BAND GAMIFICATION AMONG HIGH SCHOOL STUDENTS WITH AUTISM SPECTRUM DISORDER: A QUALITATIVE CASE STUDY

By

Carolyn Rusnak

Liberty University

A THESIS PRESENTED IN PARTIAL FULFILLMENT

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Liberty University, Lynchburg, VA

April 17, 2024

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Abstract

This qualitative case study aims to describe, explore, and identify how the high school beginning band student's choice of computer applications was implemented to demonstrate increased music literacy for percussion students with autism spectrum disorder (ASD). This qualitative research examines two male and four female high school beginning band percussionists with ASD. Data was collected over four weeks via computer applications, observations, and recorded exit interviews of each student. Students' respective schools were selected to conduct research; data was analyzed by studying the computer application scores and educational implications. Perspectives on improving communication, cognitive, and music reading skills are also examined. Employing student choice may encourage ASD students to self-advocate in other areas. This work is important because few studies have been conducted on adolescents with ASD in music education: there are still very few randomized control studies on the effectiveness of computer applications, even though the literature on this topic appears to have demonstrated advantages for people with ASD. This study could encourage the research of a more extensive survey of the population with ASD and students with other disabilities to use technology, gaining a deeper understanding of needs and challenges and encouraging growth in communication and cognitive skills in different subject areas.

Keywords: autism spectrum disorder, music education, technology, computer applications, case study

Acknowledgments

I would first like to thank my Lord and Savior, Jesus Christ, for sustaining me through this whole process. I could not have finished without my dear husband, Bill, who made sure I ate and had tea during long periods of writing and kept up with the laundry and house cleaning. I also want to thank my family, and extended family for all their support and love during this journey. Thank you to my Lutheran North and Concordia colleagues, who cheered me on. Thank you to the Educational Specialists at Lutheran South who allowed me to come into their classroom and collect data. A big shout out to Rob who allowed me to borrow iPads and made sure everything was set up correctly. Dr. Street and Dr. Stiffler, you were the best committee chair and committee reader! Your guidance, patience, and support have been invaluable to me.

Dedication

I would like to dedicate this work to my husband, children, and grandchildren. I would also like to dedicate it to all music educators who work tirelessly to bring the gift of music into students' lives. What an amazing calling.

For the LORD your God is living among you.

He is a mighty savior.

He will take delight in you with gladness.

With his love, he will calm all your fears.

He will rejoice over you with joyful songs. Zephaniah 3:17

Chapter 1: Introduction

Introduction

Recently, the field of special education has begun to sparsely investigate the potential role of organized sound and music in teaching and learning. One in twenty children with autism spectrum disorder (ASD) is thought to experience exceptional musical abilities, which, when encouraged, can promote a more robust learning opportunity, and foster a sense of well-being.[1] Researchers have proposed that studying musicality in individuals with Intellectual or Developmental Disability (IDD) is important because music can aid in developing cognitive skills in non-autistic individuals. Perhaps these same cognitive gains can occur in autistic individuals.[2] Daniel Johnston et al. discuss "there is extensive evidence in studies that supports the use of music in fostering neurological development."[3] Researchers also propose that music can directly connect with autistic students despite cognitive impairments.[4]

Autistic disorder is a neurological condition that emerges in the first three years of life. The severity of symptoms varies in children and may change with age, usually toward improvement; this generally follows if intervention and educational programs are introduced early and modified to address the student's needs.[5] According to the American Psychiatric Association's Diagnostic Statistical Manual of Mental Disorders – Text Revision (DSM-IV-TR),

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[1] Adam Ockelford, "The Potential Impact of Autism on Musical Development," In *The Child As Musician: A Handbook of Musical Development,* (New York, NY: Oxford University Press, 2015), 124.

[2] Miriam D. Lense and Elisabeth M. Dykens, "Chapter Eight – Musical Interests and Abilities in Individuals with Developmental Disabilities," Editor(s): Robert M. Hodapp, *International Review of Research in Developmental Disabilities*, Academic Press, 41, 2011, 299.

[3] David Johnston, Hauke Egermann, and Gavin Kearney, "Innovative Computer Technology in Music-Based Interventions for Individuals with Autism Moving Beyond Traditional Interactive Music Therapy Techniques," *Cogent Psychology* 5, (2018): 2.

[4] Ibid.

[5] *The Encyclopedia of Giftedness, Creativity, and Talent*, Autism, ed. Barbara Kerr (Thousand Oaks, CA: SAGE Publications, Access Date September 8, 2021), p. 81.

autism, or autistic disorder, belongs to a group of pervasive developmental disorders.[6] These disorders include Asperger's syndrome, Rett's syndrome, childhood disintegrative disorder, and pervasive developmental disorder not otherwise specified (PDD-NOS), also referred to as atypical autism. Sheryl Feinstein explains some brain differences in people with ASD:

> More than sixty studies confirm that differences in the cerebellum, which is primarily involved in motor control, occur in approximately 95 percent of all people diagnosed Autism Spectrum Disorder (ASD). These differences include smaller overall size, smaller but more densely packed neurons, and inefficient functioning. The loss of or decrease in the number of Purkinje neurons, specialized cells concentrated in the middle layer of the cerebellar cortex that have the most significant number of branches and long-distance connections to other brain areas, occurs in some people with ASD. This may account for their delayed processing and responding and lost or skewed messages between various parts of their brains.[7]

According to a Centers for Disease Control report published on March 27, 2014, an estimated one in 68 school-aged children, or about 15 per 1,000, identifies with ASD.[8] Published in 2012, the Centers for Disease Control estimates that 1 in 88 students has ASD. For boys, it is 1 out of every 54, and for girls, 1 out of every 252.[9],[10] In 2004, teachers with 25 children per class were likely to never meet a student with ASD during their career; a teacher can expect to encounter one in as few as every seven classes today.[11] More research is necessary to serve these exceptional students, especially regarding music, since music may aid the development of other

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[6] *The Encyclopedia of Giftedness, Creativity, and Talent*, Autism, ed. Barbara Kerr, p. 81.

[7] Sheryl Feinstein, *The Praeger Handbook of Learning and the Brain*, (Westport, CT: Greenwood Publishing Group eBook, 2006), p.100.

[8] CDC Web Archive, (2014, March 27), CDC Estimates 1 in 68 School-Aged Children Have Autism; No Change from Previous Estimate, CDC, https://www.cdc.gov/media/releases/2016/p0331-children-autism.html.

[9] CDC Newsroom, Press Release, (2012, March 29), CDC Estimates 1 in 88 Children in United States Has Been Identified as Having an Autism Spectrum Disorder, CDC, https://www.cdc.gov/media/releases/2012/p0329_autism_disorder.html.

[10] Seyyed Nabiollah Ghasemtabar, Mahbubeh Hosseini, Irandokht Fayyaz, Saeid Arab, Hamed Naghashian, and Zahra Poudineh, "Music Therapy: An Effective Approach in Improving Social Skills of Children with Autism," *Advanced Biomedical Research* 4 (2015): 2.

[11] Linda H. Rammier, In *From the Brain to the Classroom: The Encyclopedia of Learning*, ed. 2014 Sheryl Feinstein, (Westport: ABC-CLIO, LLC, accessed September 9, 2021, ProQuest Ebook Central), 97.

cognitive skills in students with IDDs.[12] The lack of information on the educational benefits of music-based methods while implementing technology for adolescents with disabilities is unfortunate since involvement in music may aid the development of other cognitive skills.[13] This study will attempt to contribute to music education and special education by exploring how employing student choice of computer applications will influence the adolescent band percussion student with ASD in developing music literacy in reading notes and rhythms.

This chapter will introduce the study and provide a background of the topic, the problem statement, the purpose, and the research questions and methodology that will guide the study. A brief comparison to a similar investigation is described and explained. The chapter will also discuss the significance of the current study and its core concepts and define standard terms used throughout the chapter.

Background of the Topic

Music is an essential source of enjoyment and a rich, powerful, and versatile stimulus for the brain. Over the past several years, increasing interest and progress in adopting music as a therapeutic tool has grown.[14] Jason Nolan, who discusses being an autistic living in a neurotypical world, says, "It would seem as if the one thing we are not given is the opportunity to pay attention to and engage in the practices that interest us. Teaching music should be about

[12] Lense and Dykens, "Musical Interests and Abilities in Individuals with Developmental Disabilities," 299.

[13] Ibid.

[14] Teppo Särkämö, Eckart Altenmüller, Antoni Rodriguez-Fornells, and Isabelle Peretz, "Editorial: Music, Brain, and Rehabilitation: Emerging Therapeutic Applications and Potential Neural Mechanisms," *Frontiers in Human Neuroscience* 10 (2016): 103.

helping the children learn about something they are growing passionate about. What is the goal if this is not the goal of teaching?"[15]

This study aims to discover in what ways a high school beginning band percussion student's choice of computer applications, allowing for practices that interest the student, demonstrated an increased understanding of reading music in an individual with ASD. While some studies conducted implemented computer applications for adolescents with disabilities, most have examined students with ASD at 13 and younger. Marco Esposito et al. analyze using technology with four-year-old participants with ASD.[16] The research attempts to connect technology and learning for special education. By administering computer applications to attention, vocabulary, and imitation, the experimental group in the investigation showed better understanding than the control group after four weeks; a considerable increment of scores was achieved with tablet applications in the experimental group, particularly in attention and vocabulary. The researchers cautioned the reader about the results because, while the scores showed more significant progress in the experimental group, the differences did not exceed a significant level. In addition, the sample of participants tested may not represent the entire population with ASD. This research shows the capability of computer applications to improve educational training for children with ASD, particularly in attention and vocabulary. Analyzing computer applications with adolescents who desire to participate in the band program and employing computer applications focusing on repetition and reward regarding music literacy may allow these exceptional students to participate. Students with disabilities who have no prior

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[15] Jason Nolan, "(Self) Interview with an Autistic: Intrinsic Interest and Learning With and About Music and the Missing Modality of Sound," *The Canadian Music Educator* 62, no. 1 (2020): 9.

[16] Marco Esposito, Janette Sloan, Andrea Tancredi, Giovanna Gerardi, Paola Postiglione, Francesca Fotia, Eleonora Napoli, Luigi Mazzone, Giovanni Valeri, and Stefano Vicari, "Using Tablet Applications for Children with Autism to Increase Their Cognitive and Social Skills," *Journal of Special Education Technology* 32, no. 4 (2017): 201.

experience in a musical group may be able to join after employing computer applications in music literacy and rhythm.

F. Xin and Deborah A. Leonard conducted research employing iPads with ten-year-olds with ASD to assist these students in learning communication skills.[17] The investigation tested three learners with little or no speech. Self-advocacy among people with an intellectual disability presents opportunities for these students to develop skills to influence change in activities and decisions for themselves.[18] During the intervention, Xin and Leonard's results showed an increase in the students' requests indicating their needs or self-advocacy by touching the icon on the device with reduced prompts from the teacher.

Two of the participants analyzed reached the level of independence without prompting.[19] One of the participants improved scores. The investigation showed improved communication and provides feedback for the teacher to adjust instruction to meet students' needs. The inquiry notes that initiating expressive language is comparatively more difficult than responding to questions for students with ASD. If students employ highly preferred objects and activities, motivation to be involved in class could be high, resulting in the students expressing themselves and initiating communication, which is beneficial in a school setting. Responding to questions is also a vital communication skill in the classroom: it allows for student assessment and understanding of individual needs. In students with ASD who express little speech, learning communication skills are critical. Intensive and frequent interactions are provided between teachers and students in

[17] Joy F. Xin and Deborah A. Leonard, "Using iPads to Teach Communication Skills of Students with Autism," *Journal of Autism and Developmental Disorders* 45, no. 12 (2015): 4154.

[18] Ove Mallander, Therese Mineur, David Henderson, and Magnus Tideman, "Self-Advocacy for People with Intellectual Disability in Sweden – Organizational Similarities and Differences," *Disability Studies Quarterly* 38, no. 1 (2018):1.

[19] Xin and Leonard, "Using iPads to Teach Communication Skills of Students with Autism," 4154.

both class and social settings to improve these exceptional students' initiation for communication. Applying the investigation results employing computer applications in music literacy, which the student with ASD highly prefers, communication may be improved in music literacy and with peers, parents, and teachers.[20]

Yen Na Yum et al. propose a trial with 6 to 13-year-old children with ASD.[21] Participants in the trial receive musical training targeting social skills and interactions. This is key because students with ASD may be highly unassertive in social situations because of low verbal ability. The investigation suggests that music may become a channel for students with hindered social interactions because group music encourages turn-taking in a non-verbal circumstance. Participating in group music therapy, students with ASD can learn to tolerate the presence of others and practice social behaviors. The final results of the investigation, which have not been concluded, will be released when the intended sample size is reached. Participation in a musical group at school may benefit students with ASD by aiding in learning to tolerate the presence of others and practice social behaviors. Though this investigation by Yen Na Yum et al. will not utilize technology, significant findings may occur showing how participating in music groups aids social interactions for students with ASD.

In studies with adolescents implementing student choice in computer applications, there is very little research on long-term cognitive gains, social communication, technology improvement, or self-advocacy learning in individuals with ASD. The self-advocacy movement is about people with disabilities advocating for themselves, especially those with intellectual

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[20] Xin and Leonard, "Using iPads to Teach Communication Skills," 4154.

