet or another. The differing results are likely due to students' technological proficiency skills across iterations. The first iteration of 29 fourth-graders out of 117 at western peaks for this research project revealed key findings. In the survey of 29 fourth graders, nearly half, 48.3%, reported struggling with interpreting pitches when reading music, while over a third, 37.9%, found tracking the music challenging. 10.3% reported difficulties with rhythm interpretation, and 3.4% struggled with tempo.

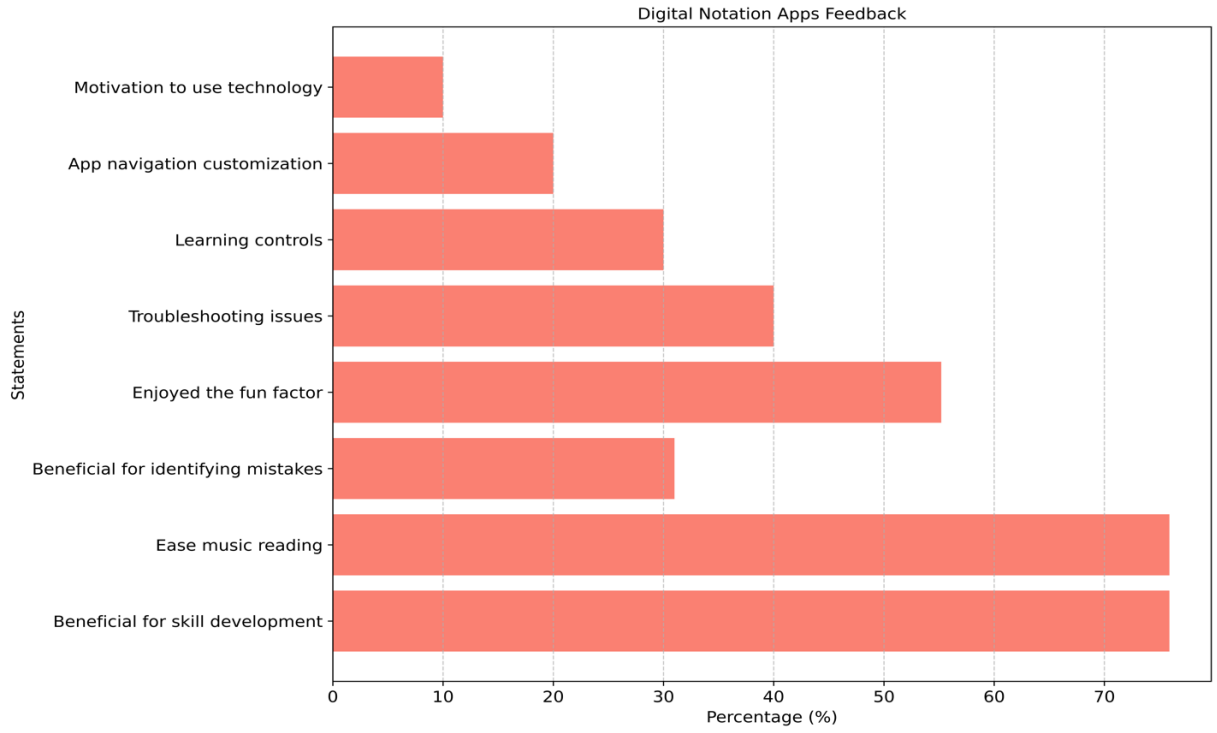
When asked about their preferred method for reading music, the majority, 55.2%, favored scrolling figure-note notation. Nearly half, 48.3%, selected traditional scrolling notation, a quarter, 24.1%, preferred a combination, and 17.2% chose sheet music. Regarding digital notation apps, 75.9% of students found the apps beneficial for skill development, and 24.1% disagreed. 75.9% believed apps ease music reading, 31.0% found them beneficial for identifying mistakes, and 55.2% enjoyed the added fun factor. However, troubleshooting apps proved the most significant hurdle, with 40% facing issues. Students reported difficulty learning controls by 30%, app navigation customization challenged by 20%, and motivation to use the technology was a barrier by 10%.

The survey allowed the students to elaborate on each question either written on the survey or verbally as they completed sight-reading exercises. Regarding technical issues, 31% reported having crashes or glitches with apps often enough to disrupt their learning. Another 30% reported unfamiliarity with traditional notation due to a lack of practice or familiarization. 31% reported only having confidence in reading notation with color and letter because it allowed them to acclimate and participate in performance-related activities quickly.

A smaller subset of students revealed vital qualitative data with testimonies claiming students would rather hear and experiment with notation through composition apps. Students also claim that using an instrument became overwhelming because they learned two to three concepts simultaneously: instrument, technology, and reading technicalities. Students claim that not being comfortable in each domain influenced their success in both reading and instrument playing/singing.

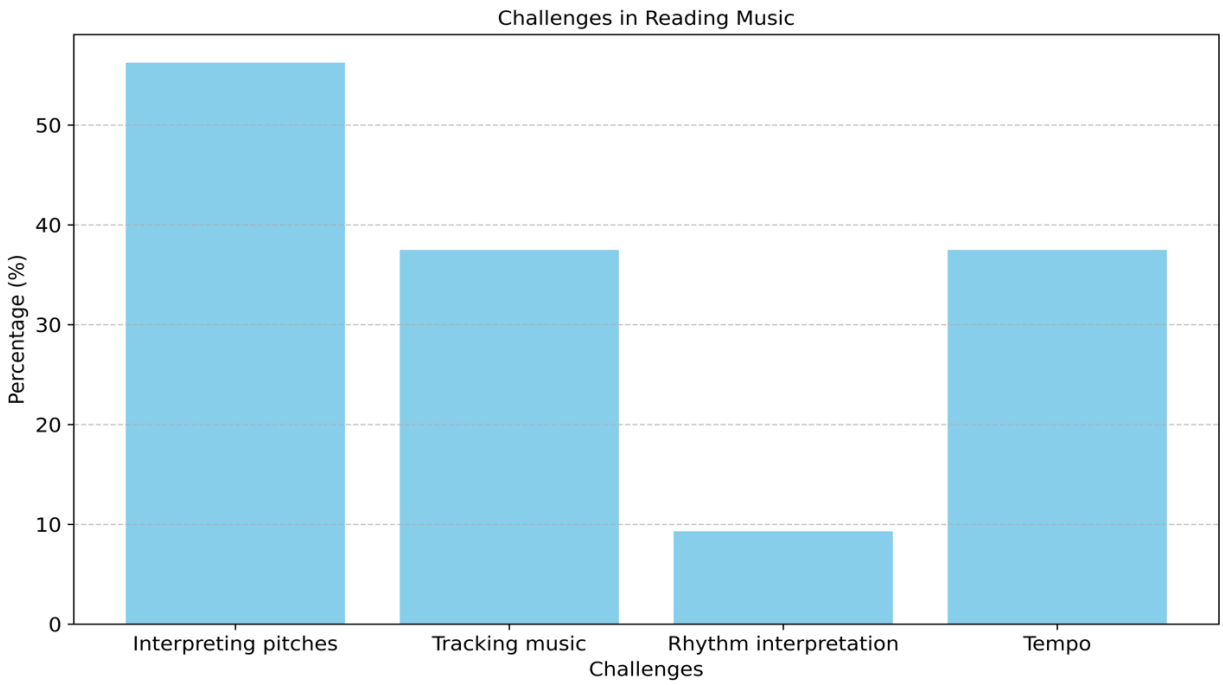



Preferred Methods for Reading Music
Percentage (%)
0
10
20
30
40
50
Scrolling figure-note notation
Traditional scrolling notation
Combination
Sheet music
Methods


Digital Notation Apps Feedback
Statements
Motivation to use technology
App navigation customization
Learning controls
Troubleshooting issues
Enjoyed the fun factor
Beneficial for identifying mistakes
Ease music reading
Beneficial for skill development
0
10
20
30
40
50
60
70
Percentage (%)

Data analysis from the second iteration of this research project investigating music-reading skills in fourth-graders at Western Peaks Elementary School revealed vital findings. Among 32 participants, 37.5% demonstrated difficulty with pitch tracking, 56.25% with pitch interpretation, 9.3% with rhythmic interpretation, and 37.5% with tempo consistency. Regarding notation preference, 12.5% favored traditional sheet music, 25% preferred conventional scrolling notation, 59.3% preferred scrolling figure-note notation, and 12.5% indicated a combination preference. Notably, 78% of participants reported perceiving digital notation as beneficial for skill development, while 18.75% disagreed. Further investigation revealed that 46.8% agreed that the tools within these applications eased music reading, 59.3% agreed they aided in error recognition, and 25% perceived them as enjoyable. However, challenges with app usage were also identified, with 47% reporting difficulties remembering controls, 16% experiencing frequent malfunctions, 28% struggling with customization, and 9% expressing a preference for alternative methods.

Additionally, qualitative observations from a small subset of students suggested concerns regarding excessive variables within the applications, a preference for learning through composition apps, and a desire for screen-free practice opportunities. Notably, one student reported improved pitch recognition after utilizing colored notation. The student claimed to have a more general idea of the pitch spatially.


Challenges in Reading Music
Percentage (%)
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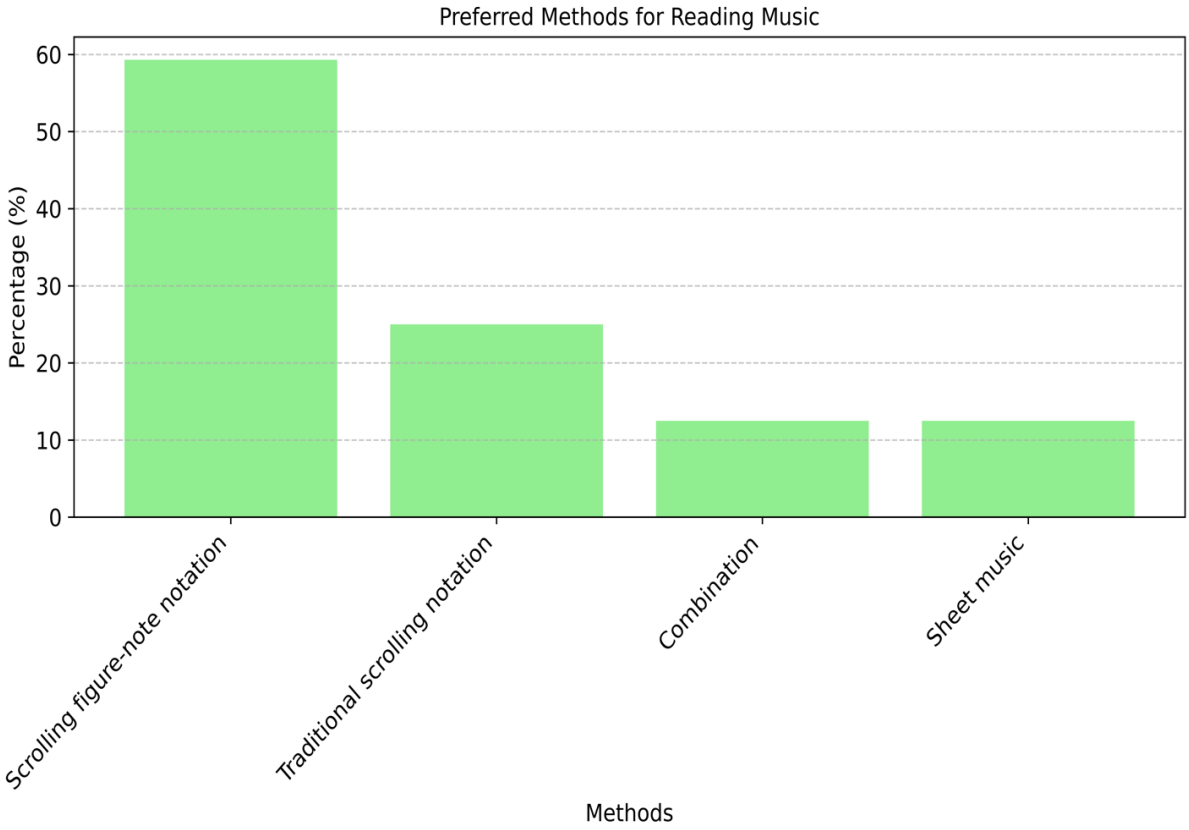
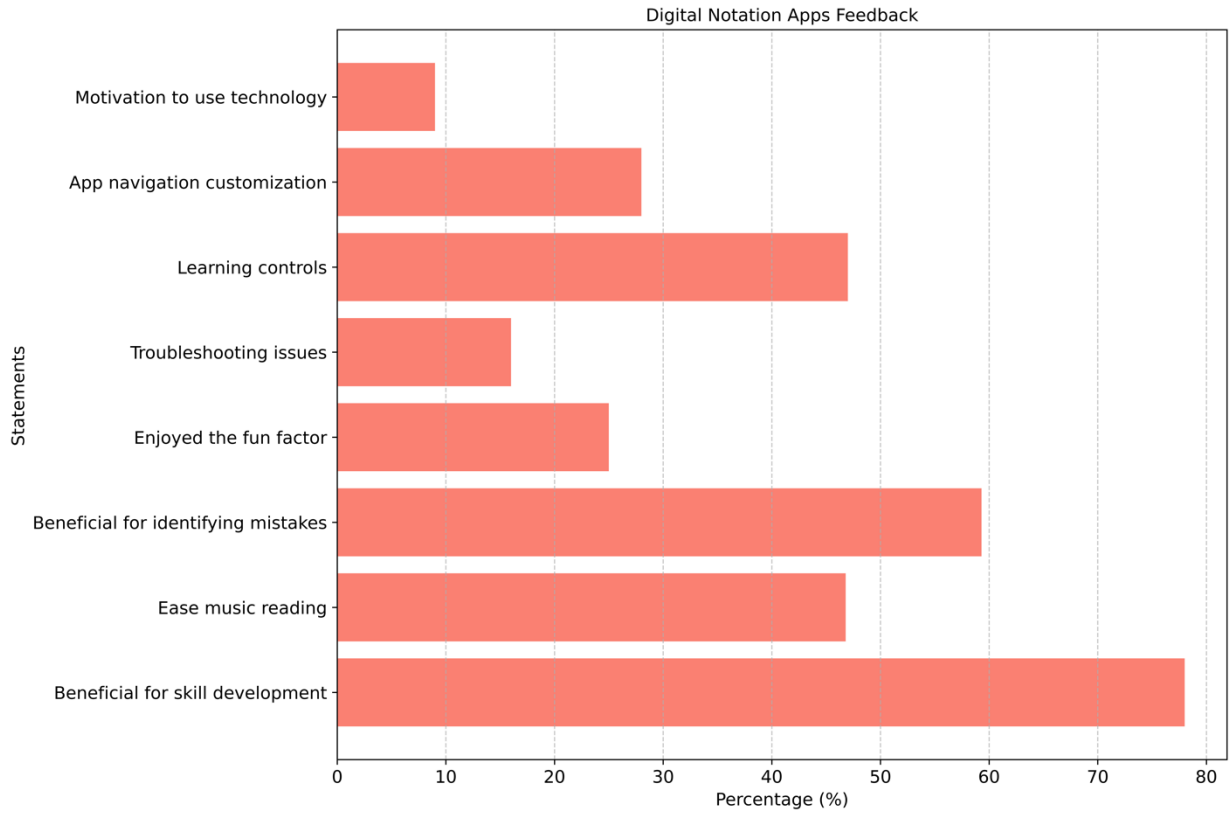
30
40
50
Interpreting pitches
Tracking music
Rhythm interpretation
Tempo
Challenges

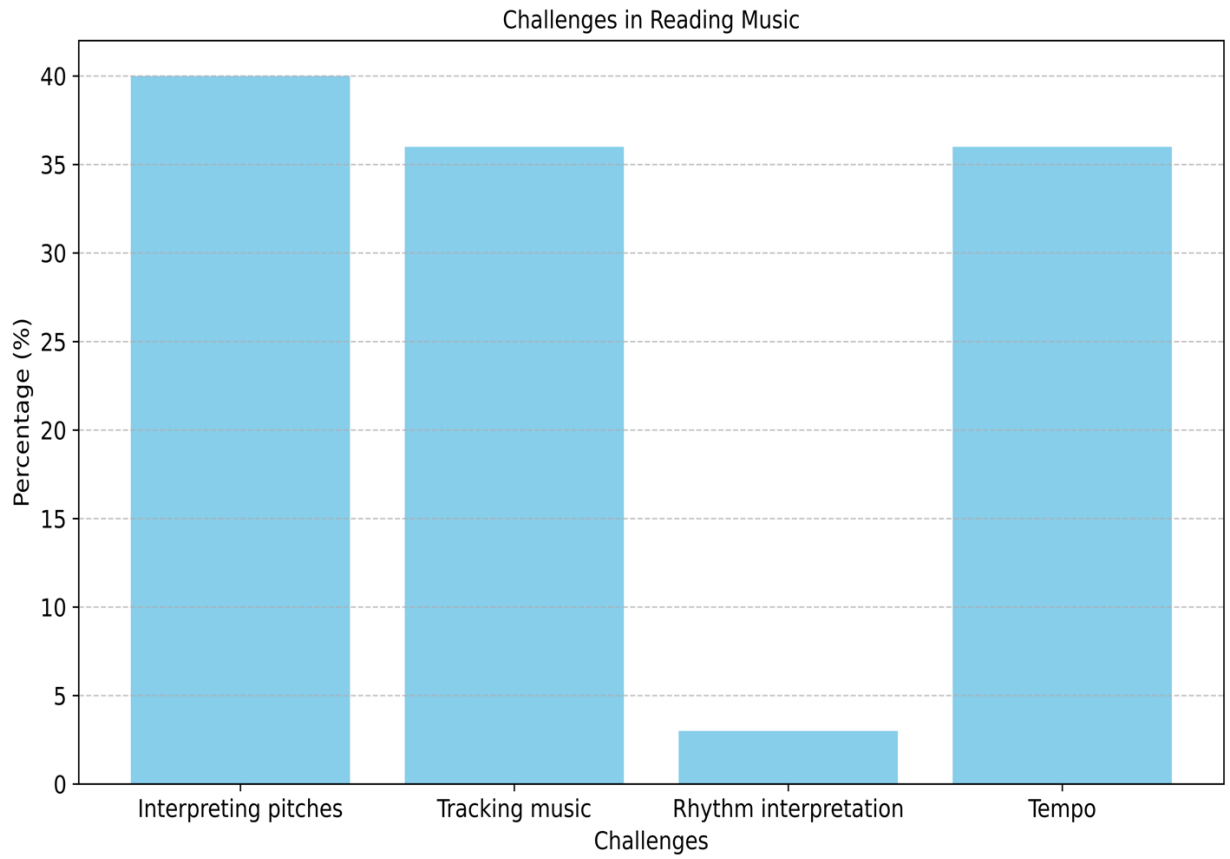

Preferred Methods for Reading Music
Percentage (%)
0
10
20
30
40
50
60
Scrolling figure-note notation
Traditional scrolling notation
Combination
Sheet music
Methods

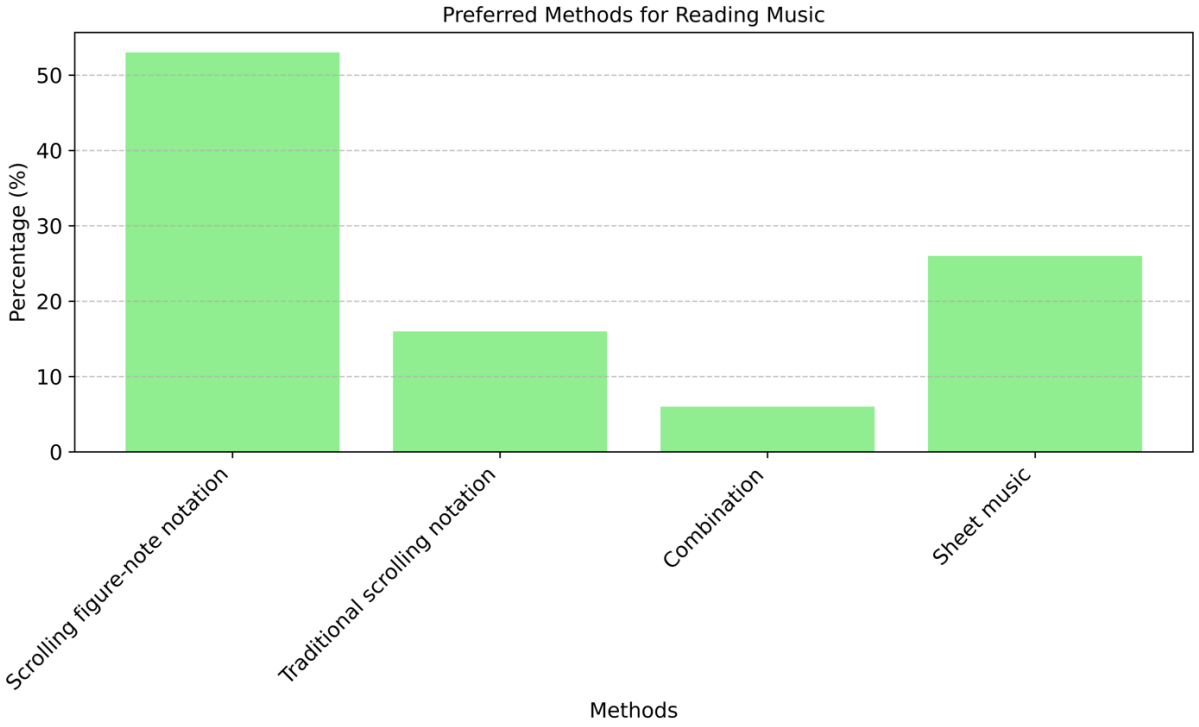


Data analysis from the third iteration of this research project investigating music-reading skills in fourth-graders at Western Peaks Elementary School revealed similar findings. Among 30 participants, 36% demonstrated difficulty with pitch tracking, 40% with pitch interpretation, 3% with rhythmic interpretation, and 36% with tempo consistency. Regarding notation preference, 26% favored traditional sheet music, 16% preferred traditional scrolling notation, 53% preferred scrolling figure-note notation, and 6% indicated a combination preference. Notably, 70% of participants reported perceiving digital notation as beneficial for skill development, while 30% disagreed. Further investigation revealed that 70% agreed that the tools within these applications eased music reading, 21% agreed they aided in error recognition, and

21% perceived them as enjoyable. However, challenges with app usage were also identified, with 30% reporting difficulties remembering controls, 50% experiencing frequent malfunctions, 10% struggling with customization, and 10% expressing a preference for alternative methods.