[21] Yen Na Yum, Way Kwok-Wai Lau, Kean Poon, and Fuk Chuen Ho, "Music Therapy as Social Skill Intervention for Children with Comorbid ASD and ID: Study Protocol for a Randomized Controlled Trial," *BMC Pediatrics* 20, no. 545 (2020): 4.

disabilities like autism.[22] Self-advocacy groups have received considerable scholarly attention recently, and the findings of the research studies indicate that self-advocates who engaged in new activities made new friends, developed more confidence, and assumed new and positive social identities and roles.[23] In investigating music's benefits in modifying the brain and behavior, Megha Sharda et al. study children with ASD aged 6 to 12.[24] The exploration findings are that music interventions positively influenced social interactions, and music intervention can alter brain connectivity and result in improved parent-reported outcomes in social communication. For individuals with ASD, this supports using music as a therapeutic tool. This research developed a strong case for employing music programs to reach the learner with ASD.

Ashleigh Hillier et al. study adolescents between the ages of 13 and 29, considered to be high functioning with ASD.[25] Applying the computer application SoundScape, participants engaged in activities to create musical compositions. The curriculum was designed around small group work, encouraging social interactions and collaboration. The research demonstrates improved parent-reported outcomes in social communication, collaboration with others, and mood regulation. Hillier suggests that exploring the students' choice of computer applications may be a course of action for future research in music education.[26] Future research such as this study would show which applications encourage the most collaboration, are most favorable for

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[22] Mallander et al., "Self-Advocacy for People with Intellectual Disability in Sweden," 1.

[23] Ibid., 2.

[24] Megha Sharde, Carola Tuerk, Rakhee Chowdhury, Kevin Jamey, Nicholas Foster, Melanie Custo-Blanch, Melissa Tan, Aparna Nadig, and Krista Hyde, "Music Improves Social Communication and Auditory-Motor Connectivity in Children with Autism," *Translational Psychiatry* 8, no. 231 (2018): 7.

[25] Ashleigh Hillier, Gena Greher, Alexa Queenan, Savannah Marshall & Justin Koper, "Music, Technology, and Adolescents with Autism Spectrum Disorders: The Effectiveness of the Touch Screen Interface," *Music Education Research* 18, no. 3 (2016): 271-272.

[26] Ibid., 278.

music literacy understanding, and are valuable for improving social development among students with special needs.

Researchers have developed novel music-based methods in recent years to improve cognitive, language, and social deficits in persons suffering from neurological illnesses such as autism. Results of studies applying novel, music-based methods in children and adults with ASD demonstrated improved neuropsychological status regarding attention, communication, and increased cognitive processing.[27] Researchers have also indicated that music therapy improves social communication and cognitive skills. LaGasse states, "There are several reasons musical stimuli may help develop social skills."[28] The rhythmic components of musical stimuli provide an external cue to further aid children with ASD in organizing, predicting, and responding. These individuals also experience the inability to plan, initiate, and follow through with complex motor plans required for social skills; this lack of organization could affect a person's ability to engage socially. Rhythm and music may provide a unique accommodation for these deficits.[29]

Music therapy interventions can improve social skills, such as increased engagement behavior, emotional engagement, and social interaction.[30] Computers can be a more suitable learning tool for individuals with ASD than traditional instruments, as they provide a predictable response and help maintain students' interest.[31] Amy Clements-Cortés and Joyce Yip discuss that individuals with ASD respond "positively to music experiences presented in a more

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[27] Särkämö et al., "Editorial: Music, Brain, and Rehabilitation," 103.

[28] A. Blythe LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder: A Review of Music Therapy Outcomes," *Patient Related Outcome Measures* 8 (2017): 25.

[29] Ibid.

[30] Ibid.

[31] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 3.

individualized goal-centered approach with a higher success rate than traditional music lessons or group lessons."[32] Educators can offer to listen to the requests and choices of their students to be incorporated into instruction, which benefits the students, as well as encouraging students to express oneself and influence change in activities and decisions.[33]

Problem Statement

Music-based methods applying technology and student choice of technology are not robustly studied with adolescents with disabilities. Various approaches to researching students with ASD and technology have included children under 13.[34],[35],[36],[37] No studies have been conducted on adolescents using student choice on a computer for instruction. The closest one was Esposito et al. who studied the increase of cognitive and social skills in students with ASD aged four years using iPads to measure attention, vocabulary, and imitation.[38] The research attempted to link technology and learning for special education. A considerable improvement in scores in Esposito et al's. study was achieved with tablet applications in the experimental group, particularly in attention and vocabulary.

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[32] Amy Clements-Cortés and Joyce Yip, "Benefits of Community Music Experiences for Persons Along the Autism Spectrum," *The Canadian Music Educator* 59, no. 1 (2017): 34.

[33] Xin and Leonard, "Using iPads to Teach Communication Skills of Students with Autism," 4158.

[34] Ibid.

[35] Esposito et al., "Using Tablet Applications for Children with Autism 201.

[36] Benjamin E. Yerys, Jennifer R. Bertollo, Lauren Kenworthy, Geraldine Dawson, Elysa J. Marco, Robert T. Schultz, and Linmarie Sikich, "Brief Report: Pilot Study of a Novel Interactive Digital Treatment to Improve Cognitive Control in Children with Autism Spectrum Disorder and Co-occurring ADHD Symptoms," *Journal of Autism and Developmental Disorders* 49, no. 4 (2019): 1727-1737.

[37] Christopher J. Rivera, Lee L. Mason, Iffat Jabeen, and Josiah Johnson, "Increasing Teacher Praise and on Task Behavior for Students with Autism Using Mobile Technology," *Journal of Special Education Technology* 30, no. 2 (2015): 101-111.

[38] Esposito et al., "Using Tablet Applications for Children with Autism," 201.

Xin and Leonard examine the effects of iPad use to assist students with autism aged ten years who presented little or no speech in learning communication skills.[39] The investigation suggests that music may become a channel for students who have hindered social interactions because group music encourages turn-taking in a non-verbal circumstance. Participating in group music therapy, students with ASD can learn to tolerate the presence of others and practice social behaviors.

Research with adolescents over the age of 13 needs to be improved. One study by Hillier et al. investigates the effectiveness of the iPad for 23 high-functioning adolescents with autism ages 13 – 29 within a music therapy program.[40] Applying the computer application SoundScape, participants engaged in activities to create musical compositions. The research demonstrates improved parent-reported outcomes in social communication, collaboration with others, and mood regulation. Hillier discusses, "Technology in music education is gaining momentum, although very little work has focused on students with disabilities."[41]

A few studies have investigated music's benefits in modifying the brain and behavior. Sharda et al. study children aged 6 to 12 with ASD using music intervention to improve social communication.[42] The exploration findings were that music interventions positively influenced social interactions, altered brain connectivity, and enhanced parent-reported outcomes in social touch. Hillier et al. study adolescents with ASD who demonstrated enhancement of skill

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[39] Xin and Leonard, "Using iPads to Teach Communication Skills of Students with Autism, 4154.

[40] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 271-272.

[41] Ibid., 269.

[42] Sharde et al., "Music Improves Social Communication and Auditory-Motor Connectivity," 7.

development with social understanding.[43] The research revealed improved parent-reported effects in social communication, collaboration with others, and mood regulation.

The problem is that the literature has not fully addressed music-based methods using technology and student choice of technology with adolescents with disabilities to promote music literacy. Most investigations conducted studied autistic students younger than 13, however, not all experiments were music-based with computer applications. This study highlights adolescents with disabilities employing computer applications of student choice with reading notes and rhythms to promote music literacy.

Purpose Statement

This qualitative case study aimed to describe and identify how the high school beginning band students' choice of computer applications may increase music literacy for percussion students with ASD. There are still very few randomized control studies on the effectiveness of computer applications, although the literature on this topic appears to have demonstrated advantages for people with ASD. Cynthia Putnam and Lorna Chong conducted a review of software and technology for the ASD individual.[44] They concluded that relaxed interactions with touch-screen devices offer a simple exchange especially beneficial to those on the autism spectrum.[45] Information collected from the review would help designers and developers create more meaningful and useable products for the expanding segment of the population that suffers from ASD.[46] The review supports Hillier's findings that computer applications gave creative

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[43] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 271-272.

[44] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 9.

[45] Cynthia Putnam and Lorna Chong, "Software and Technologies Designed for People with Autism: What Do Users Want?," in *Proceedings of the 10th International ACM SIGACCESS Conference on Computers and Accessibility* (New York, NY: Association for Computing Machinery), 9.

[46] Ibid.

freedom, reducing stress for non-music students.[47] Hillier's consideration for future research, "greater exploration of the student's choice of applications seems a fruitful avenue for future research," is the research inquiry guiding the current study.[48]

Meetings were conducted with two male and four female adolescents with ASD, implementing a choice of note-reading and rhythm computer applications, observations, and exit interviews. Utilizing a selection of computer applications may provide insight into better supporting adolescents with ASD who want to participate in the music program. This work is important because few studies have been conducted on adolescents with ASD in music education.

Two male and four female participants with ASD were recruited from one private high school to conduct the current study. Ages ranged from 14 to 17; the students were considered high functioning on the autism spectrum. All participants were interested in music but needed help figuring out how to participate. Only one participant had experience reading percussion music in the high school band. Not all participants presented with a diagnosis of autism, but the school resource teachers helped identify that the participants were on the spectrum. Some participants had high anxiety and language processing difficulties, and employing computer applications seemed to calm them. Utilizing the percussion instruments after investigating the computer applications gave confidence and provided less stress for the participants.

Significance of the Study

This study serves as an example of how the high school beginning band students' choice of applications can increase their understanding of music reading for percussionists with ASD.

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[47] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 275-276.

[48] Ibid., 278.

This study also demonstrates how technology could be implemented as a tool so that the music teacher may integrate individuals with ASD into the band program. Students with ASD can benefit from an educational environment supporting learning styles and collaboration while learning social skills. Additionally, this study explains how the beginning band percussion student could learn to develop skills to have a say and influence change in activities and decisions for oneself in other disciplines, as involvement in music may aid other cognitive skills.[49],[50]

The significance of the current study is essential as it will add to the literature on music-based computer applications for autistic students. Comparing the current study to Hillier's investigations, both are similar in employing music-based computer applications and involving adolescents ages 13 – 19.[51] The author and Hillier chose computer applications, however, in the current study, students could choose which of the five or more computer applications they enjoyed the best.[52] Improving social interactions and building self-esteem and confidence are challenges for students with ASD. Touch screen technology may benefit this population segment as research has shown tablet use fosters social interactions between users.[53] The current study demonstrated positive responses to the applications and maintained motivation for learning notes and rhythms.

Research Questions

The following research questions formed the basis of this study:

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[49] Mallander et al., "Self-Advocacy for People with Intellectual Disability in Sweden," 2.

[50] Lense and Dykens, "Musical Interests and Abilities in Individuals with Developmental Disabilities," 299.

[51] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 271-272.

[52] Ibid.

[53] Ibid., 278.

RQ1: What ways does the high school beginning band student's choice of computer applications demonstrate an understanding of the reading of music for percussionists with autism spectrum disorder?

RQ2: What ways can the high school beginning band students with ASD learn to self-advocate in other disciplines while focusing on the choice of instructional materials in music class?

Research Methodology and Design

The method most appropriate for this research is a qualitative case study. The case study method favors the collection of data in a natural setting; students and other new researchers apply this approach when assuming a research project based on their workplace.[54] The case study is a multiple case design gathering evidence from direct observations, participant observation, and interviews.[55] Computer applications are utilized that were predictable and controllable, an essential component for those with ASD. Applying research from Hillier et al., the sessions promoted structure and predictability by keeping the participants informed. Each session occurred on the same day and time each week and utilized the same rooms, participants, and staff. The components of structure and predictability are essential for developing a successful case study of individuals with autism.[56]

Previous research has shown that those with ASD demonstrate enhanced musical abilities.[57] Work in this area has been increasing, and most research has focused on music

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[54] Jennifer Rowley, "Using Case Studies in Research," *Management Research News* 25, no. 1 (2002): 16.

[55] Ibid., 23.

[56] Ashleigh Hillier, Gena Greher, Nataliya Poto, and Margaret Dougherty, "Positive Outcomes Following Participation in a Music Intervention for Adolescents and Young Adults on the Autism Spectrum," *Psychology of Music* 40, no. 2 (March 2012): 209.

[57] Ockelford, "The Potential Impact of Autism on Musical Development," 124.

therapy-type interventions with less emphasis on technological-based approaches.[58] Research has revealed the benefits of music for reducing the core symptoms of ASD. Music programs for individuals with ASD have shown improved self-esteem, positive mood regulation, enhanced verbal communication, and reduced stress and anxiety levels.[59] By studying Hillier et al.'s research, with technological-based approaches, allowing for student choice may improve student learning of reading notes and rhythms.[60]

A rubric determines student participation in the study (see Appendix G).[61] The researcher observes and evaluates each student on how well the computer application is understood and whether or not achievement improves during the set time of the meeting (see Appendix H).[62] Observing and assessing students during each meeting checks for understanding if musical literacy transfers from the computer applications to drums and mallets in the music room (see Appendix I).[63] Each meeting ends with an exit interview for the students to give feedback. Students provide feedback on the class, the computer applications, negative and positive feelings, and social and emotional development (see Appendix L).[64]

Meetings one and two established the routines and allowed the participants to become familiar with all six computer applications. Subsequent meetings permitted the participants to determine which application or applications were the application(s) of choice, and each student

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[58] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 270.

[59] Ibid.

[60] Ibid., 278.

[61] Dr. Nathan Street, "Chorus Music Exemplar Plan" (example in MUSC 846 at Liberty University, Lynchburg, VA, July 19, 2021).

[62] Kimberley VanWeelden and Julia Heath-Reynolds, "Steps to Designing Authentic Assessments for Students with Disabilities in Music Classes," *Music Educators Journal* 104, no. 2 (2017): 30.

[63] Ibid.