Additionally, qualitative observations from a small subset of students suggested some students appreciate being able to isolate certain sections through apps and follow along with the cursor to ensure performance accuracy. Other students report that pitch recognition is not complex initially but that sight-reading on the xylophone is difficult because they need to look down at the instrument to ensure they strike the correct pitch. As a result of looking at the music and instruments back and forth, the student often loses their place in the music. One student reported disliking digital methodologies because of the many steps needed to log in to the application and set it up accordingly.




Preferred Methods for Reading Music
Percentage (%)
0
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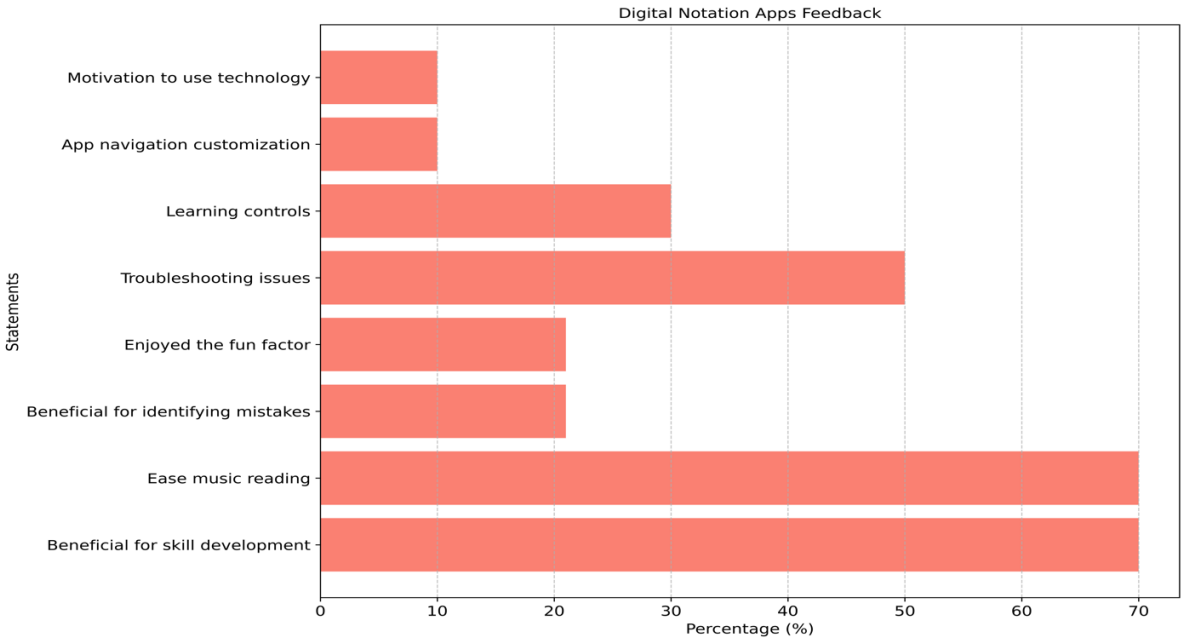
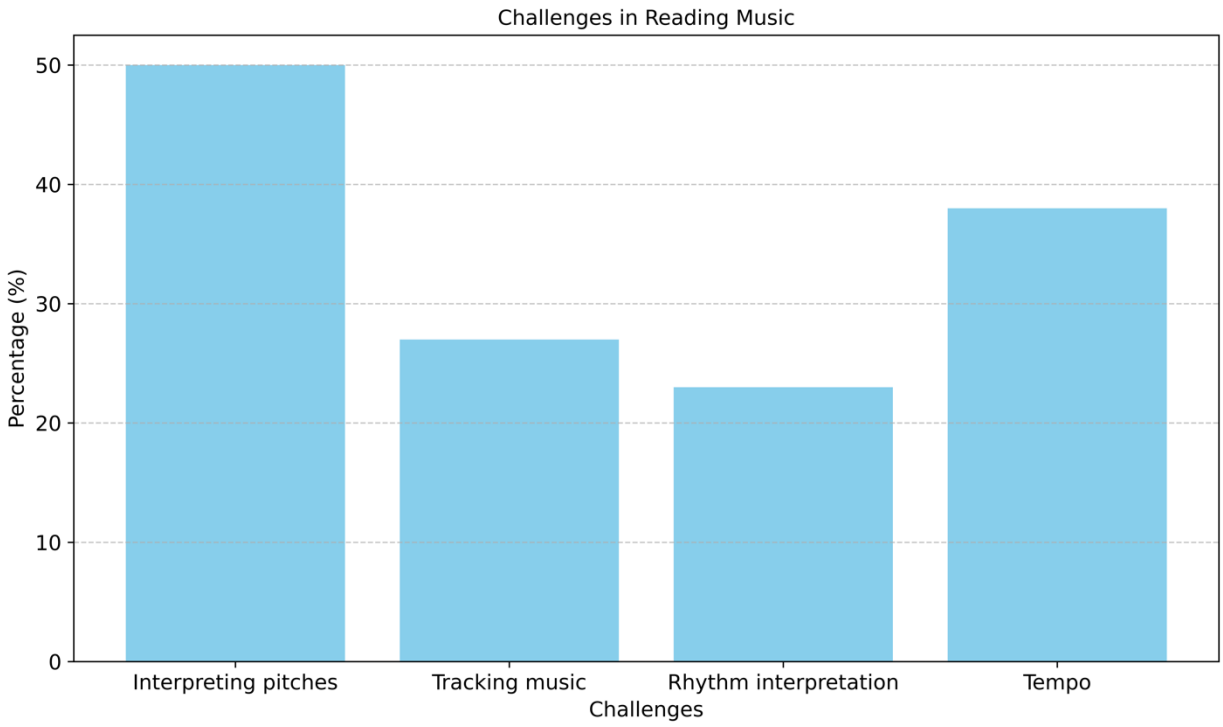
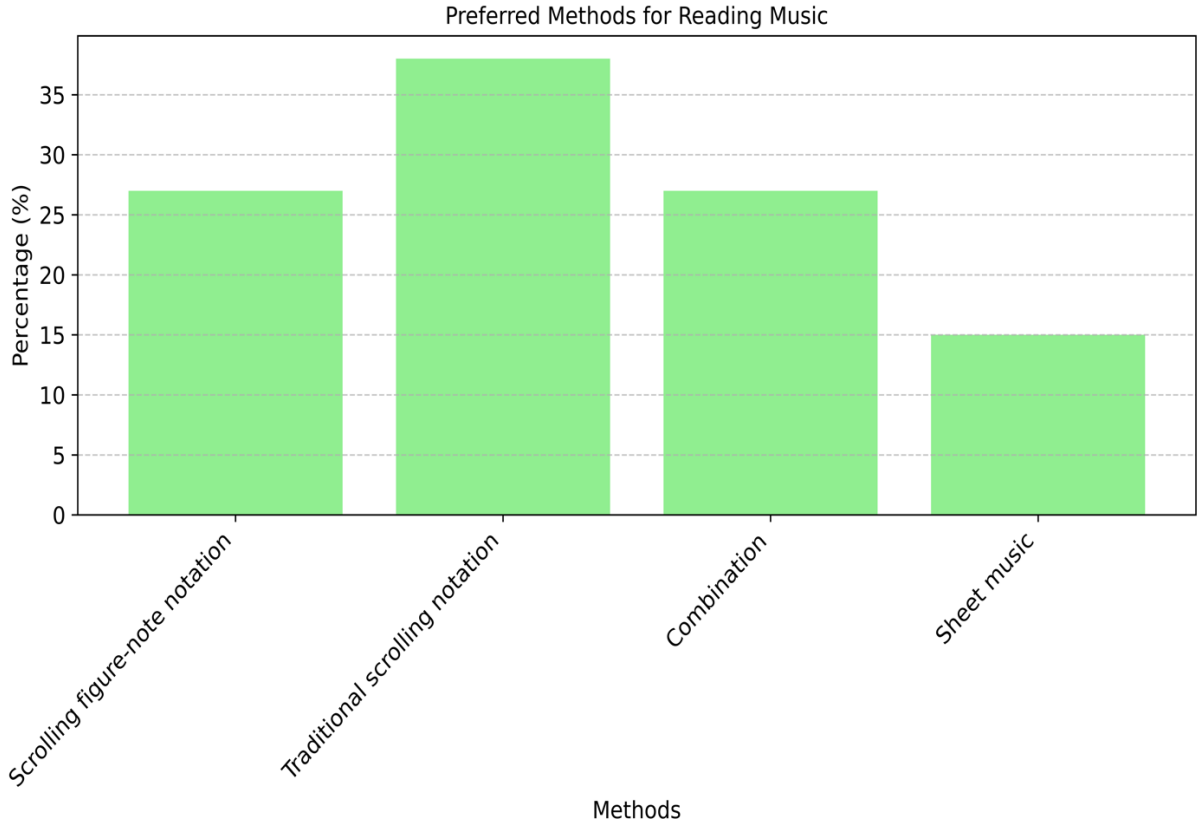
30
40
50
Scrolling figure-note notation
Traditional scrolling notation
Combination
Sheet music
Methods

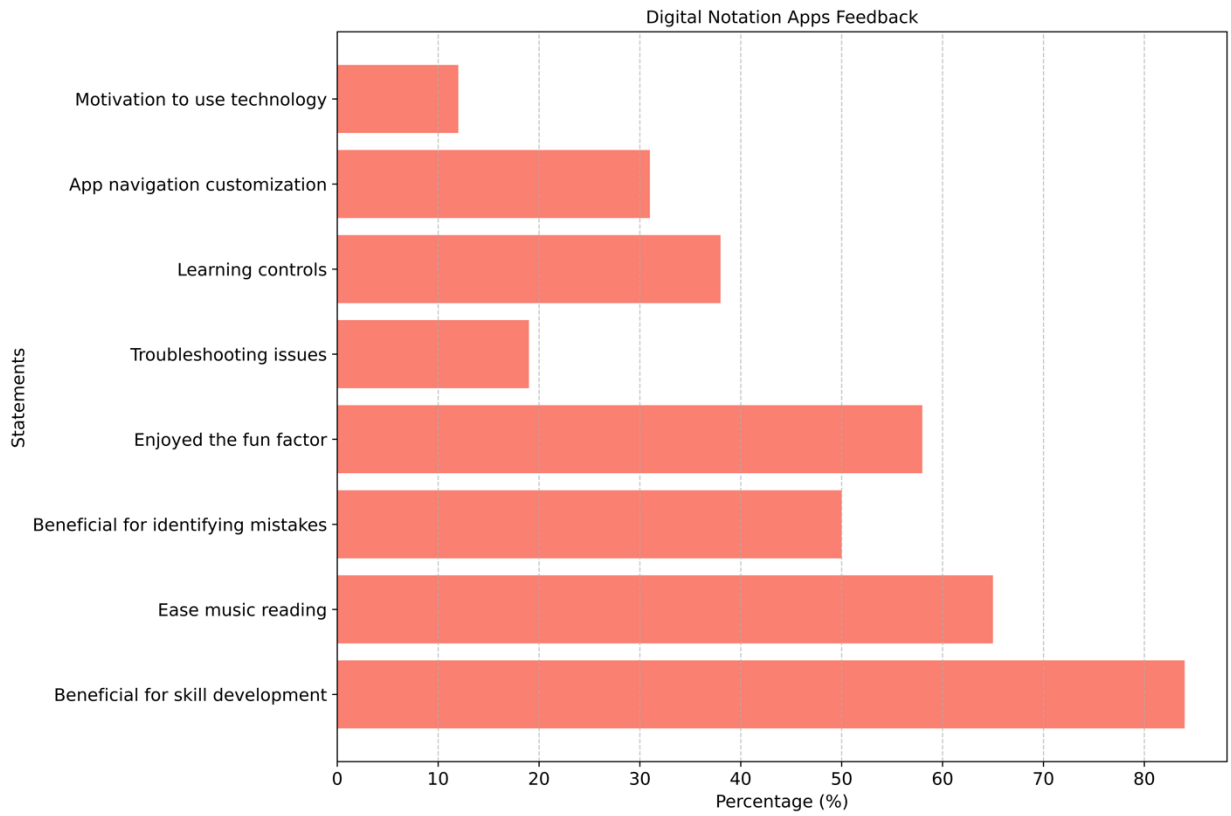

Digital Notation Apps Feedback
Statements
Motivation to use technology
App navigation customization
Learning controls
Troubleshooting issues
Enjoyed the fun factor
Beneficial for identifying mistakes
Ease music reading
Beneficial for skill development
0
10
20
30
40
50
60
70
Percentage (%)

Data analysis from the fourth iteration of this research project investigating music-reading skills in fourth-graders at Western Peaks Elementary School revealed similar findings. Among 26 participants, 27% demonstrated difficulty with pitch tracking, 50% with pitch interpretation, 23% with rhythmic interpretation, and 38% with tempo consistency. Regarding notation preference, 15% favored traditional sheet music, 38% preferred traditional scrolling notation, 27% preferred scrolling figure-note notation, and 27% indicated a combination preference. Notably, 84% of participants reported perceiving digital notation as beneficial for skill development, while 16% disagreed. Further investigation revealed that 65% agreed that the tools within these applications eased music reading, 50% agreed they aided in error recognition, and 58% perceived them as enjoyable. However, challenges with app usage were also identified, with 38% reporting difficulties remembering controls, 19% experiencing frequent malfunctions, 31% struggling with customization, and 12% expressing a preference for alternative methods.

Additionally, qualitative observations from a small subset of students suggested that composition exercises through Bandlab helped them develop a better sense of time since the app works off of gridded patterns that students can visually differentiate regarding whether or not loops line up rhythmically. Also, many more of this group were technologically competent and needed little to no assistance accessing each online exercise. Students in this class also enjoyed collaborating on projects and exercises, allowing them to each provide feedback between exercise iterations.


Challenges in Reading Music
Percentage (%)
0
10
20
30
40
50
Interpreting pitches
Tracking music
Rhythm interpretation
Tempo
Challenges


Preferred Methods for Reading Music
Percentage (%)
0
5
10
15
20
25
30
35
Scrolling figure-note notation
Traditional scrolling notation
Combination
Sheet music
Methods



Summary

In summary, this study investigated the effectiveness of digital notation apps in improving fourth-grade students' music reading skills, focusing on rhythm interpretation, note identification, and overall performance scores. The experimental design allowed for controlled exploration of various notation methods, including scrolling notation and figure-note or colored notation. Participants, drawn from a diverse demographic at Western Peaks Elementary School in Surprise, Arizona, engaged in a curriculum incorporating traditional and technological approaches to music education.

Students completed pre- and post-assessments throughout the study using traditional and digital notation methods. Data analysis revealed insights into students' preferences, challenges, and performance outcomes. While most participants preferred scrolling figure-note notation and

perceived digital notation apps as beneficial for skill development, challenges such as technical issues and app navigation were identified.

The findings of this study align with previous research indicating the potential of digital tools to enhance music learning experiences. One study tested the effectiveness of digital software and Solfeggio attendance with adult students aged 18-23 using academic performance and missed classes as parameters. The mean score for the experimental group was 87.50 out of 100, and the control was 65.37. The study confirmed the hypothesis that apps help teach in an exciting way ($p<0.05$).[8]

Another study with sixth-grade secondary school students in Turkey confirmed that students who took an eight-week course using mobile strategies (experimental) vs traditional strategies (control) saw a significant difference in pre to post-test data. In control, students' mean score was 62.28, while the experimental group ended with 72.99. The study concludes that the mobile apps contributed to success because they allowed students a more creative pathway to learning, while traditional methods were teacher-centered.[9]

In a global study testing the effectiveness of Auralbook, a mobile application training students in aural skills, 89.19% of users agreed that the Auralbook motivates them to learn aural skills. 94.59% of users also agreed that Auralbook could enhance their skills. In the performance analysis, beginners (grades 1-3) showed the most significant improvement in clapping, with a mean score difference of 6.03. Intermediate (grades 4-5) showed considerable improvement in singing, with a mean score difference of 4.29. Stylistic recognition improved significantly in

[8] Ming Ouyang, "Employing Mobile Learning in Music Education," *Education and information technologies* 28, no. 5 (2022): 5421.

[9] Ali K. Uludag and Ugur K. Satir, "Seeking alternatives in Music Education: The effects of Mobile Technologies on students' achievement in basic music theory," *International Society for Music Education,* (2023): 11.

beginner students, with a mean score of 7.21. This study demonstrates that young students in the beginning stages of learning can benefit from technological methods of instruction.[10]

In a study testing the effectiveness of the sightreadingfactory app, three groups were assessed; two groups used the application daily in band or group lessons, while a third group did not use the app for instruction. Group 1 (M=2.80, SD=1.76) showed significantly higher results than Group 3 (M=0.90, SD=2.02, $p = 0.006$). The study confirms that applications can significantly increase students' sight-reading capabilities over eight weeks.[11]

In a qualitative study assessing student interest in learning instruments, students answered before the study if they were completely uninterested in instrumental playing, unsure, a bit, or a lot. Initially, more than half of the students (56%) were uninterested or uncertain about learning an instrument. Halfway through the project, 32% reported being uninterested. By the end, only 1% remained. This study used a blended approach using traditional and technological methods. By the middle of the project, 68% of students decided to learn an instrument and reported increased interest and engagement. By the end of the project, 93% of students decided to learn an instrument.[12]

Furthermore, it is essential to acknowledge the researcher's positionality, shaped by a background immersed in digital technology and education. While one tried to maintain objectivity and balance in the study design, the researcher's familiarity with digital tools may have influenced the research process. Nonetheless, the study aimed to provide valuable insights

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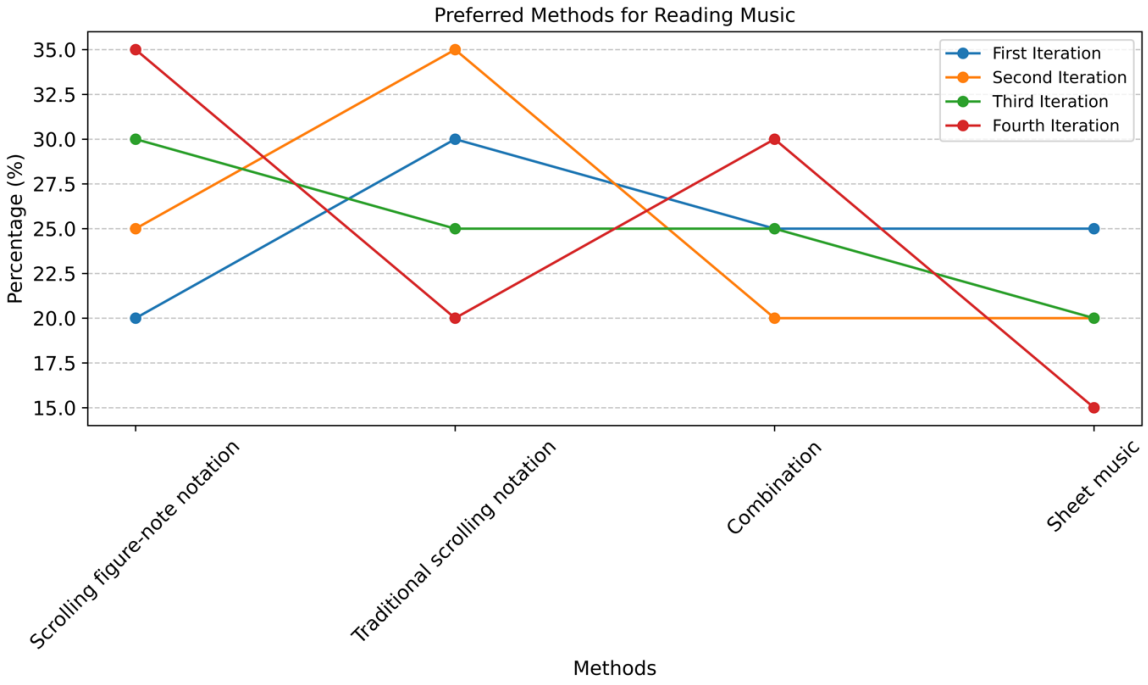
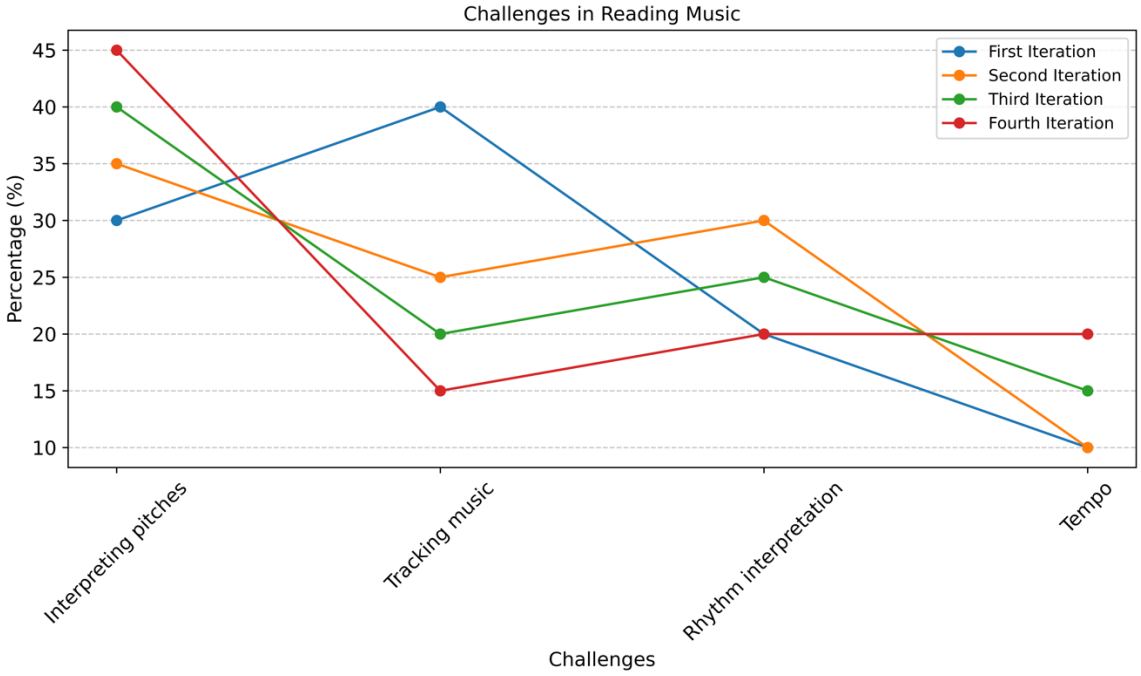
[10] Chi Wai Jason Chen, "Mobile Learning: Using application *Auralbook* to learn aural skills," *International Journal of Music Education,* (2014): 11.