[64] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 274.

reported on which application(s) they enjoyed. The researcher then gathered scores from the applications as participants engaged. The last four meetings focused on more timed versions of the application(s) if the participants agreed, along with participants experimenting with reading notes and rhythms by playing the mallets and snare drum.

Following Hillier's research example, participants will meet two to three times weekly to employ the computer applications and for observation.[65] Giving a student a choice with the computer applications, rather than only offering one application choice, provides more information on learning styles, preferences, and collaboration. Also observed was music literacy understanding and social and emotional development among participants with special needs.

Core Concepts

The core concepts of this study are to understand and discover how implementing beginning band students' choice of computer applications demonstrated an increased understanding of reading rhythms and notes for percussionists with ASD. Since students with ASD present with specific deficits in verbal and nonverbal social communication skills, another pertinent aspect of the study is to consider whether the student with ASD, by applying student choice, can begin to develop skills to have a say and influence change in activities and decision for oneself in other disciplines.[66],[67] If students employ highly preferred objects and actions, motivation to be involved in class could be high, resulting in the student expressing themself, which is beneficial in a school setting. By employing student choice, the student can express him or herself instead of the teacher advising the student's choice.

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[65] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 272-273.

[66] Lense and Dykens, "Musical Interests and Abilities in Individuals with Developmental Disabilities," 282.

[67] Mallander et al., "Self-Advocacy for People with Intellectual Disability in Sweden," 2.

Children with ASD have difficulty with social interaction skills according to A. Blythe LaGasse.[68] Research on social skills in ASD indicates that these skills are challenging to learn, and more focus can be applied to developing social skills because of lifelong implications.[69] Implementing music may help to address social skills in children with ASD, and research evidence has indicated that music therapy interventions can successfully promote social skills.[70] Adam Ockelford explains that many children on the autism spectrum have little to no language and resist social contact.[71] Music activities have been proposed as a strength-based rehabilitation tool for ASD as music enjoys universal appeal, a natural reward value, and the ability to modify the brain and behavior.[72]

Each individual with ASD will respond differently to teaching styles because each one is unique.[73] Slower presentation styles provide choices for the educator to determine the best methods for the student.[74] Being respectful of cognitive differences in individuals with ASD because of brain differences yields more possibilities for effective interventions.[75] Educators can offer provisions for aiding in memory by providing step-by-step instructions, allowing dictation for verbal students instead of handwriting, permitting students to walk around the room if individuals experience sensory overload, and not calling attention to irrelevant movements so as not to increase anxiety.[76]

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[68] LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder," 24.

[69] Ibid.

[70] Ibid.

[71] Ockelford, "The Potential Impact of Autism on Musical Development," 124.

[72] Sharde et al., "Music Improves Social Communication and Auditory-Motor Connectivity," 7.

[73] Feinstein, *The Praeger Handbook of Learning and the Brain,* 104.

[74] Ibid., 105.

[75] Ibid., 104.

[76] Ibid.

Teachers should be aware that sensitivity to specific touch or tactile experiences occurs in over 50 percent of individuals with ASD.[77] A reassuring touch on the forearm or a hug may be unpleasant. There is a substantial amount of data that suggests that distorted senses are in an individual on the autistic spectrum. Teachers should communicate clearly with an ASD student so that a new sensation will not be a total surprise, causing a startled reaction.[78]

Children with ASD are often described as preoccupied and withdrawn and can be unresponsive in social situations because of low verbal ability. Music may become a method of expression for these individuals to facilitate taking turns and interacting socially in a non-verbal case. In group music therapy, children with ASD can learn to tolerate the presence of and physical contact with other people, distinguish between oneself and others, and practice social behavior.[79]

Definition of Terms

The following terms will be employed throughout and will be defined as follows:

Abstract Conceptualization: The learner attempts to generalize a model of what the experience is.[80]

Active Experimentation: The learner applies the model to a new experiment.[81]

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[77] Ann Cravero, "Exceptional Students in the Voice Studio: Understanding and Training Students with Asperger's Syndrome," *Journal of Singing* 77, no. 2 (2020): 166.

[78] Ibid.

[79] Yen Na Yum et al., "Music Therapy as Social Skill Intervention," 2.

[80] Abdullah Konak, Tricia K. Clark, and Mahdi Nasereddin, "Using Kolb's Experiential Learning Cycle to Improve Student Learning In Virtual Computer Laboratories," *Computers & Education* 72 (2014): 13.

[81] Ibid.

Active Learning: "The learning process engages learners in a mindful processing of information."[82]

Autism Spectrum Disorder (ASD): Autism is a spectrum disorder, typically diagnosed by the age of three. Autism is considered a spectrum disorder with three general areas of impairment: communication, socialization, and repetitive patterns of behavior.[83]

Creative Thinking: "That thought that leads to judgment, oriented by context, self-transcendental and sensitive to criteria."[84]

Cognitive Control: Maintains situational information and inhibits prepotent responses to achieve goal-directed behaviors.[85]

Cognitive Flexibility: The capacity to flexibly adjust our behavioral responses to meet the needs of a given situation.[86]

Cognitive Processes: Critical thinking, creative thinking, and metacognition.[87]

Cognitive Training: Assumes that the brain and cognition can be improved through training that target specific cognitive functions, such as memory, attention, or executive function. Exposure to

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[82] Päivi Hakkarainen, Tarja Saarelainen, and Heli Ruokamo, "Assessing Teaching and Students' Meaningful Learning Processes in an E-Learning Course," In *E-learning Technologies and Evidence-based Assessment Approaches,* eds., Christine Spratt and Paul Laibcygier, (Hershey, PA: IGI Global, 2009), 24.

[83] Putnam and Chong, "Software and Technologies Designed for People with Autism", 4.

[84] Cristián Silva Pacheco and Carolina Iturra Herrera, "A Conceptual Proposal and Operational Definitions of the Cognitive Processes of Complex Thinking," *Thinking Skills and Creativity* 39 (2021): 100798.

[85] Benjamin E. Yerys, Jennifer R. Bertollo, Lauren Kenworthy, Geraldine Dawson, Elysa J. Marco, Robert T. Schultz, and Linmarie Sikich, "Brief Report: Pilot Study of a Novel Interactive Digital Treatment to Improve Cognitive Control in Children with Autism Spectrum Disorder and Co-occurring ADHD Symptoms," *Journal of Autism and Developmental Disorders* 49, no. 4 (2019): 1727.

[86] Adam R. Cassidy, "Cognitive Flexibility in Critical CHD: A Target For Intervention," *Cardiology in the Young* 30, no. 8 (2020): 1062.

[87] Pacheco and Herrera, "Cognitive Processes of Complex Thinking," *Thinking Skills and Creativity,* 100796.

cognitive training is supposed to improve the performance of cognitive tasks and induce functional and structural changes in the brain that help to reduce cognitive decline.[88]

Concrete Experience: The learning actively experiments with a concept.[89]

Cooperative Learning: Entails using groups as tools for enhancing individual learning.[90]

Critical Thinking: Judgments, understanding that a judgment is a determination of thought, speech, action, or creation; includes judgments of relationships, connections, comparisons, similarities, and differences.[91]

Executive Functions (EF): A family of top-down mental processes that make it possible for individuals to: pay attention, reason, and problem-solve; exercise choice; see things from different perspectives; and flexibly adjust to change or new information. Three core EFs exist working memory, inhibitory control, and cognitive flexibility.[92]

Experiential Learning: The process of making meaning from direct experience and is a student-centered form of instruction.[93]

Goal-orientated Learning: An environment in which students work actively to achieve a cognitive goal and can define their learning objectives.[94]

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[88] Clémence Joubert and Hanna Chainay, "Aging Brain: The Effect of Combined Cognitive and Physical Training on Cognition as Compared to Cognitive and Physical Training Alone – A Systemic Review," *Clinical Interventions in Aging* 13 (2018): 1272.

[89] Konak et al., "Using Kolb's Experiential Learning Cycle," 13.

[90] Hakkarainen et al., "Assessing Teaching and Students' Meaningful Learning Processes, 24.

[91] Ibid., 100798.

[92] Adele Diamond, "Executive Functions," In *Handbook of Clinical Neurology,* Vol. 173 of *Neurocognitive Development: Normative Development*, ed. A. Gallagher, C. Bulteau, D. Cohen, and J. L. Michaud (Amsterdam, Netherlands: Elsevier, 2020), 225.

[93] Robert M. Cornell, Carol B. Johnson, and William C. Schwartz, Jr., "Enhancing Student Experiential Learning with Structured Interviews," *Journal of Education for Business* 88, no. 3 (2013): 136.

[94] Hakkarainen et al., "Assessing Teaching and Students' Meaningful Learning Processes, 25.

Individual Learning: Learners have unique learning styles and strategies and that students' prior knowledge always influences understanding.[95]

Inhibitory Control: Involves controlling one's attention, behavior, thoughts, or emotions to override a strong internal predisposition or external lure and do what one intends instead.[96]

Intellectual or Developmental Disorder (IDD): Conditions of incomplete mental development based on known or unknown biological or environmental causes; can be considered first and foremost as a failure of cognitive progression that occurs during the developmental period, with loss in cognitive advancement during development affects adaptive reasoning and may result in deficits in functioning and disability.[97]

Learning Process: Refers to the effect of the pedagogy on students' learning.[98]

Learning Outcome: The effect of the pedagogy on the student's learning.[99]

Metacognition: Refers to knowledge of one's cognitive processes, products, or anything related.[100]

Music Education: A field of study focused on teaching and learning music.[101]

Reflective Observation: The learner consciously reflects on the experience.[102]

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[95] Hakkarainen et al., "Assessing Teaching and Students' Meaningful Learning Processes, 25.

[96]Diamond, "Executive Functions," In *Handbook of Clinical Neurology*, 226.

[97] Nirbhay N. Singh, *Handbook of Evidence-Based Practices in Intellectual and Developmental Disabilities,* (Switzerland: Springer Science and Business Media, 2016), 11.

[98] Shuhong Luo and Melanie Kalman, "Using STML as a Theoretical Model for a Qualitative Case Study," *Nurse Researcher* 27, no.1 (03, 2019): 14.

[99] Ibid.

[100] Pacheco and Herrera, "Cognitive Processes of Complex Thinking," *Thinking Skills and Creativity,* 100798.

[101] Charles R. Hoffer *Introduction to Music Education.* Fourth ed. (Long Grove, IL: Waveland Press Inc., 2017), 13.

[102] Konak et al., "Using Kolb's Experiential Learning Cycle," 13.

Self-Advocacy: Speaking up on one's behalf and deciding what is best for oneself, concerned with ensuring that people with intellectual disabilities can have a say about issues important to them.[103]

Theory of Mind: The ability to process information from another individual's perspective; the autistic individual has trouble picking up on body language, glances, or other social cues to perceive if another individual is angry, happy, or sad.[104]

Weak Central Coherence: A focus on the local rather than the global aspects of an object or interest.[105]

Working Memory: The limited-capacity storage system that maintains and manipulates information over short periods; an essential predictor of academic aptitude and a critical bottleneck underlying higher-order cognitive processes, including controlled attention and reasoning.[106],[107]

Summary

Chapter 1 provides the background related to implementing music in special education, specifically with students with autism, the percentage of the student population that may present with ASD, and the potential for music education and technology to address learning among this population. The discussion presents the gap in the literature on the educational benefits of music-

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[103] Mallander et al., "Self-Advocacy for People with Intellectual Disability in Sweden," 1.

[104] Ryan M. Hourigan and Alice M. Hammel, "Understanding the Mind of a Student with Autism in Music Class," *Music Educator's Journal* 104, no. 2 (2017): 22.

[105] Hourigan and Hammel, "Understanding the Mind of a Student with Autism in Music Class," 23.

[106] Hikaru Takeuchi, Atsushi Sekiguchi, Yasuyuki Taki, Satoru Yokoyama, Yukihito Yomogida, Nozomi Komuro, Tohru Yamanouchi, Shozo Suzuki, and Ryuta Kawashima, "Training of Working Memory Impacts Structural Connectivity," *Journal of Neuroscience* 30, no. 9 (2010): 3297.

[107] Jacky Au, Ellen Sheehan, Nancy Tsai, Greg J. Duncan, Martin Buschkuehl, and Susanne M. Jaeggi, "Improving Fluid Intelligence with Training on Working Memory: A Meta-Analysis," *Psychonomic Bulletin & Review* 22, no. 2 (2015): 366.

based methods connected to technology and long-term cognitive gains for adolescents with ASD. Therefore, this qualitative case study aims to identify aspects of student choice using technology, demonstrating an increased understanding of music literacy, which has not been explored and researched regarding adolescent beginning band students with ASD. The problem is that the literature has not fully addressed music-based methods using technology and student choice of technology with adolescents with disabilities to promote music literacy. Most investigations conducted studied autistic students younger than 13, however, not all experiments were music-based with computer applications. The current study highlights adolescents with disabilities employing computer applications of student choice with reading notes and rhythms to promote music literacy. Many exceptional students would like to be involved in a music program but need more experience playing an instrument. Providing an opportunity for these adolescent students to learn reading music through computer applications can transfer to playing percussion instruments in the beginning band. Students with ASD can benefit from an educational environment that supports learning styles and collaboration with others, such as beginning band while learning social skills.

More research is necessary to serve these exceptional students, especially in music, since music may aid the development of other cognitive skills in students with IDDs.[108] The lack of information on the educational benefits of music-based methods while implementing technology for adolescents with disabilities is unfortunate since involvement in music may aid the development of other cognitive skills.[109]

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[108] Lense and Dykens, "Musical Interests and Abilities in Individuals with Developmental Disabilities," 299.

[109] Ibid.