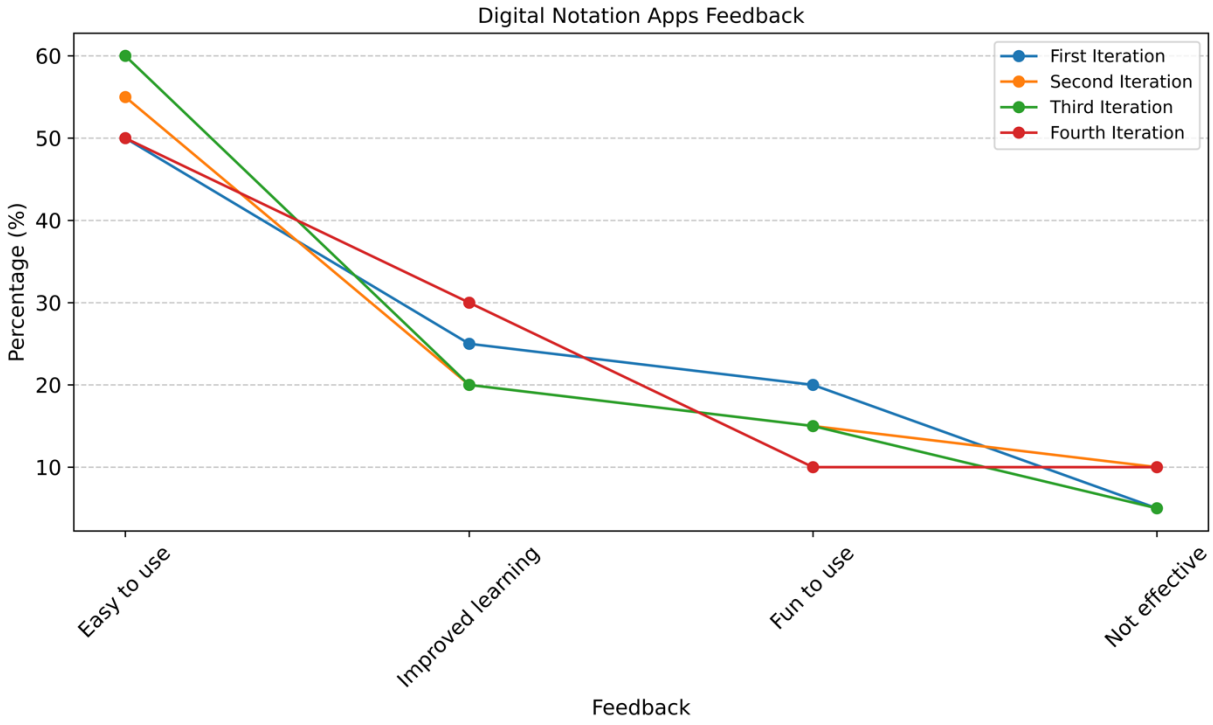
[11] Amy J. Bovin, "The effects of frequent use of a web-based sight-reading software on eighth graders' music notational literacy," *Journal of Music, Technology & Education,* 11 (2) (2018): 131.

[12] Renee Crawford, "Rethinking teaching and learning pedagogy for education in the twenty-first century: blended learning in music education," *Music Education Research,* 19 (2) (2017): 204.

into technology integration in music education, contributing to ongoing discussions and practices in the field.






Digital Notation Apps Feedback
First Iteration
Second Iteration
Third Iteration
Fourth Iteration
Percentage (%)
60
50
40
30
20
10
Easy to use
Improved learning
Fun to use
Not effective
Feedback

Chapter Four: Results

Introduction

This study used a chi-square statistical examination to conduct and discern patterns and associations regarding the effectiveness of digital notation applications on student sight-reading ability. The analysis focused on students' struggles with music reading, their preferences for notation methods, and their perceptions of the helpfulness of digital applications in sight reading. The following sections present the outcomes of these analyses, outlining the implications for sight-reading strategies and the efficacy of digital notation apps in facilitating sight-reading skills among fourth-grade students.

Presentation of Findings

Results

This study delves into fourth-grade students' perceptions of digital notation apps in sight-reading development. Through quantitative and qualitative analyses, the research underscores students' strong preference for figurenote and scrolling notation methods facilitated by these apps. Participants consistently expressed positive views on the usability and benefits of digital notation, particularly in enhancing rhythm interpretation and note identification. The chapter utilizes visual representations, including tables and figures, to complement the textual analysis. Figures 1, 2, 3, 4, and 5 provide graphical insights into various aspects of the study, such as music reading difficulty, notation preferences, perception of digital notation apps, belief statements regarding app effectiveness, and student challenges. Each graph details interpretations that connect the findings to the research hypothesis and implications for sight-reading strategies. For example, Figure 1 illustrates the distribution of responses regarding music reading difficulty

among fourth-grade students, providing insights into specific areas where students may require additional support. Similarly, Figure 2 presents students' preferences for reading music notation after implementing the curriculum, highlighting the popularity of more interactive notation formats among fourth-grade students. These visual representations enhance the presentation of findings and serve as valuable tools for educators, curriculum developers, and researchers to understand the data more comprehensively.

Table 1. Chi-Square Results

Question 1 "What do you struggle with in reading music"?	• Chi-Square Statistic: 17.46	• p-value: 0.042	• Degrees of Freedom: 9
Question 2 "How do you like to read music"?	• Chi-Square Statistic: 14.27	• p-value: 0.11	• Degrees of Freedom: 9
Question 3 "True or False: Digital notation apps help me with my music reading skills."	• Chi-Square Statistic: 5.758	• p-value: 0.124	• Degrees of Freedom: 3
Question 5	• Chi-Square Statistic: 7.70	• p-value: 0.564	• Degrees of Freedom: 9

"What is difficult about using digital notation apps"?			

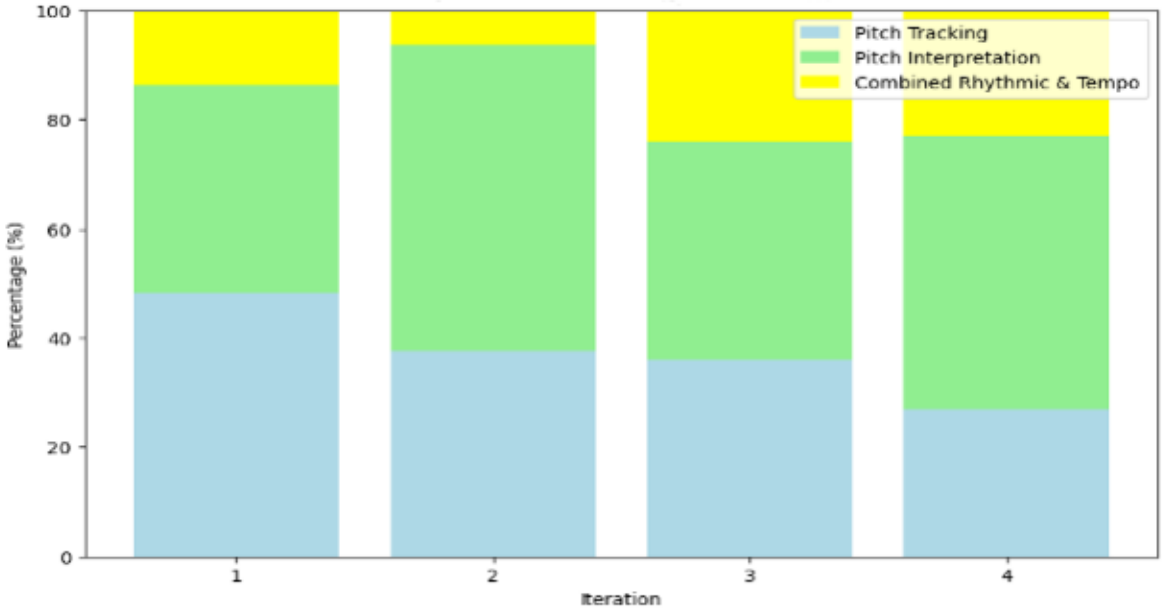
Table 1 provides an overview of the chi-square analyses conducted for each question in the survey. For Question 1, which examines areas of difficulty in music reading, the chi-square statistic of 17.46 with a p-value of 0.042 suggests no significant difference. Similarly, Question 2, exploring preferences for reading music notation, yielded a chi-square statistic of 14.27 with a p-value of 0.11, indicating no significant difference. In Question 3, investigating the perceived benefits of digital notation apps, the chi-square statistic was 5.758 with a p-value of 0.124, also showing no significant difference. However, Question 4 revealed a significant association between students' beliefs about digital notation apps and provided statements, with chi-square statistics ranging from 12.88 to 20.92 and p-values < 0.05. Finally, Question 5, examining difficulties with digital notation apps, showed no significant association, with a chi-square statistic of 7.70 and a p-value of 0.564. While some findings did not reach statistical significance, they highlight important insights for future research and improvement in digital notation app usability.

Table 2. Belief Statements

Belief Statements (Question 4)	Chi-Square Statistic	Degrees of Freedom	p-value	Expected Frequencies
App tools ease music reading	20.92	3	0.0001	[[13. 13.] [13. 13.] [13. 13.] [13. 13.]]
Apps help identify mistakes	20.8	3	0.0001	[[9.75 16.25] [9.75 16.25] [9.75 16.25] [9.75 16.25]]
Apps make reading enjoyable	12.88	3	0.0049	[[8.75 17.25] [8.75 17.25] [8.75 17.25] [8.75 17.25]]

The chi-square analyses conducted for statements regarding the perceived benefits of digital notation apps revealed significant associations between students' beliefs and these statements. For the statement "Digital Notation apps give me customized tools that make music reading easier," a chi-square statistic of 20.92 ($p = 0.0001$) was obtained, suggesting a strong relationship between students' beliefs and this statement. Similarly, for the statement "Digital Notation apps help me recognize my mistakes more easily," a chi-square statistic of 20.8 ($p = 0.0001$) indicated a significant association. Additionally, for the statement "Digital Notation apps make music reading more enjoyable," a chi-square statistic of 12.88 ($p = 0.0049$) was observed, suggesting a significant correlation. These results underscore the perceived benefits of digital notation apps in aiding students' music reading skills, enhancing error recognition, and making the learning process more enjoyable, as supported by the survey responses.

Figure 1. Music Reading Difficulty



The graph in Figure 1 illustrates the distribution of responses regarding music reading difficulty among fourth-grade students. The data showcases varying challenges students

encounter in different aspects of music reading. This comprehensive visualization provides insights into the specific areas where students may require additional support or instructional interventions to enhance their sight-reading skills.

These findings support the hypothesis that digital notation apps, through their provision of visual cues, colored notation, lettering, and auditory aids, can potentially address specific challenges students face in music reading. The significance of these results suggests that students can benefit from individualized learning, which digital notation tools have the potential to offer through tailored learning aids that can mitigate the cognitive load associated with traditional music reading methods. Ultimately, these findings support that curriculum developers can benefit from integrating digital notation apps by enhancing learning outcomes through personalized, accessible approaches to sight-reading instruction.

Therefore, we fail to reject the hypothesis that there is a significant difference in the areas students struggle with when reading music. The chi-square analysis yielded a statistic of 17.46 with a p-value of 0.042, suggesting insufficient evidence to reject the hypothesis at the 0.05 significance level. Therefore, based on the data collected from the survey, one can infer that students have varying degrees of difficulty in different aspects of music reading. This finding underscores the need for a differentiated approach to teaching music literacy to accommodate individual learning needs.

Figure 2. Notation Preferences by Iteration

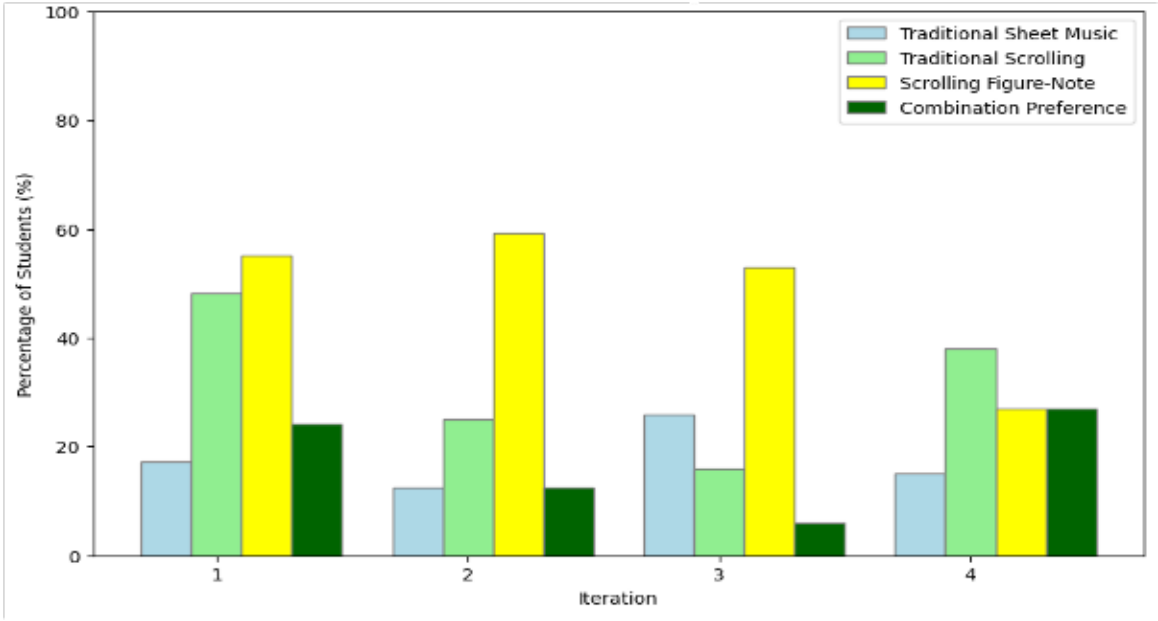


Figure 2 illustrates students' preferences for reading music notation after implementing the curriculum. The graph presents the distribution of students' preferences across various notation methods, including traditional sheet music, scrolling notation, and figure-note notation. This visual representation offers insights into students' preferred approaches to music reading, informing educators and curriculum developers about the most effective instructional strategies to engage students in sight-reading.

Although not statistically significant, the trend highlights a preference for digital notation methods. These findings align with the hypothesis that digital tools offer appealing and effective alternatives to traditional notation, potentially enhancing engagement and learning outcomes.

Therefore, we fail to reject the hypothesis that a significant difference exists in students' preferences for reading music notation. The chi-square analysis yielded a statistic of 14.27 with a p-value of 0.11, suggesting insufficient evidence to reject the hypothesis at the 0.05 significance level. Therefore, based on the data collected from the survey, one can infer that a substantial portion of students prefer the scrolling figure-note notation format for reading music. This

finding underscores the popularity of more interactive notation formats among fourth-grade students. It emphasizes the importance of providing flexible instructional materials that cater to various learning styles and preferences.

Figure 3. Perception of Digital Notation App For Skill Development By Iteration

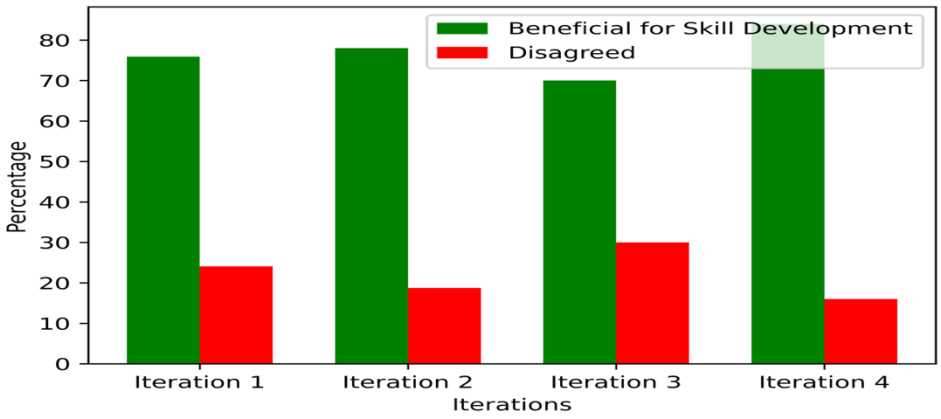


Figure 3 illustrates the perceptions of fourth-grade students regarding the effectiveness of digital notation apps in enhancing their music reading skills, as observed across four iterations of the study. The data reveals a positive trend, with a majority of students across all iterations—75.9%, 78%, 70%, and 84% in iterations one through four, respectively—acknowledging the beneficial impact of these apps on their skill development. Conversely, a minority of students—24.1%, 18.75%, 30%, and 16% in the respective iterations—did not perceive these tools as beneficial.

This trend suggests a growing appreciation for digital notation apps as effective educational aids in sight-reading, aligning with the hypothesis that such technologies can provide engaging, interactive, and personalized learning experiences. However, the chi-square analysis (Chi-Square Statistic: 5.758, p-value: 0.124, Degrees of Freedom: 3) indicates that the variation in responses across iterations does not reach statistical significance at the 0.05 level. The results

suggest that while there is a general trend towards positive perceptions of digital notation apps, the evidence is insufficient to conclusively assert a uniform benefit across the fourth-grade student population at Western Peaks Elementary.

Therefore, we fail to reject the hypothesis that digital notation apps have a significant perceived benefit in aiding students' music reading skills. The chi-square analysis yielded a statistic of 5.758 with a p-value of 0.124, suggesting insufficient evidence to reject the hypothesis at the 0.05 significance level. Therefore, based on the data collected from the survey, one can infer that most students perceive digital notation apps to be beneficial in improving their music reading abilities. This finding aligns with previous research indicating the positive impact of technology in music education.

Figure 4. Belief Statements of Digital Notation Apps by Iteration

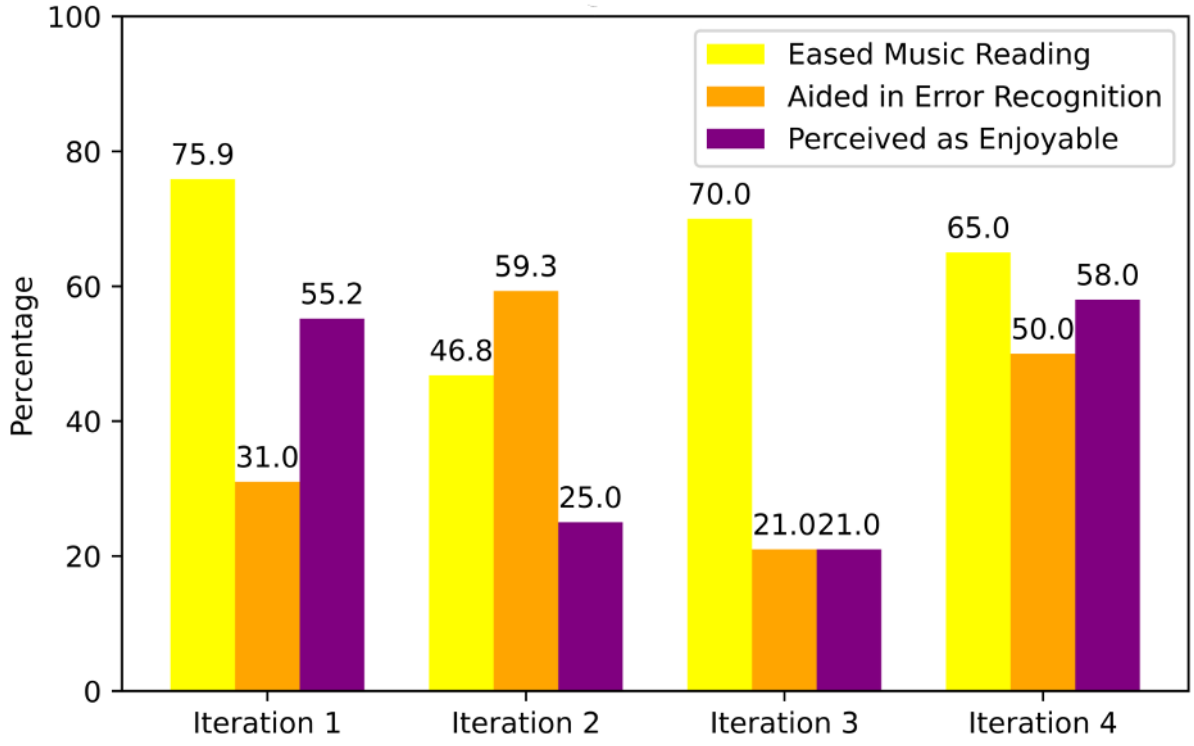


Figure 4 further builds students' perceptions of digital notation apps. The graph presents data gathered from a survey administered after the completion of the project, showcasing students' attitudes toward the effectiveness and usability of digital notation apps. This snapshot provides insights into students' perceptions of these tools, offering essential feedback for educators and curriculum developers.