Research shows that students with ASD respond positively to music therapy interventions incorporating active and improvisational techniques.[110] Music activities have been proposed as a strength-based rehabilitation tool for ASD as music enjoys universal appeal, a natural reward value, and the ability to modify the brain and behavior.[111] Self-advocacy groups have received considerable scholarly attention recently, and the findings of the research studies indicate that self-advocates who engaged in new activities made new friends, developed more confidence, and assumed new and positive social identities and roles.[112] This study could benefit other discipline areas by encouraging growth in cognitive skills, self-advocacy skills, and communication skills for the ASD individual.

[110] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 1.

[111] Sharde et al., "Music Improves Social Communication and Auditory-Motor Connectivity," 7.

[112] Mallander et al., "Self-Advocacy for People with Intellectual Disability in Sweden," 1.

Chapter 2: Literature Review

Introduction

Children with ASD have difficulty with social interaction skills, according to A. Blythe LaGasse.[113] Research on social skills in ASD indicates that these skills are challenging to learn, and more focus can be applied to developing social skills because of lifelong implications. Implementing music may help to address social skills in children with ASD, and research evidence has indicated that music therapy interventions can successfully promote social skills.[114] The main challenge for the remediation of ASD is finding the most effective remediation programs and selecting a personalized program for each child with ASD.[115]

This qualitative case study addresses music-based methods via technology and student choice of computer applications with adolescents with disabilities to promote music literacy. Most investigations conducted studied autistic students younger than 13, however, not all experiments were music-based with computer applications. The current study highlights adolescents with disabilities employing computer applications of student choice with reading notes and rhythms to promote music literacy. Promoting music literacy may allow these exceptional adolescent students to be part of the beginning band program as percussionists to encourage social skills and collaborate with others in a group setting. Using student choice with computer applications could aid in utilizing the most effective remediation program for ASD students.

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[113] LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder," 24.

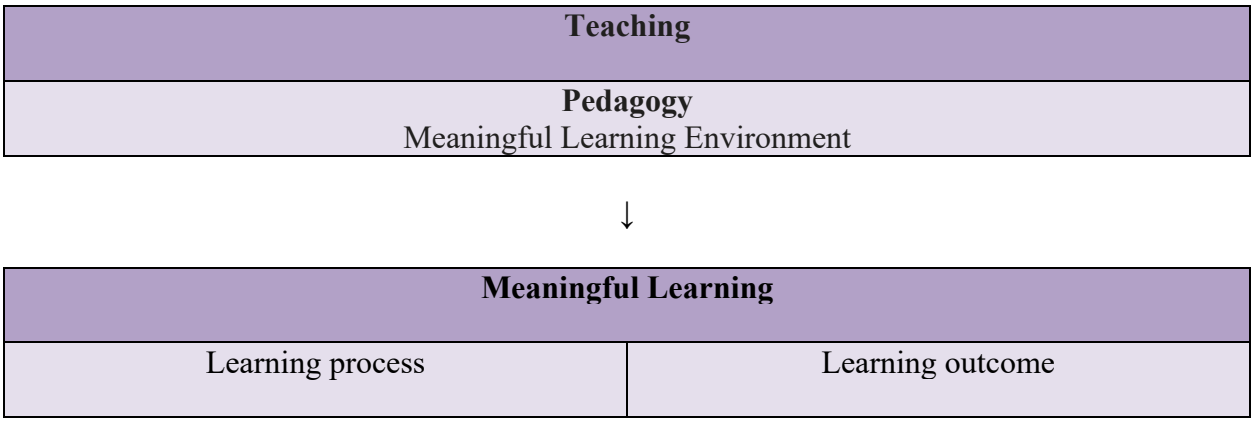
[114] Ibid.

[115] Pasqualotto et al., "Effects of Cognitive Training," *Brain Sciences* 11, no. 10 (2021): 1299.

Theoretical Framework

Studying the educational theoretical model of Luo and Kalman, the researchers developed and utilized a model for a qualitative case study.[116] The simplified teaching-meaningful learning (STML) model utilizes two main components: teaching and meaningful learning. Meaningful learning has two segments: the learning process and the learning outcome, as shown in Figure 1.[117]

Figure 1. The simplified teaching meaningful learning (STML) model



Source: Data from Shuhong Luo and Melanie Kalman, "Using STML as a Theoretical Model for a Qualitative Case Study," *Nurse Researcher* 27, no.1 (03, 2019): 13. Figure 1.

The STML model's teaching and learning concepts perspective utilizes a cognitive rather than a behavioral viewpoint. Experiential learning, or hands-on learning, is the concept of learning by doing suggested by John Dewey in the early 20th century.[118] In the 1980s, David

[116] Luo and Kalman, "Using STML as a Theoretical Model for a Qualitative Case Study," 13.

[117] Ibid., 12-13.

[118] Peng-Hsu Chen, Hsuan-Wei Ho, Hung-Chou Chen, Ka-Wai Tam, Ju-Chi Lui, and Li-Fong Lin, "Virtual Reality Experiential Learning Improved Undergraduate Students' Knowledge and Evaluation Skills Relating to Assistive Technology for Older Adults and Individuals with Disabilities," *BMC Medical Education* 24, no. 1 (2024): 2.

Kolb published the Kolb Experiential Learning Cycle Theory.[119] Kolb's theory will be discussed in the following pages and is based on Dewey's theory. This form of learning is also associated with meaningful learning.[120] Experiential learning aims to involve the learner actively, and students learn through self-directed investigation of topics that the individual finds attractive.[121] Luo and Kalman developed the STML based on experiential learning and Hakkarainen's teaching-meaningful learning (TML) model.[122] The current study included an analysis of the student's cognitive learning through computer applications of student choice related to previous knowledge and learning processes. The STML model was an appropriate model to utilize for this study.[123]

Hakkarainen's TML model consists of teaching and meaningful learning, defined in terms of 17 process characteristics and expected outcomes.[124] The model draws on the concept of meaningful learning, which is most often associated with the work of Ausubel.[125] At the core of applying the TML model is that not all of the 17 characteristics of meaningful learning need to be present at any given time. This is shown in Figure 2[126]

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[119] Abdullah Konak, Tricia K. Clark, and Mahdi Nasereddin, "Using Kolb's Experiential Learning Cycle to Improve Student Learning in Virtual Computer Laboratories," *Computers & Education* 72 (2014): 13.

[120] Luo and Kalman, "Using STML as a Theoretical Model," 13.

[121] Cornell et al., "Enhancing Student Experiential Learning," 136-137.

[122] Luo and Kalman, "Using STML as a Theoretical Model," 13.

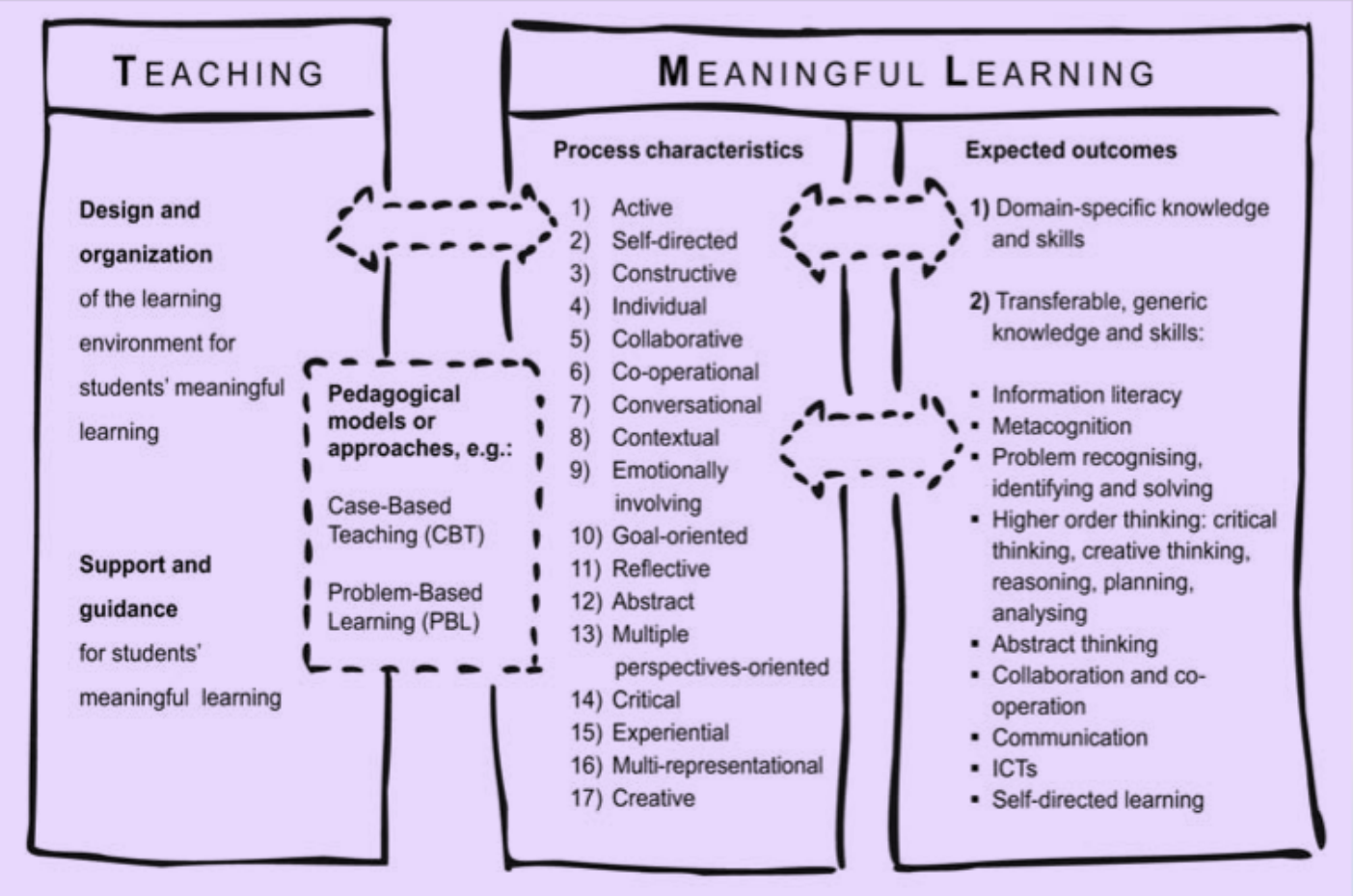
[123] Ibid.

[124] Hakkarainen et al., "Assessing Teaching and Students' Meaningful Learning Processes, 21.

[125] Ibid., 23.

[126] Ibid., 24.

Figure 2. The TML model



Source: Data from Päivi Hakkarainen, Tarja Saarelainen, and Heli Ruokamo, "Assessing Teaching and Students' Meaningful Learning Processes in an E-Learning Course," In *E-learning Technologies and Evidence-based Assessment Approaches,* eds., Christine Spratt and Paul Laibcygier, (Hershey, PA: IGI Global, 2009), 23. Figure 1.

Characteristics of meaningful learning incorporated into this study for students' learning processes were as follows; active learning, in which "the learning process engages learners in a mindful processing of information;"[127] individual learning, where learners have unique learning styles and strategies and that students' prior knowledge always influences learning; cooperative learning, entailing using groups to enhance individual learning; goal-oriented learning, where

[127] David H. Jonassen, "Supporting Communities of Learners with Technology: A Vision for Integrating Technology with Learning in Schools," *Educational Technology* 35, no. 4 (1995): 60.

students work actively to achieve a cognitive goal and can define their learning objectives; and experiential learning, in which students can use their experiences as starting points in learning and apply their practical experiences.[128] The expected outcomes of the meaningful learning process were that students are self-directed and encouraged to learn through understanding rather than memorizing.[129]

Under experiential learning, students learn by doing, discovering, reflecting, and applying rather than teacher-directed instruction.[130] According to Kolb, "Learning is the process of creating knowledge through transforming experience."[131] Kolb identifies the Experiential Learning Cycle in four stages and suggests that for a complete learning experience, students must go through all four steps; this is seen in Figure 3 below.[132]

[128] Hakkarainen et al., "Assessing Teaching and Students' Meaningful Learning Processes, 24-25.

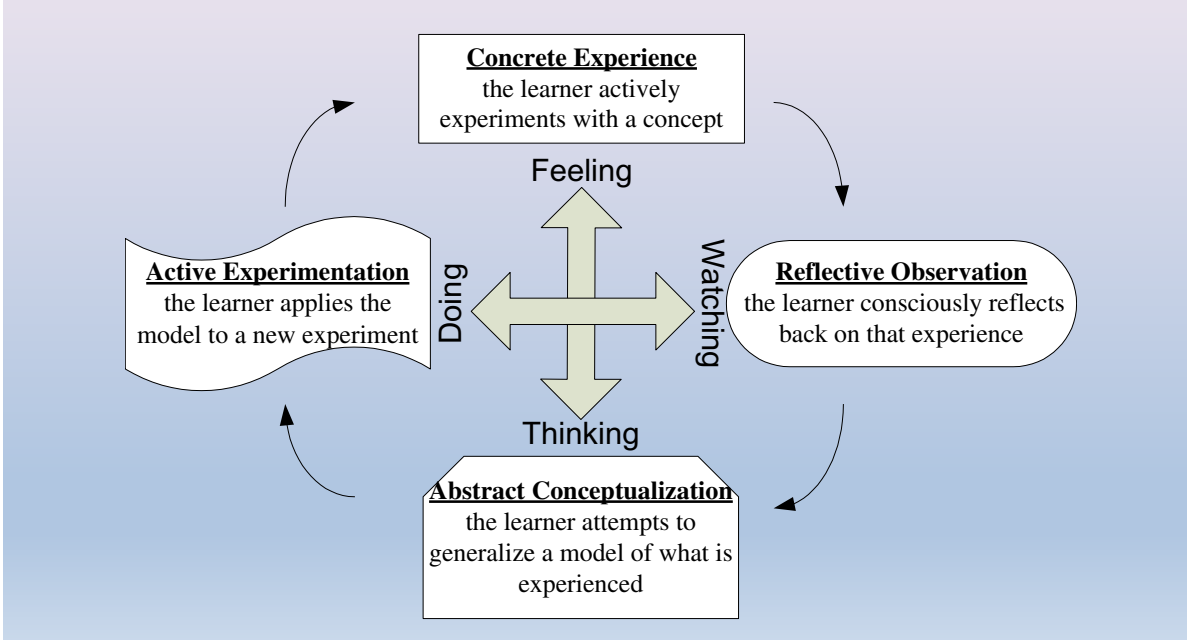
[129] Ibid., 25.

[130] Shuhong Luo and Melanie Kalman, "A Technology Training Protocol for Meeting QSEN Goals: Focusing on Meaningful Learning," In *Nursing Forum* 53, no. 1 (2018): 21.

[131] Konak et al., "Using Kolb's Experiential Learning Cycle," 13.

[132] Ibid.

Figure 3. Four Stages of the Kolb's Experiential Learning Cycle



Source: Data from Abdullah Konak, Tricia K. Clark, and Mahdi Nasereddin, "Using Kolb's Experiential Learning Cycle to Improve Student Learning In Virtual Computer Laboratories," *Computers & Education* 72 (2014): 13. Figure 1.

The main difference between Kolb's learning cycle and other active learning styles is that Kolb considers experience as the foundation of learning.[133]

The four stages of Kolb's Learning Cycle support the goal of hands-on learning, identified as follows:

- Concrete Experience: the education actively experiments with a concept – Feeling
- Reflective Observation: the learner consciously reflects on that experience – Watching
- Abstract Conceptualization: the learner attempts to generalize a model of what one is experiencing – Thinking
- Active Experimentation: the learner applies the model to a new experiment – Doing[134]

[133] Konak et al., "Using Kolb's Experiential Learning Cycle," 13.

[134] Ibid.

Some criticisms of Kolb's learning cycle are that the steps overlap and do not occur in sequential order, however, implementing this framework can support learning outcomes in activities that aim to improve students' technical abilities.[135]

Data was collected from authentic activities using Kolb's learning cycle on student learning, incorporating computer applications of student choice and experimenting with drums and mallets in the music classroom. After each session, the researcher asked students to complete a short questionnaire describing the activity and to provide feedback on the learning experience (see Appendix C). Observations of the students made by the instructor during each session included student participation, student involvement, the level of participation with other students, and improvements in music literacy by naming notes and performing rhythms (see Appendix A and B).

Analyzing the learning outcomes during each session, the instructor rated students with a coding system using the 'poor,' 'good,' or 'excellent' categories. The instructor needed to consistently assess students' performance to understand what students had learned. Students may need to practice using previous knowledge from computer applications to retain information. Each student in this case study had a unique academic background, prior knowledge, and a unique learning process, affecting the learning outcomes.[136] This researcher's qualitative case study found that all participants had a similar learning outcome at the end of the survey, including improved music literacy of reading notes and rhythms to participate at the beginning of high school band.

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[135] Konak et al., "Using Kolb's Experiential Learning Cycle," 14.

[136] Luo and Kalman, "Using STML as a Theoretical Model," 15.

Intellectual Disabilities such as Autism Spectrum Disorder

Several studies confirm that the frequency of ASD is significantly increasing.[137] Teachers with an average of 25 students per class have grown from never meeting a student with ASD during their entire career to being likely in 2014 to encounter one in as few as every seven classes.[138] In 2012, the Centers for Disease Control and Prevention estimated that 1 in every 88 children had been diagnosed with ASD. This number has doubled since 2000.[139] In 2018, 1 in 44 eight-year-old children were identified with ASD from 11 states with the Autism and Developmental Disabilities Monitoring Network (ADDM) in the United States; these states include Arizona, Arkansas, California, Georgia, Maryland, Minnesota, Missouri, New Jersey, Tennessee, Utah, and Wisconsin.[140] These findings report an overall higher ASD prevalence than previous estimates from the ADDM Network.

Autism is not a single condition. Instead, it is an umbrella term for many causes of atypical cognitive development. If one is searching for a single neurological reason when studying autism, it is likely to be frustrating.[141] Autism is a neurological condition that usually manifests within the first two or three years of childhood. Impairments in social interaction, communication, and repetitive or stereotyped movements characterize ASDs.[142] More than sixty studies confirm that differences in the cerebellum, which is primarily involved in motor control

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[137] Feinstein, *The Praeger Handbook of Learning and the Brain*, 99.

[138] Rammier, *From the Brain to the Classroom: The Encyclopedia of Learning*, 97.

[139] CDC Newsroom, Press Release, (2012, March 29), https://www.cdc.gov/media/releases/2012/p0329_autism_disorder.html.

[140] Matthew J. Maenner, Kelly A. Shaw, Amanda V. Bakian, et. al., Prevalence and Characteristics of Autism Spectrum Disorder Among Children Aged 8 Years – Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2018, MMWR Surveill Summ 2021;70 (No. SS-11): 1-16, DOI: http://dx.doi.org/10.15585/mmwr.ss7011a1.

[141] Ockelford, "The Potential Impact of Autism on Musical Development," 122-123.

[142] Lense and Dykens, "Musical Interests and Abilities in Individuals with Developmental Disabilities," 282.

and initiating movement-based responses, occur in approximately 95 percent of all people diagnosed with ASD. These differences include the smaller overall size of the cerebellum, smaller but more densely packed neurons, and inefficient functioning.[143] Each person who presents with ASD is affected differently. People with ASD have many challenges related to social demands, transitions, and speech production, as all of these require a movement-based response.[144] The cerebellum affects overall language generation, and cerebellum differences also affect sensory discrimination, visual-spatial perception, and sequencing.[145]

Other brain-based sensory differences have been well-documented among people with ASDs. Decreased blood flow to the auditory cortex may make it difficult for some individuals with ASDs to ascertain auditory input. Deficiencies in the neuronal pathways from the limbic system leading to the prefrontal cortex may also explain why the expression of emotions in people with ASDs sometimes appears unusual and why some feelings are so intense. These structures and functions are also involved in social interactions that are, by definition, compromised in people with ASD.[146] Effective brain-based strategies to promote learning among students with ASDs include accommodating movement differences, reducing anxiety, providing access to multiple but universally understood communication options, respecting cognitive differences, and supporting sensory differences.[147]

The following is an extended perspective of a person with ASD in a crowded place talking about sensory processing difficulties:

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[143] Rammier, *From the Brain to the Classroom: The Encyclopedia of Learning*, 99.

[144] Ibid.

[145] Ibid., 100-101.

[146] Ibid., 101.

[147] Ibid., 102.

> My hearing may be very sharp. Dozens of people speak fast at the same time. The speakers loudly announce the offer of the day. The music sounds loud. Cash registers beep and squeak, a roaring coffee grinder. The meat slicer creaks, the little ones cry, the strollers squeak, the fluorescent lights buzz. My brain can't filter all this information and I'm overwhelmed! I could have an extremely sensitive sense of smell. The fish on the counter is not fresh, the man next to us did not take a shower today, the delicacy district offers sausage samples, the baby in front of us has a dirty diaper, in turn 3 employees wash the pickles spread on the floor. I feel like throwing up. And so many things disturb my eyes! Fluorescent light is too strong and flickering. Space seems to be moving. The flashing light makes everything around jump and distorts what I see. For me, there are too many objects to focus on (my brain could compensate with "tunnel vision"), the fans spinning on the ceiling, and there are so many silhouettes in constant motion. All of this affects the way I feel just sitting there and I no longer have a sense of my own being in space.[148]

ASD affects children of all ages, in varying degrees of severity, but this current study will focus on adolescents 13 and older who are high functioning with ASD. Some cognitive progressions, such as processing information, decoding body language, or other social cues, do not occur naturally in individuals with ASD. Cognitive processes often taken for granted are the theory of mind (ToM), central coherence, executive functioning, cognitive processing, and engagement. By understanding how music students with autism process information, appropriate ways to provide musical opportunities for them can be found.[149] Following the research example of Hillier and applying motivational components of incorporating student choice of computer applications and contingent positive reinforcement, students enjoyed learning notes and rhythms during the study.

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[148] Gheorghita Nistor and Cristian-Laurentiu Dumitru, "Preventing School Exclusion of Students with Autism Spectrum Disorder (ASD) Through Reducing Discrimination: Sustainable Integration Through Contact-Based Education Sessions," *Sustainability* 13, no. 13 (2021): 7061.

[149] Hourigan and Hammel, "Understanding the Mind of a Student with Autism," 21-22.

Intellectual Disabilities such as Autism Spectrum Disorder in the Music Classroom

As a form of nonverbal communication, music constitutes a domain of preserved skills and interests. It is a powerful and accessible affective stimulus that captures and emotionally rewards individuals with ASD.[150] Sota et al. found that in children presenting with ASD, musical training could improve working memory and reduce symptom severity.[151] The ASD group in the study demonstrated significantly lower musical ability but preserved rhythm. Rhythm is frequently applied to music therapy for ASDs and relates to movement. In previous studies, musical ability relates to many aspects of cognitive functioning.[152] Musical training at an early age develops general IQ, verbal memory, executive function, working memory, and visuospatial ability.[153] Molnar-Szakacs, Assuied, and Overy showed that musical understanding and appreciation are intact in individuals with ASD, which may explain the effectiveness of music therapies executed with individuals with autism.[154]

By understanding how an ASD student thinks, educators can find appropriate ways to provide musical opportunities. Cognitive progressions, such as processing information, or decoding body language, or other social cues, do not come naturally to an ASD individual.[155] The theory of mind, or ToM, refers to an individual's ability to process information from

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[150] Molnar-Szakacs and Heaton, "Music: A Unique Window Into the World of Autism," 322.

[151] Satoko Sota, Sanae Hatada, Kinji Honjyo, Tomoyuki Takatsuka, William G. Honer, Shigeru Morinobu and Ken Sawada, "Musical Disability in Children with Autism Spectrum Disorder," *Psychiatry Research* 267 (2018): 358.

[152] Ibid.

[153] Ibid.

[154] Istvan Molnar-Szakacs, Vanya Green Assuied, and Katie Overy, "Shared Effective Motion Experience (SAME) and Creative, Interactive Music Therapy," In *Musical Imaginations: Multi-Disciplinary Perspectives on Creativity, Performance and Perception,* by David Hargreaves, Dorothy Miell, and Raymond MacDonald, eds., David Hargreaves, Dorothy Miell, and Raymond MacDonald, Oxford: Oxford University Press, (2011): 315-316.

[155] Hourigan and Hammel, "Understanding the Mind of a Student with Autism in Music Class," 21.

another's perspective.[156] Individuals with ASD are often characterized by delayed or impaired ToM development and poor social skills.[157] Another challenge connected to impaired ToM is emotion. Students with autism struggle to understand body language, glances, or other social cues to perceive whether another individual is angry, happy, or sad.[158] Music allows all individuals, not just individuals with autism, to explore emotions. Providing opportunities to investigate a piece of music educators can provide details about the intentions and emotions for a better understanding of the desires of others.[159]

Weak central coherence is another challenge that appears in individuals with autism. Weak central coherence tends to focus on the local rather than the global aspects of an object or interest.[160] ASD students who present with weak central coherence have difficulty organizing information, such as a storyline, or an ASD student will hyper-focus on a topic but cannot articulate the more significant ideas. Visually mapping themes of a storyline in music is beneficial to a student with autism.[161]

For ASD students who experience executive function and cognitive function challenges, simplifying a task into small steps to decode and process instructions and information and offering more time to complete tasks will assist students with ASD in the music classroom. Research has shown that 40 to 50 percent of school-age children with autism have comorbid cognitive deficits. Allowing the autistic students in the music classroom additional processing

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[156] Hourigan and Hammel, "Understanding the Mind of a Student with Autism in Music Class," 22.

[157] Mishon Lacheler, Jon Lasser, Phillip W. Vaughan, Jesi Leal, Kirstina Ordetx, and Michelle Bischofberger, "A Matter of Perspective: An Exploratory Study of a Theory of Mind Autism Intervention for Adolescents," *Psychological Reports* 124, no. 1 (2021): 39-53.

[158] Hourigan and Hammel, "Understanding the Mind of a Student with Autism in Music Class," 22.

[159] Ibid., 23.

[160] Ibid.

[161] Ibid.

time, assistance in decoding emotional and social cues, and allowing students to pursue their interests will increase engagement and aid these students in finding meaning in music and enhance the musical experience.[162]

Studies by Cooper and Nye and Koegel, Tran, and Mossman found that immediate positive reinforcement and motivational components improved homework participation in students with ASD.[163],[164] The motivational parts included the following:

- Choice (allowing the student to choose writing utensils, where to sit, order of problems)
- Natural and Direct Reinforcers (giving the student a treat)
- Reinforcing Attempts (reinforce trying to write a word even if it contains errors)
- Interspersing Maintenance and Acquisition Tasks (mixing simple math problems with more complex issues)
- Contingent Reinforcement (providing reinforcement immediately after correct completion)[165]

The research established that applying the motivational components to homework decreased disruptive behavior, increased positive student comments, and improved homework completion rate. The research suggests that applying the motivational components may also help adolescents with ASD stay on track academically. Incorporating the motivational elements assures students will participate in a more enjoyable and motivating way for all of the students in the class.[166]

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[162] Hourigan and Hammel, "Understanding the Mind of a Student with Autism in Music Class, 25-26.