The lack of statistical significance suggests mixed perceptions among fourth-grade students regarding the app's effectiveness. This outcome prompts a reevaluation of the hypothesis, indicating the need for further investigation into how digital tools are implemented and perceived in the learning process. For instance, the analysis of the fourth iteration of students, who had significantly fewer learning accommodations and disabilities, naturally demonstrated higher technological aptitude and perceived digital notation apps more positively, suggesting a nuanced relationship between students' background in technology, their specific learning needs, and the effectiveness of these educational tools. This observation prompts a refined hypothesis: students' technological proficiency influences the impact that digital notation apps have on enhancing sight-reading skills and the extent of accommodations required for their learning. Consequently, future research should adopt a differentiated approach, tailoring digital tools to align with individual students' technological comfort levels and educational needs. Such an approach can maximize the educational benefits of digital notation apps, consider the importance of diverse technological landscapes, and cater to diverse learning profiles within student populations. This insight advocates for developing adaptive instructional strategies that leverage technology to cater to a broad spectrum of learners and ensures that digital innovations in sight-reading strategies are accessible and effective for all students.

Therefore, we fail to reject the hypothesis that digital notation apps have a significant perceived benefit in aiding students' music reading skills. The chi-square analysis yielded a statistic of 5.758 with a p-value of 0.124, suggesting insufficient evidence to reject the hypothesis at the 0.05 significance level. Therefore, based on the data collected from the survey, one can infer that most students perceive digital notation apps to be beneficial in improving their music reading abilities. This finding aligns with previous research indicating the positive impact of technology in music education.

Figure 5. App Challenges Faced by Students (Percentage of Students Reporting Difficulty)

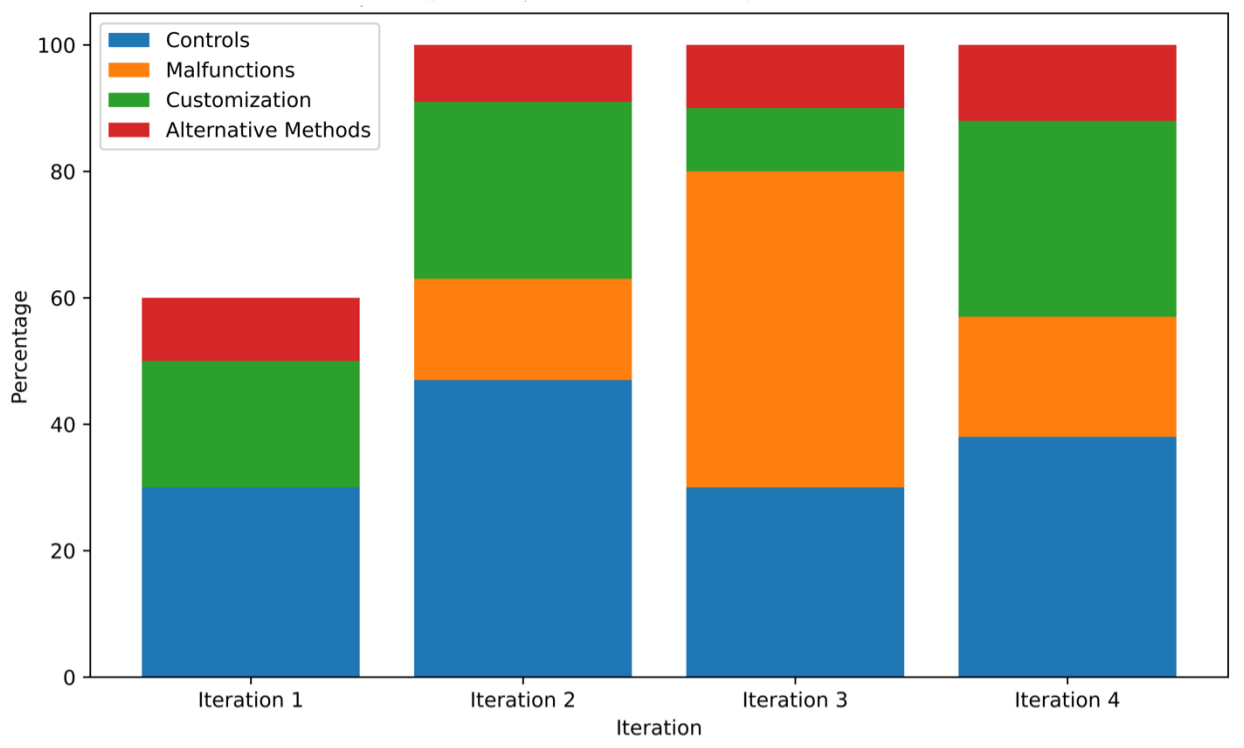


Figure 5 displays the percentage of students reporting difficulties with digital notation apps, highlighting common challenges encountered during lessons. This graph offers valuable insights into students' usability issues when utilizing digital notation tools, providing meaningful

feedback for improving app design and implementation strategies. The findings underscore the importance of user-friendly design and reliable functionality in digital notation apps. While these tools can potentially enhance sight-reading, the technical barriers can impede their effectiveness in learning. Students consistently reported challenges with using digital notation apps, highlighting significant areas for improvement in app design and implementation. The difficulties in remembering controls were persistent, with percentages ranging from 30% to 47% across the iterations.

Additionally, frequent malfunctions were reported by 16% to 50% of students, indicating reliability concerns with the apps or perhaps the devices students used to access the apps. The study also notes struggles with customization, with 10% to 31% of students finding it challenging to tailor the apps to their learning needs. Notably, a minority of students, ranging from 9% to 12%, preferred alternative methods to digital apps for sight-reading, suggesting that while digital tools offer innovative solutions, they may not fully meet all students' diverse needs and preferences. The reported difficulties suggest perhaps more intuitive interfaces and thorough student onboarding processes.

Based on the statistical analysis of the survey responses regarding the difficulties encountered with digital notation apps, the chi-square statistic for this question is 7.70, with a p-value of 0.564 and degrees of freedom of 9 with a significance level of 0.05. The null hypothesis suggested no association between the reported difficulties with digital notation apps and the options in the survey question. However, given the lack of statistical significance, we fail to reject the null hypothesis. Although the results did not reach statistical significance, the observed patterns of reported difficulties highlight areas for further investigation and improvement in the usability of digital notation apps for music education purposes.

Summary

This chapter presents the findings from a study examining the impact of digital notation applications on the sight-reading abilities of fourth-grade students. The study used a chi-square statistical analysis and explored various dimensions: students' challenges with music reading, their preferences for notation methods, and their perceptions of the usefulness of digital applications in learning sight-reading. The results offer valuable insights into the role of digital notation apps aiding students in sight-reading and their potential to facilitate sight-reading development among fourth-grade students.

The analysis concerning the music reading challenges revealed significant variability in students' difficulties with music reading (Chi-Square Statistic: 17.46, p-value: 0.042), underscoring the diverse challenges encountered in learning music notation. This variability supports the potential of digital notation apps to provide customized learning aids that address individual student needs, thereby reducing the cognitive load associated with traditional music reading methods. By reducing the cognitive load associated with music reading, students can employ a systematic approach that enables students to engage in a scaffolding learning process, working on specific music reading facets that challenge them.

Concerning notational preferences, students showed a trend towards preferring digital notation methods over traditional sheet music (Chi-Square Statistic: 14.27, p-value: 0.11); although this did not reach statistical significance, this trend suggests an inclination among students towards more interactive and engaging notation formats, highlighting the importance of incorporating flexible and diverse instructional materials in sight-reading methodologies. Concerning perceptions, most students across all iterations perceived digital notation apps as beneficial for their music reading skill development, with positive responses ranging from 75.9%

to 84%. However, the chi-square analysis (Chi-Square Statistic: 5.758, p-value: 0.124) indicated that these differences across iterations did not achieve statistical significance, suggesting mixed perceptions among students regarding the effectiveness of these tools. Finally, regarding app challenges, Students reported facing several challenges with digital notation apps, including technical issues and difficulties with app navigation (Chi-Square Statistic: 7.70, p-value: 0.564). While these challenges did not show a significant association in the analysis, they highlight areas for improvement in app design and implementation to enhance user experience and learning outcomes.

The findings from this study underscore the potential of digital notation apps to enhance sight-reading development among fourth-grade students by offering personalized, engaging, and interactive learning experiences. However, the mixed perceptions and reported challenges emphasize the need for careful consideration in selecting and integrating these tools into a music curriculum. Future research should investigate how digital notation apps can be optimized to meet student's diverse needs and preferences, ensuring that technology effectively complements traditional music education methods. Digital notation apps represent a promising avenue for supporting sight-reading instruction in music education. By addressing the specific challenges and preferences identified in this study, educators and curriculum developers can leverage these tools to create more inclusive, engaging, and effective student learning environments.

Chapter Five: Conclusion/Discussion

Summary of Study

This study aimed to investigate the effectiveness of leading music notation apps, including Prodigies, Yousician, and Noteflight, in improving sight-reading skills among students. The study utilized an experimental design by employing a mixed-method approach to assess the impact of digital notation apps on student learning. The working hypothesis posited that these apps would enhance sight-reading skills by providing visual cues, colored notation, and other auditory and visual aids tailored to individual student needs.

Following completing a curriculum utilizing the aforementioned apps, students participated in a survey comprising six questions to gauge their interest, engagement, and any issues encountered with the digital notation systems. The quantitative analysis revealed a mixed response, with certain aspects of the apps, such as visual cues and colored notation, being positively perceived by students. However, students reported challenges such as technical issues and difficulty in customizing app settings. Furthermore, the survey identified varying student preferences regarding different notation formats, underscoring the need for flexible instructional materials to accommodate diverse learning styles. The implications of these findings emphasize the importance of adopting diverse teaching strategies in music education, particularly in integrating digital tools to enhance learning experiences.

Educators should address technical challenges and ensure customization options to meet the needs of all students effectively. Moreover, fostering independent learners capable of adapting to evolving educational technologies is paramount, highlighting the role of visual and gamification methodologies in enhancing student engagement and proficiency in music literacy. In summary, while digital notation apps hold promise in improving sight-reading skills, further

research and development are warranted to design effective digital learning environments tailored to the unique needs of music students.

Summary of Findings and Prior Research

This study investigated the effectiveness of music notation apps in enhancing sight-reading skills among students. The findings revealed a mixed response to digital notation apps, with varying student preferences regarding notation formats. While students positively perceived visual cues and colored notation, many reported technical and customization difficulties. These findings align with prior research indicating the effectiveness of digital learning tools in music education, particularly in improving academic performance and fostering creative pathways to learning.

The mixed-method approach allowed for a nuanced understanding of how music educators can integrate digital tools into sight-reading strategies to support diverse learning needs. The conceptual frameworks discussed in Chapter 2, discussing the importance of reflexive teaching strategies and pragmatic values, align with the findings and underscore the potential of digital notation apps to create personalized and engaging learning experiences. The findings also align with the literature emphasizing the need for music education methods to evolve in response to societal changes and technological advancements. The positive perceptions of digital tools among students, as evidenced by the quantitative and qualitative data, reflect the broader trend towards integrating technology in educational settings to cater to the digital native generation.

In light of the findings and the reviewed literature, it is evident that while digital notation apps offer significant benefits in enhancing rhythm interpretation and note identification, educators must also navigate the challenges associated with app usability and customization.

Therefore, music educators should seek a balanced approach to technology integration, where they possess the necessary technological pedagogical skills and techniques to utilize digital tools in music education effectively. The study further supports the literature's call for education systems to develop digital literacy competencies, ensuring educators and students can thrive in a techno-centric society.

Limitations

Despite the valuable insights gained from this study, one must acknowledge several limitations. Firstly, the study's sample size may limit the findings' generalizability to a broader population. The study focused on a group of fourth-grade students, and the results may not apply to students of different ages or educational backgrounds. Additionally, the reliance on self-reported data through surveys may introduce response biases and inaccuracies. Moreover, the study primarily focused on the effectiveness of digital notation apps without considering other factors such as individual learning styles, prior musical experience, or teacher influence. Furthermore, the duration of the study may not have been sufficient to capture long-term effects or changes in sight-reading proficiency. Future research should address these limitations by incorporating more extensive and diverse samples, utilizing objective assessment measures, considering multifaceted influences on learning outcomes, and conducting longitudinal studies to track the sustained impact of digital learning tools on music education.

Recommendations for Future Study

Several avenues warrant future research to build upon the findings of this study and further our understanding of the effectiveness of digital notation apps in music education. Firstly, conducting longitudinal studies that track students' progress over an extended period would

provide valuable insights into the long-term effects of digital learning tools on sight-reading proficiency and overall musical development. Additionally, exploring the impact of individualized learning approaches within digital notation apps, such as adaptive algorithms or personalized feedback mechanisms, could shed light on how tailored interventions influence student learning outcomes. Moreover, comparative studies that assess the effectiveness of different digital notation apps or integrate them into existing music curricula would offer insights into best practices for incorporating technology in music education. Finally, investigating the role of teacher training and support in maximizing the benefits of digital learning tools could provide practical recommendations for enhancing educators' pedagogical practices in the digital age. Lastly, while the initial focus of this study was to ascertain the effectiveness of digital notation apps in developing sight-reading skills among fourth-grade students, the findings have also hinted at a broader implication. The significant interest and preference for digital notation methods observed among students suggest an emergent hypothesis: digital tools may offer appealing and effective alternatives to traditional notation, potentially enhancing student engagement and learning outcomes.

Implications for Practice

The findings of this study have several important implications for music educators and practitioners. Firstly, incorporating digital notation apps into music instruction can provide valuable opportunities for individualized learning and engagement, catering to diverse learning styles and preferences. Educators can leverage these apps' visual and gamification features to create dynamic and interactive learning experiences that foster students' sight-reading skills and overall musical development. Additionally, integrating technology in music education can help educators adapt to the changing landscape of digital learning environments and better prepare

students for the technological demands of the modern music industry. Moreover, the insights gained from this study underscore the importance of ongoing professional development for music educators to enhance their proficiency in utilizing digital tools effectively and integrating them into their teaching practices. In music education, embracing digital notation apps can contribute to more engaging, inclusive, and effective student learning experiences, ultimately fostering a lifelong appreciation and understanding of music.

Summary

This study investigated the effectiveness of digital notation apps in enhancing music reading skills among students, employing a mixed-method approach to gather quantitative and qualitative data. The findings revealed varying degrees of difficulty among students in different aspects of music reading, emphasizing the necessity for a tailored instructional approach to accommodate individual learning needs. Moreover, the study identified students' preferences for notation formats, highlighting the popularity of interactive tools such as scrolling figure-note notation. Drawing from prior research, which similarly underscores the positive impact of technology in music education, this study contributes to the growing body of literature supporting integration of digital tools in pedagogical practices. However, limitations, including sample size constraints and potential biases in self-reported data, warrant cautious interpretation of the findings. Moving forward, recommendations for future research include exploring the longitudinal effects of digital notation apps on music literacy development and investigating innovative instructional strategies to maximize their effectiveness. Practitioners in music education can leverage these insights to design more inclusive and engaging learning experiences, fostering independent learners capable of navigating the complexities of music notation in diverse contexts. Ultimately, this study underscores the transformative potential of

technology in shaping the landscape of music education, paving the way for continued innovation and advancement in pedagogical practice.

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Appendix A: Visuals

Figure 1: Prodigies incorporates Immersive visuals that aid in priming students for new material.

Figure 2: The bottom of each Prodigies song has touch screen handbells students may use if they do not have a bell set of their own.

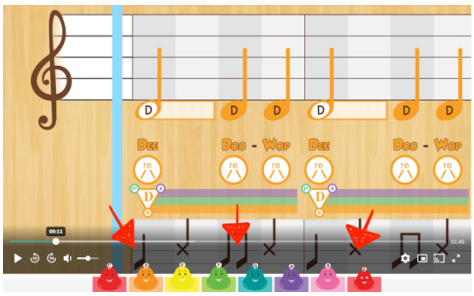


Figure 3: Each Prodigies song allows students to control playback speeds.

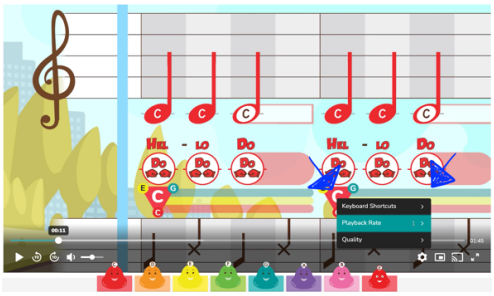


Figure 4: Yousician grades each student on pitch accuracy by highlighting correct notes in green and incorrect in red.

Figure 5: Yousician grades each student on timing accuracy by providing written feedback above each note.

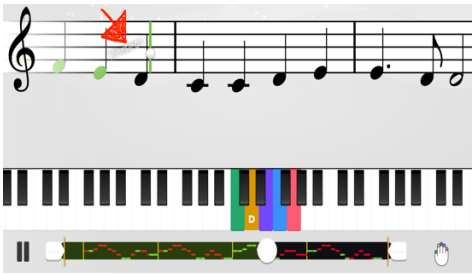
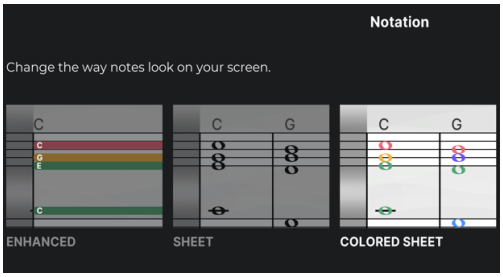
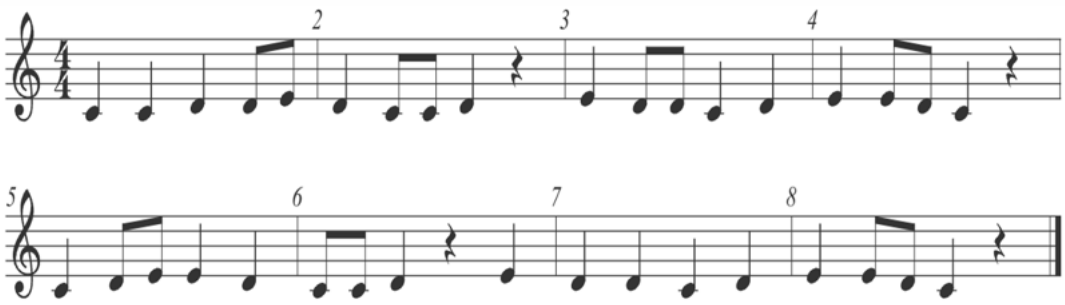


Figure 6: Yousician allows students to choose a notation system they are most comfortable with.



Appendix B: Visual

Figure 7: Pre-assessment given to fourth grade students at the beginning of the year.



1.) Sight Read the above passage with Mr. Bedolla

2.) Reflect and discuss with Mr. Bedolla which of the following you can improve:
- a.) Playing the correct pitches
- b.) Playing the correct rhythms
- c.) Tempo
- d.) Tracking the music

2.) Write down all the feedback in the appropriate measures Mr. Bedolla gives

3.) Recreate this passage in Noteflight, labeling and listing any element you believe will help you read the passage successfully.

4.) Re-examine Mr. Bedolla's feedback, then attempt to play the above passage a second time.

5.) Sight-read a random passage on an app of your choosing, Prodigies, Yousician, or Sight-Reading-Factory with Mr. Bedolla.

6.) Reflect and discuss with Mr. Bedolla which of the following you can improve:
- a.) Playing the correct pitches
- b.) Playing the correct rhythms
- c.) Tempo
- d.) Tracking the music

Appendix C: Visual

Figure 8: Survey Questions

Survey Questions

1.) What do you struggle with in reading music?
- a.) Tracking the music
- b.) Interpreting correct pitches (Knowing whether to hit C, D, or E)
- c.) Interpreting correct rhythms (playing each pitch as a Beet or Cherry)
- d.) Tempo (maintaining a steady beat while playing the music)

2.) How do you like to read music?
- a.) Regular Sheet Music (Paper)
- b.) Scrolling traditional notation (Music that moves with the line or Prodigies, Yousician, Sight-Reading-Factory)
- c.) Figure-note notation (colors, shapes with scrolling).
- d.) Combinations

3.) True or False: Digital notation apps help me with my music reading skills.
- a.) True
- b.) False

4.) Check all that you believe are true:
- Digital Notation apps give me customized tools that make music reading easier.
- Digital Notation apps help me recognize my mistakes more easily.
- Digital Notation apps make music reading more enjoyable.

5.) What is difficult about using digital notation apps?
- a.) It is hard to learn and remember the controls.
- b.) Sometimes, the apps do not function properly.
- c.) I have difficulty customizing the app settings to meet my needs.
- d.) I do not enjoy using digital notation apps; I prefer a different method to practice music reading.

6.) Provide additional comments about your experience with digital notation apps, such as what else you have enjoyed or disliked about using them this year.