[163] Fred R. Volkmar, *Handbook of Autism and Pervasive Developmental Disorders, Diagnosis, Development, and Brain Mechanisms: Diagnosis, Development, and Brain Mechanisms*, ed. Rhea Paul, Sally J. Rogers, and Kevin A. Pelphrey. (New York, NY: John Wiley & Sons, Incorporated, 2014), accessed April 2, 2022. ProQuest Ebook Central, 178.

[164] Ibid.

[165] Ibid.

[166] Ibid.

Students with ASD may display sensory processing difficulties, which create a significant need for structure and consistency. When studying the classroom or studio space, items that curb sensory processing difficulties include the following:

- Clean up piles of music and papers
- Give students adequate room to sing, play instruments, and move
- Light bulbs should emit soft light, nothing glaring
- Electronics that emit a consistent hum need to be repaired or removed
- The temperature of the space should not be overly warm or cold
- Hang up posters and photos sparsely on the walls

The area should have a pleasant smell, not an overpowering air freshener scent.[167] Sensory processing difficulties, or the inability to process information through the senses, result in unusual responses to light, sound, texture, smell, taste, and movement. The inability to process information through the senses can cause anxiety when the student attempts to decipher the environment. These sensory difficulties can noticeably decrease the student's ability to sustain focused attention or can result in hyperactivity, impulsivity, aggressiveness, self-injury, and anger.[168]

Individuals with ASD have impaired executive function. Executive functions include cognitive strategies, such as working memory, planning, task initiation, and attention skills.[169] Robinson et al. found that individuals with ASD demonstrated a particular pattern of executive impairments, including poor planning performance, inhibition of responses, and self-

[167] Cravero, "Exceptional Students in the Voice Studio" *Journal of Singing*, 162.

[168] Ibid.

[169] Ibid., 167-168.

monitoring.[170] The findings of Robinson et al. determined that these areas of deficit are specific to ASD itself since participants were studied who did not have an intellectual disability in addition to ASD.[171] Three core executive functions are working memory, inhibitory control, and cognitive flexibility. Each of these three is composed of two subparts.[172] Working memory involves actively holding information in mind and working with information not perceptually present. Inhibitory control involves self-control over one's behavior and interference control, resisting internal and environmental distractions. Cognitive flexibility consists in switching between different tasks or mindsets and quickly accommodating to change.[173]

Impaired executive functions exhibited in ASD students may include displays of repetitive behaviors, resistance to change, difficulty starting and maintaining conversations, difficulty with time management, poor attention skills, and difficulty switching attention from one task to another.[174] To assist these exceptional students with executive functioning, instructors may need to revise the pace of the lesson, provide multiple verbal prompts when activities are going to change, display a visual clock that offers the time remaining in a class, and allow extra time to finish tasks.[175] Educators must realize that academic performance, no matter how high, does not ensure a degree of independence for a child with ASD. Cognitively, students diagnosed with ASD present at the level of their age and sometimes even a little higher. Emotionally,

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[170] Claudia List Hilton, Kristina Cumpata, Cheryl Klohr, Shannon Gaetke, Amanda Artner, Hailey Johnson, and Sarah Dobbs, "Effects of Exergaming on Executive Function and Motor Skills in Children With Autism Spectrum Disorder: A Pilot Study," *The American Journal of Occupational Therapy* 68, no. 1 (Jan, 2014): 58.

[171] Ibid.

[172] Adele Diamond, "Executive Functions," In *Handbook of Clinical Neurology,* Vol. 173 of *Neurocognitive Development: Normative Development*, ed. A. Gallagher, C. Bulteau, D. Cohen, and J. L. Michaud (Amsterdam, Netherlands: Elsevier, 2020), 225-226.

[173] Ibid.

[174] Ann Cravero, "Exceptional Students in the Voice Studio," *Journal of Singing,* 167-168.

[175] Ibid.

however, students with ASD experience difficulty relating to those around them and managing emotions, which makes them vulnerable in front of peers.[176]

The main challenge for the remediation of ASD is finding the most effective remediation programs and selecting a personalized program for each child with ASD. The study results from Pasqualotto et al. show significant variability in the training effectiveness for specific executive functions and different groups of children with ASD.[177] For this reason, a clinician will define times, modes, and training more suitable for the specific characteristics of the subject with ASD after careful evaluation of the executive functions.[178] Dijkhuis et al. suggest that caregivers, tutors, and students with ASD planning for college should appraise executive functions to identify strengths and concerns, sharing items with disability service officers and counselors in higher education.[179] Dijkhuis et al. recommend that students with ASD get the chance to improve their self-regulation while still in high school or preparing for higher education by learning how to cope with unexpected blocks of time and schedule changes.[180]

Teaching Students with Autism Utilizing Music Therapy

Individuals with ASD are often described as engrossed in their world, maybe unresponsive in social situations, and may have low verbal ability, limiting their engagement in social situations. Music may become a channel for these exceptional individuals whose social interactions are impaired because group music-making encourages turn-taking behavior and

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[176] Nistor and Dumitru, "Preventing School Exclusion of Students with Autism Spectrum Disorder," 7058.

[177] Pasqualotto et al., "Effects of Cognitive Training Programs," 1299.

[178] Ibid.

[179] Renée Dijkhuis, Leo de Sonneville, Tim Ziermans, Wouter Staal, and Hanna Swaab, "Autism Symptoms, Executive Functioning and Academic Progress in Higher Education Students," *Journal of Autism and Developmental Disorders* 50, no. 4 (2020): 1359.

[180] Ibid., 1360.

instigation in a non-verbal case. In group music therapy, individuals with ASD can learn to tolerate the presence of and physical contact with other people, distinguish between oneself and others, and practice social behaviors.[181]

The impairment of social skills may present lifelong implications for individuals with ASD, affecting families, community interactions, academic skills, self-worth, and independence. Ghasemtabar et al. add that these individuals' social skills deficits do not rescind with their development.[182] Because one's environment may become more complex and the awareness of social inabilities increases, the impairment and distress of these individuals may increase in the period getting close to adolescence.[183] Reports on social skills in ASD are complicated to learn, and educational objectives should focus on developing social skills because of lifelong implications.[184] Molnar-Szakacs and Heaton state that in these cases, music may become increasingly important to alleviate loneliness and suffering and improve communication and cognitive abilities.[185] Johnston et al. discuss that individuals with ASD respond positively to music therapy interventions incorporating active and improvisational methods.[186] Clements-Cortés and Yip found that individuals with ASD respond positively to creative processes that diverge from traditional music learning: music experiences presented in a more individualized goal-centered approach have a higher success rate than conventional music lessons.[187]

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[181] Yen Na Yum et al., "Music Therapy as Social Skill Intervention," 2.

[182] Ghasemtabar et. al., "Music Therapy: An Effective Approach" 2.

[183] Ibid.

[184] LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder," 24.

[185] Molnar-Szakacs and Heaton, "Music: A Unique Window Into the World of Autism," 318.

[186] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 1.

[187] Clements-Cortés and Yip, "Benefits of Community Music Experiences," 34.

Johnston et al. report that extensive evidence in the literature supports the implementation of music therapies for individuals with ASD.[188] Music promotes communication, social-emotional, motor, and neurological development.[189] LaGasse discusses and recommends that music therapy is an effective treatment intervention for social interaction, verbal communication, and socioemotional collaboration.[190] The specific stimulus of music provides an engaging way for individuals with ASD to interact socially and work toward nonmusical social outcomes.[191] Kern and Alridge, Starr and Zenker, and Wilgram and Gold state that music offers structure and predictability, which those with ASD prefer.[192] Allen et al. found that those with ASD benefit from music in many ways, including reducing depression, changing mood, having a restorative healing effect, and providing feelings of belonging and social connectedness.[193]

Watson and Brown present four reasons why music therapy is vital when working with autistic individuals.[194] First, musical structures exhibit similarities with the creative and organizational elements required for an individual's interaction with the world. Second, implementing music can promote social relationships. Third, therapists can use musical components such as pitch and rhythm to establish emotional communication with the individual. Finally, Watson and Brown suggest that the expressive qualities of music form a direct connection with an individual that can bypass cognitive and language impairments altogether.[195]

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[188] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 2.

[189] Ibid.

[190] LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder," 23.

[191] Ibid.

[192] Hillier et al., "Positive Outcomes Following Participation in a Music Intervention," 202.

[193] Ibid.

[194] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 2-3.

[195] Ibid.

LaGasse points out that there are several reasons that musical stimuli may help with developing social skills.[196] Research has demonstrated that music can activate neural networks and the ability to optimize target behaviors through synchronized neural firings; research has also shown that individuals with ASD are uniquely attracted to musical stimuli and enhanced musical ability.[197] Ockelford discusses that the thought is that at least one in 20 individuals with ASD have exceptional musical skills. Music is critically important for this one in 20 children, sometimes constituting the only way of reaching a severely autistic child's identity.[198] Bonnel et al. study individuals with ASD who have auditory talents in music, such as superior pitch recognition, discrimination of musical tones, or enhanced perception of specific frequencies of sounds that others do not discern.[199] Analyzing the data, music in treatment may provide a solid basis for learning social skills and integrating into a non-musical context.[200]

Hardy and LaGasse found that when intervening with students with ASD, a primary agent can be rhythm, as supported by evidenced effects of rhythmic cueing for the motor functioning of individuals with neurological impairment.[201] A rhythm-based intervention involving simple and complex body imitation increased body coordination scores in a study by Srinivasan et al., Eigsti, Neelly, and Bhat.[202] Two studies led by Janzen and Thaut in ASD individuals discuss deficits of motor control and attention; the research from the first study exhibits that these deficits affect one's ability to engage, reciprocate, and learn, significantly

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[196] LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder," 25.

[197] Ibid.

[198] Ockelford, "The Potential Impact of Autism on Musical Development," 124.

[199] Volkmar et. al., *Handbook of Autism and Pervasive Developmental Disorders*, 380.

[200] LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder," 25.

[201] Ga Eul Yoo, "Rhythm-Mediated Music Therapy Protocol for Improving the Social Skills of Children with Autism Spectrum Disorder," PhD diss., Collection @ewha, 2016, 37.

[202] Ibid., 38.

influencing social development.[203] The second study found auditory rhythm profoundly affects the motor system and attention functioning.[204] Pasiali, LaGasse, and Penn discover that auditory-motor entrainment significantly affects motor and attention functions and brain connectivity in adolescents with neurodevelopmental delays, including autism.[205]

Music can be a vital component in aiding students with ASD in developing social skills. A focus should be made on lifelong implications to activate neural networks, reduce depression, improve mood, and provide the enjoyment of belonging to a group. Studying the gap in the literature working with adolescents with ASD, who may have heightened feelings of distress associated with social impairments, participating in music may improve communication and cognitive abilities for these exceptional students. Further, the investigation will include the gap in the literature utilizing student choice with computer applications to increase and develop music literacy in adolescents. Following the findings of Hardy and LaGasse, and Sota et al., students with ASD had lower musical ability but preserved rhythm.[206],[207] Providing an opportunity for these adolescent students to learn reading rhythm and notes through computer applications may transfer to learning how to play rhythmic percussion instruments in the beginning band. Following the research of Pasiali, LaGasse, and Penn, the ability to apply rhythm will be addressed to prime the motor system and improve attention in adolescents with ASD as a necessary treatment.[208] Preliminary studies reveal that auditory rhythmic entrainment

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[203] Thenille Braun Janzen and Michael H. Thaut, "Rethinking the Role of Music in the Neurodevelopment of Autism Spectrum Disorder," *Music & Science* (January 2018): 9.

[204] Ibid., 6-7.

[205] Ibid., 9.

[206] Yoo, "Rhythm-Mediated Music Therapy," PhD diss., 38.

[207] Sota et al., "Musical Disability in Children with Autism Spectrum Disorder," 358.

[208] Janzen and Thaut, "Rethinking the Role of Music," 10.

can improve motor and attention functions in adolescents with ASD, improving one's social development.[209] Participants could use computer applications to enhance rhythm literacy and apply learned material in the applications using the mallets and the snare drum. Enhanced motor control and reduced attention deficits with music-based training may aid adolescents with ASD. In light of this evidence, Janzen and Traut suggest that music-based developmental training for attention and motor control may receive a critical new functional role in autism treatment due to the significant effect of auditory-motor entrainment on motor and attention functions and brain connectivity.[210]

Students with Autism Utilizing Technology and Classroom Percussion Instruments

Those with ASD have cognitive strengths, including piecemeal processing and attention to detail. The mind works differently in an individual with autism, and technology seems to be particularly accessible as a way to learn new concepts and share new ideas. The wide range of intuitive music applications allows individuals who may need to be trained on an instrument to have access to music and the ability to be creative with music in a new way.[211] Findings suggest that digital treatments are a highly feasible approach to addressing cognitive control impairments in children with ASD.[212]

Utilizing technology to improve executive functions with ASD students may be effective. Hillier et al. discovered that adolescents with ASD preferred activities involving technology like iPads and synthesizers to produce creative and meaningful pieces.[213] A review by Putnam and

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[209] Janzen and Thaut, "Rethinking the Role of Music," 7.

[210] Ibid., 10.

[211] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 277.

[212] Yerys, "Pilot Study of a Novel Interactive Digital Treatment," 1733.

[213] Clements-Cortés and Yip, "Benefits of Community Music Experiences," 35.

Chong concluded that informal and natural interactions with multi-touch devices deliver a simple interaction mechanism that is especially beneficial to those on the autistic spectrum.[214] In typical teen populations, technology is a draw for adolescents with ASD.[215] Research suggests that the logical and structured aspects of computers and other technologies strongly appeal to the cognitive processing strengths in the rule-based, analytical, and structured thinking of many people with ASD.[216] Kagohara et al. reviewed the research that examined the application of iPads to teach new skills to individuals with developmental disabilities, including autism.[217] Specifically, targeted skills included academic skills, communication skills, developing employment skills, leisure skills, and transitioning.[218]

Limitations of the findings from Kagohara et al. include small sample sizes, a wide range of participants' ages, and supporting computer application effectiveness, however, the findings concluded that iPad devices were exceptionally superior to other technologies as interventions.[219] Valencia et al. caution that not treating accessibility and user experience with the importance needed occurred in previous research when working with ASD individuals.[220] Accessibility, usability, and user experience are crucial when working with autistic people.

Whyte, Snyth, and Scherf found what elements effectively fostered motivation and learning during computer application games for individuals with neuropsychiatric disorders, such

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[214] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 9.

[215] Hillier et al., "Positive Outcomes Following Participation in a Music Intervention," 203.

[216] Dijkhuis et al., "Autism Symptoms, Executive Functioning and Academic Progress," 1360.

[217] Samantha D. Jaminez, "An Exploration of Teaching Music to Individuals With Autism Spectrum Disorder," PhD diss., Antioch University, Seattle, 2014, 24.

[218] Ibid.

[219] Ibid.

[220] Katherine Valencia, Cristian Rusu, Daniela Quiñones and Erick Jamet, "The Impact of Technology on People with Autism Spectrum Disorder: A Systemic Literature Review," *Sensors* 19, no. 20 (2019): 4494.

as autism.[221] The first is the creation of a storyline that explains the game's goals. Another essential element is the help provided by the mentor. Third, the levels of the game should have a gradual increment of difficulty with clear final goals. Lastly, giving choices to players is essential to promote motivation and enjoyment.[222] Yerys et al. found high acceptability utilizing digital treatment relating to the graphics, the user interface, and the "reward hooks," choosing treatments that matched that of commercially available recreational computer applications, making the therapy appear more rewarding and game-like.[223]

Pasqualotto et al. focus on interventions with ASD children and adolescents that directly train executive function to improve cognitive function, increasing executive function, particularly regarding cognitive flexibility, problem-solving, and emotion regulation utilizing non-computerized training.[224] Through computerized training, Pasqualotto et al. conduct interventions employing virtual tools with results showing significant improvement in performing administrative tasks, including attention, working memory, and inhibitory control.[225] Jiménez-Muñoz et al. explore the effectiveness of video games in increasing academic performance in individuals with ASD.[226] The findings show significant pre/post-test improvement in the following areas investigated with autistic students: sixteen percent improvement in non-verbal skills, 85.9 % in mathematics, 50.5% in reading comprehension, and 81.5% in copying rate.

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[221] Esposito et al., "Using Tablet Applications for Children with Autism," 201.

[222] Ibid.

[223] Yerys, "Pilot Study of a Novel Interactive Digital Treatment," 1733.

[224] Pasqualotto et al., "Effects of Cognitive Training Program," 1294.

[225] Ibid., 1296.

[226] Laura Jiménez-Muñoz, Immaculada Peñuelas-Calvo, Pilar Calvo-Rivera, Isaac Diaz-Oliván, Manon Mareno, Enrique Baca-Garcia, Alejandro Porras-Segovia, "Video Games for the Treatment of Autism Spectrum Disorder: A Systemic Review," *Journal of Autism and Developmental Disorders* 52 (2022): 183.

The gap in the literature is evident as studies utilizing cognitive training of executive functions are limited. Utilizing technology to support training activities to improve administrative functions with ASD students may be effective as ASD students enjoy learning through gamification. Technology-based training allows for a safe and secure environment where ASD individuals can commit errors with minor consequences and less social anxiety.[227] Research findings support constructing personalized programs for each individual with ASD, as each individual responds differently. The researcher allowed ASD students to choose which computer applications, within parameters, grant motivation to participate in computerized training to improve executive function and working memory. Careful selection of computer applications to match that of commercially available video games may make digital treatments more rewarding for students. Following Valencia et al.'s research, user experience, usability, and accessibility are crucial when working with people with ASD.[228] Studying adolescents with ASD and utilizing computer applications to improve music literacy may improve executive functions such as attention and working memory, allowing these exceptional students to participate as percussionists in the beginning band.

An additional gap in the literature is that reviews on computer applications as an area for intervention for ASD individuals are scarce.[229] Recently, however, the development of cognitive training studies with ASD students and the impact of these studies have been the subject of discussion.[230] Following the research of Hillier and LaGasse, applying technology with student choice of computer applications and utilizing rhythm-based applications, this study showed

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[227] Pasqualotto, "Effects of Cognitive Training Programs," 1283.

[228] Valencia et al., "The Impact of Technology on People with Autism Spectrum Disorder" 4494.

[229] Jiménez-Muñoz et al., "Video Games for the Treatment of Autism Spectrum Disorder," 169.

[230] Ibid.

individual improvement in learning notes and rhythms, thus enabling the individual with ASD to participate as a percussionist in the beginning band.

Teaching Students with Disabilities such as Autism to "Help One Connect" with Others

While not included in this study, helping one connect with others is worth noting for the individual with ASD. Adolescents with ASD participate 25 percent less in cooperative interactions during inclusive schooling. They have a higher score for loneliness, are often bullied, and commonly experience social anxiety. About 50 percent have no peer relationship outside of prearranged settings, and friendship level is reportedly low. Few participate in social groups, such as those engaging in recreational activities or attending religious services. There are reports of low attendance rates for postsecondary education, vocational participation, and community participation.[231]

In one study, Bauminger and Kasari found that children and pre-adolescents with high-functioning autism seem aware of their social situations and desire social engagement but lack the skill and opportunity to engage with others.[232] When studying older adolescents with ASD, less information is available, especially for those fully included in regular education.[233] Social problems typically worsen for adolescents with ASD. High-functioning adolescents with ASD are painfully aware of the deficits with social status and desire a high-quality friendship: when peers do not meet expectations, loneliness and isolation occur.[234] These exceptional students with

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[231] Beate Krieger, Barbara Piškur, Christina Schulze, Uta Jakobs, Anna Beurskens, and Albine Moser, "Supporting and Hindering Environments for Participation of Adolescents Diagnosed with Autism Spectrum Disorder: A Scoping Review," *PloS One* 13, no. 8 (2018): 2-30, e0202071-e0202071.

[232] Jill Locke, Eric H. Ishijima, Connie Kasari, and Nancy London, "Loneliness, Friendship Quality, and the Social Networks of Adolescents with High-Functioning Autism in an Inclusive School Setting," *Journal of Research in Special Education Needs* 10, no. 2 (2010): 74.

[233] Ibid., 75.

[234] Ibid.

ASD experienced more significant levels of bullying, and it is crucial to understand the effects of such social exclusion on these adolescents.[235]

Williams et al. investigate that ostracism or social exclusion is integral to life, from school to work.[236] Social exclusion can have lasting adverse effects, including depressed mood, loneliness, anxiety, frustration, and helplessness. Williams proposes that ostracism threatens four fundamental needs: belonging, self-esteem, control, and meaningful existence.[237] Studies to further research encouraging high-functioning older adolescents with ASD to participate in the high school beginning band to aid in social engagement with others, build self-esteem, form friendships, and offer a place to belong with peers.

Connecting with others could help an ASD individual improve one's frame of mind. Trimmer et al. report that individuals with ASD recognize and experience ostracism similarly to non-ASD individuals, yet with magnified and lasting physiological effects.[238] Hillier et al. show that music engagement could positively impact psychological outcomes for those with ASD.[239] Participants exhibited significantly higher self-esteem, lower anxiety, and improved attitudes toward peers. Hillier et al. focus on the older population, adolescents, and young adults, where a service gap is a concern with rising numbers of individuals diagnosed with ASD. Engaging with music in various ways was enjoyable and exciting for the participants with ASD, and how much the participants benefited socially was high.[240]

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[235] Emily Trimmer, Skye McDonald, Michelle Kelly, and Jacqueline Ann Rushby, "The Physiological and Psychological Effects of Ostracism in Adults with ASD," *Journal of Autism and Developmental Disorders* 47, no. 8 (2017): 2327.

[236] Ibid., 2326.

[237] Ibid.

[238] Ibid., 2333.

[239] Hillier et al., "Positive Outcomes Following Participation in a Music Intervention," 209.

[240] Ibid.

Chapter 3: Methods

Introduction

This qualitative research design aims to describe how the high school beginning band students' choice of computer applications was implemented to demonstrate the effects of music literacy for percussion students with ASD. This qualitative research examined two male and four female high school beginning band percussionists with ASD. Data was collected over four weeks via computer applications, observations, and recorded exit interviews of each participant.

This qualitative case study aims to describe and identify how the high school beginning band students' choice of computer applications may increase music literacy for percussion students with ASD. There are still very few randomized control studies on the effectiveness of computer applications, although the literature on this topic appears to have demonstrated advantages for people with ASD. Music-based methods applying technology and student choice of technology are not robustly studied with adolescents with disabilities. Various approaches to researching students with ASD and technology have included children under 13. No studies have been conducted on adolescents applying student choice to a computer device for instruction.

This chapter provides the study's setting, participant selection, instrumentation, procedures, and data collection. It also discusses the research questions and hypotheses that guide the study.

Research Design

The study will follow a qualitative case study design. The chosen methodology is qualitative research because it is an approach to exploring and understanding individuals' behaviors and actions. Data collection in a qualitative case study is conducted by talking directly with people and watching behavior in a natural setting. Researchers rely on data collected

through examining documents, observing behavior, or interviewing participants rather than relying on data from other researchers.[241] Often described as qualitative inquiry, case study research stems from the motivation to explore, seek understanding, and establish the meaning of experiences and perspectives of those involved.[242]

The philosophical worldview proposed in this study is constructivism. Through this analysis, researchers look for views' complexity rather than narrow meanings into a few categories. The goal of the research is to rely as much as possible on the participants' perspectives. Researchers seek to understand the setting of the participants by visiting this environment and gathering the information personally.[243] Constructivism aims to study the participants' social world and requires interpretation from the points of view of those residing within it.[244]

The phenomenon being studied and measured in this qualitative case study include improved music literacy. Items to be considered as this study progresses: student choice of computer applications results in improved music literacy; playing computer applications transfers to reading notes and rhythms on a score; playing computer applications leads to playing drums or mallets in class; computer applications reduce anxiety and lead to improved music literacy, allowing ASD students to participate in the beginning band.

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[241] John W. Creswell and J. David Creswell, *Research Design Qualitative, Quantitative, and Mixed Methods Approaches,* 5th ed. (Los Angeles, CA: Sage Publications, Inc., 2019), 180-182.

[242] Helena Harrison, Melanie Birks, Richard Franklin and Jane Mills, "Case Study Research: Foundations and Methodological Orientations," In *Forum Qualitative Social Research* 18, no. 1 (2017): 8.

[243] Creswell and Creswell, *Research Design Qualitative, Quantitative, and Mixed Methods,* 7-8.

[244] Frank Bogna, Aldo Raineri and Geoff Dell, "Critical Realism and Constructivism: Merging Research Paradigms for a Deeper Qualitative Study," *Qualitative Research in Organizations and Management: An International Journal* 15, no. 4 (2020): 466.

A review by Hillier et al. predicts that adolescents on the autism spectrum would be more responsive when listening to self-selected preferred music; this study utilizes self-selected applications to aid adolescents on the autism spectrum in reading notes and rhythms.[245] Thoroughly reviewing existing literature, the research culminates in proposed recommendations that supported the participation of students with ASD in music education. Improving music reading skills and communication skills was studied through self-advocating. Literature on tablet use for students in music education is gaining momentum, however, very little has focused on students with disabilities.[246]

Phenomenology is a philosophy, methodology, or approach to study or research. Generally, phenomenology is qualitative as a methodology. Commonly, phenomenology focuses on people's perceptions of the world around them and experiences in one's life. As a methodology, researchers follow a set of tasks that require them to collect and analyze the data and report the findings. A qualitative researcher will identify a phenomenon as an object of human experience and give voice to it interpretively.[247] Hermeneutic phenomenology is a human science that studies persons. Generally, phenomenology is qualitative and focuses on peoples' perspectives of the world.[248] Van Manen draws upon and connects phenomenology and hermeneutics.[249] He has applied the approach to pedagogy and parenting and considers that a hermeneutic phenomenological approach is especially relevant to educational, health, and

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[245] Ashleigh Hillier, Justin Koper, Nataliya Poto, Madalina Tiverus and David Q. Beversdorf, "Increased Physiological Responsiveness to Preferred Music Among Young Adults with Autism Spectrum Disorders," *Psychology of Music* 44, no. 3 (2016): 486.

[246] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 269.

[247] Art Sloan and Brian Bowe, "Phenomenology and Hermeneutic Phenomenology: The Philosophy, the Methodologies, and using Hermeneutic Phenomenology to Investigate Lecturers' Experiences of Curriculum Design," *Quality and Quantity* 48, no. 3 (05, 2014): 1293.

[248] Ibid.

[249] Sloan and Bowe, "Phenomenology and Hermeneutic Phenomenology," 1297.

nursing researchers.[250] This qualitative case study will apply hermeneutic phenomenology in the research design by gathering data through observations and participant interviews.

In three separate studies with adolescents and young adults with ASD, Hillier et al. (2012),[251] (2016),[252] and (2016) [253] applied hermeneutic phenomenology in their approach. The researchers conducted interviews, observed participants, and consulted parents/guardians to complete the data analysis. In 2012, the results of the music intervention were decreased anxiety in the participants with ASD, higher self-esteem, and significantly improved attitudes toward peers. Both studies in 2016 showed improvements in individuals with ASD in processing information and responding optimally to the world around them, and participants benefited both socially and emotionally.

Limitations of hermeneutic phenomenology are phenomenological documents describing a person's current life, not considering the continually changing reality of a person's lived experiences.[254] As this was a hermeneutic phenomenological study, limitations for the method applied focused on the teacher's perceptions and documentation.[255] In addition, reporting specific difficulties students experienced with other classroom subjects was unknown.[256]

Research Questions and Hypotheses

Addressed is a possible response to the first research question in Hypothesis 1:

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[250] Sloan and Bowe, "Phenomenology and Hermeneutic Phenomenology," 1297.

[251] Hillier et al., "Positive Outcomes Following Participation in a Music Intervention," 201-215.

[252] Hillier et al., "Increased Physiological Responsiveness to Preferred Music Among Young Adults with Autism Spectrum Disorders," 481-492.

[253] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 269-282.

[254] Jeanne E. Van der Zalm and Vangie Bergum, "Hermeneutic-Phenomenology: Providing Living Knowledge for Nursing Practice," *Journal of Advanced Nursing* 31, no.1 (2000): 214.

[255] Alexandra A. Lauterbach, "Hermeneutic Phenomenological Interviewing: Going Beyond Semi-Structured Formats to Help Participants Revisit Experience," *The Qualitative Report* 23, no. 11 (2018): 2892.

[256] Ibid.

RQ1: What ways does the high school beginning band student's choice of computer applications demonstrate an understanding of the reading of music for percussionists with autism spectrum disorder?

H1: The high school beginning band student's choice of computer applications can demonstrate an understanding of music reading for percussionists with autism spectrum disorder in terms of increased music literacy, improved applied playing skills, and collaborative participation in a group setting.

Addressed is a possible response to the second research question in working Hypothesis 2:

RQ2: In what ways can high school beginning band students with ASD learn to self-advocate in other disciplines as a result of the choice of instructional materials in music class?

H2: The high school beginning band students with autism spectrum disorder show evidence of self-advocating in other disciplines by improving communication skills, social engagement, and self-confidence.

Participants

The researcher will recruit two male and four female participants with ASD from one private high school, School 1. The participants' ages ranged from 14 to 17. Selected participants from School 1 had a diagnosis of autism, but not all participants presented with a diagnosis of autism. Still, the school's Educational Specialists helped identify that all the participants were on the spectrum, and all were high functioning on the autism spectrum. The researcher has previously worked at School 1 and is acquainted with the principals and the Educational Specialists.

The researcher obtained permission from the Internal Review Board. The researcher also obtained permission from the principal, the Educational Specialists, the participants, and the parents. The researcher informed the parents and participants that the study might be stopped at any time if any of the participants no longer wished to participate. The researcher informed the parents and participants of the time commitment, procedures, and equipment. School-issued iPads were utilized, with the participants choosing the applications provided by the researcher for instruction. The following applications were utilized but were not limited to Beat Sneak Bandit, Flashnote Derby, Music Tutor, Planet Quest, and Staff Wars.[257],[258],[259],[260],[261]

Setting

All meetings occurred in the school's Resource Room and Band Room during the school day. Meetings at the school allowed for percussion instruments to be available, internet connection, and space to spread out. The Resource Room was large enough that students could use the computer applications and not disturb other students who were not part of the study. The meetings were thirty minutes long. The qualitative case study spanned four weeks to illustrate the effectiveness of the research, with meetings two to three times per week with the students during the school day.

Instrumentation

The data collection methods that were employed are observations of participant behavior. Observations conducted will only be during the meetings (see Appendix G), scores collected

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[257] Beat Sneak Bandit, App Store, https://apps.apple.com/us/app/beat-sneak-bandit/id473689550.

[258] Flashnote Derby, App Store, https://apps.apple.com/us/app/flashnote-derby/id453126527.

[259] Music Tutor (Sight Reading), App Store, https://apps.apple.com/us/app/music-tutor-sight-reading/id514363426.

[260] Planet Quest, App Store, https://apps.apple.com/us/app/planet-quest/id922848069.

[261] Staff Wars, App Store, https://apps.apple.com/us/app/staffwars/id810405576.

from the applications to show improvement (see Appendix H), assessments using drums and mallets after computer applications (see Appendix I), and exit interviews (see Appendix L). Observations and exit interviews utilized a short multiple-choice questionnaire, and data collected was from the computer applications, comments, and exit interviews with the students. During the exit interviews, students were asked ten questions (see Appendix L), eight multiple-choice and two short answers. Asking parents to offer feedback from students participating in the meetings helped to note the success of outcomes (see Appendix N). Ensuring alignment between interview questions and research questions, the problem statement, and the purpose of the study, the researcher will gain information relevant to the subject matter and obtain quality interview data.

Procedures

The researcher obtained approval from the Institutional Review Board (IRB) before beginning the study. After obtaining approval, the researcher emailed the school principal and Educational Specialists to help identify five to six students with ASD. The researcher recruited participants by meeting with the potential participants at School 1. The school's Educational Specialists helped the researcher with recruitment. After choosing the potential participants, permission was obtained from the participants' parents by consent form (see Appendix E). Educational Specialists facilitated the process by collecting the consent forms at each school. The participants were approached in person to give verbal consent. After obtaining permission forms, potential participants could participate in the study. The researcher informed the participants' parents, the principal, and the Educational Specialists how privacy and confidentiality will be maintained. The researcher ensured that participants understand they can stop the study anytime.

After selecting participants and obtaining permission forms, the researcher determined the students' schedules to meet with the participants during the school day. School 1 is a one-to-one school, and students can access school-issued Chromebooks. The researcher and participants utilized the iPads School 1 owns if necessary. Mallets and snare drums were employed in the band room when required. The study implemented, but was not limited to, the following applications: Beat Sneak Bandit, Flashnote Derby, Music Tutor, Planet Quest, and Staff Wars.[262],[263],[264],[265],[266] At least one Educational Specialist will be present with the researcher to aid in data collection during the study.

In Beat Sneak Bandit, everything moves rhythmically.[267] The story is that Duke Clockface stole all the clocks in the world, and it is up to the Beat Sneak Bandit to get them back. Every time players tap the screen in time with the beat, the Bandit hops a little further through the stage. If you time your tapping wrong, he remains rooted in place. The goal is to tap through each stage while avoiding obstacles like roving security guards and spotlights. Flashnote Derby is a timed test race in which students identify different notes to urge their horses toward the finish line.[268] Answering quickly and correctly will cause the horse to gain ground, while incorrect answers will cause the horse to fall behind. Students can review the notes they missed at the end of each race and see the correct answers. Students can also respond to flashcards by playing the message on their instrument, the mallet. Participants can also react by tapping letter

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[262] Beat Sneak Bandit, App Store, https://apps.apple.com/us/app/beat-sneak-bandit/id473689550.

[263] Flashnote Derby, App Store, https://apps.apple.com/us/app/flashnote-derby/id453126527.

[264] Music Tutor (Sight Reading), App Store, https://apps.apple.com/us/app/music-tutor-sight-reading/id514363426.

[265] Planet Quest, App Store, https://apps.apple.com/us/app/planet-quest/id922848069.

[266] Staff Wars, App Store, https://apps.apple.com/us/app/staffwars/id810405576.

[267] Beat Sneak Bandit, App Store, https://apps.apple.com/us/app/beat-sneak-bandit/id473689550.

[268] Flashnote Derby, App Store, https://apps.apple.com/us/app/flashnote-derby/id453126527.

buttons or playing a key on an on-screen piano. Music Tutor has participants develop speed and accuracy in reading sheet music by identifying music notes.[269] Students may practice with notes in treble or bass clef in timed or untimed sessions. After each test, the participant can review mistakes and see progress. For Planet Quest, students play a game that features easy single-tap gameplay for short games or long stints: easy and fun to play, yet challenging to master fully.[270] Staff Wars is designed to help beginning and intermediate musicians learn the note names on the treble, bass, or grand staff.[271]

The researcher chose Applications based on the information shared by Esposito.[272] He found successful games for autistic children that foster motivation and learning utilizing the following four elements. The first element is the creation of a storyline or narrative that explains the future goals of the game.[273] Second is the help from a mentor who can offer step-by-step guidance.[274] Third, the game levels should show gradual difficulty increments with clear final goals. A popular motivation is earning tokens or rewards to reach the final objective.[275] The last element is providing student choice.[276]

Eight meetings were conducted with eligible participants during the course of the study. Meetings one and two established the routines and allowed the participants to become familiar with all computer applications. Meetings three and four allowed the participants to determine

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[269] Music Tutor (Sight Reading), App Store, https://apps.apple.com/us/app/music-tutor-sight-reading/id514363426.

[270] Planet Quest, App Store, https://apps.apple.com/us/app/planet-quest/id922848069.

[271] Staff Wars, App Store, https://apps.apple.com/us/app/staffwars/id810405576.

[272] Esposito et al., "Using Tablet Applications for Children with Autism," 201.

[273] Ibid.

[274] Ibid.

[275] Ibid.

[276] Ibid.

which app or apps were the application(s) of choice. Each participant reported on which application(s) were enjoyed and why. The researcher gathered scores from the applications as participants engaged. Meetings five and six incorporated a timed version of the applications if the participants agreed. Meetings seven and eight focused on more timed versions of the applications if the participants agreed and experimentation by playing the mallets and snare drum while following a score.

After each meeting, exit interviews were conducted with the participants. Data was collected using ten questions, eight multiple-choice questions, and two short answers (see Appendix L). After each exit interview, the researcher tallied the answers to prepare for data analysis.

Some participants needed to learn about the researcher personally. During the first meeting, the researcher used recommendations from Toni Fuller Merfeld, an autism specialist.[277] Observe the students' preferences in both the physical and emotional environment. Ask questions such as: Is the students' attention drawn to other room areas? Are the students relatively calm or nervous? An awareness of both environments will help the researcher know if there is something to redirect or modify. Keep instructions clear and straightforward, and phrase any requests positively.[278]

Data Analysis

The researcher will collect data on parents/guardians giving consent and the participants' ability to finish the eight meetings. Using a case study, this qualitative research investigated the effectiveness of participants' choice of music applications and demonstrated an understanding of

[277] Cravero, "Exceptional Students in the Voice Studio," 164.

[278] Ibid.

the reading of music, notes, and rhythms. Perspectives on learning to self-advocate in other disciplines were studied.

Computers such as iPads or Chromebooks provide experiences with consistent and predictable responses for autistic students and will maintain interest, increase motivation levels, and enable student choice.[279] Utilizing the iPads demonstrated improvement in reading notes and rhythms, and conducting exit interviews after each meeting allowed the participants to practice communication skills and vocalize what was liked or disliked. Students with ASD respond positively to music experiences presented in an individualized approach and have a higher success rate over conventional music lessons or group lessons.[280]

Records of attendance and participation were maintained. Records included school closings, special events, and other potential limitations. The researcher assessed participants' language and communication skills, behavioral patterns, and learning styles. Conducted observations of the participants only happened during the meetings.

Data was analyzed from computer applications by studying the scores at each meeting, conducting participant observations, and conducting exit interviews. Each participant will receive a notebook with multiple-choice and short answer exit interviews to complete after each meeting.

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[279] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 10.

[280] Clements-Cortés and Yip, "Benefits of Community Music Experiences," 34.

Trustworthiness

The influential work of Lincoln and Guba made a case for assessing qualitative research not only with scientific measures or reliability and validity but preferably beginning with trustworthiness.[281] According to Lincoln and Guba, evaluating trustworthiness looks at credibility, dependability, confirmability, and transferability; see Figure 4 below.

Figure 4. Strategies to Determine Rigour

Table 1 Strategies to Determine Rigour

Approaches to Rigour	Strategies
Credibility	Prolonged engagement and persistent observation. Triangulation. Peer debriefing. Member checking.
Dependability	Audit trail. Reflexivity.
Confirmability	Audit trail. Reflexivity.
Transferability	Thick descriptions.

Source: Data from Catherine Houghton, Dymona Casey, David Shaw, and Kathy Murphy, "Rigour in Qualitative Case-Study Research," *Nurse Researcher* 20, no. 4 (03, 2013): 13. Table 1.

The researcher will present as much data as possible in table form. Readers then can better understand how the researcher came to conclusions.[282] The researcher's background can affect the study's focus and analysis so that the researcher will implement epoché. Epoché occurs when the researcher sets aside theories, hypotheses, and prior knowledge about the site or participants and focuses on the participants' experiences.[283] The researcher will utilize the Educational Specialists and Counselors at the schools to gather information during meetings to account for

[281] Rachel H. Adler, "Trustworthiness in Qualitative Research," *Journal of Human Lactation* 38, no. 4 (2022): 599.

[282] Ibid., 601.

[283] Lauterbach, "Hermeneutic Phenomenological Interviewing," *The Qualitative Report* 23, no. 11 (2018): 2889.

triangulation. Investigator triangulation occurs when more than one person can cross-check each other's analysis and provide feedback to ensure the accuracy of the data collected from the participants.[284]

As stated by Lincoln and Guba, credibility refers to the benefit and validity of the findings and involves believably conducting the research.[285] Prolonged engagement with participants and ongoing evaluation will aid in credibility. The researcher can apply these skills by spending time at case-study sites to understand the data under investigation better.[286] Dependability addresses the reliability issue, showing that similar results in repeated research would be acquired.[287] Lincoln and Gabe highlight the close ties between credibility and dependability, arguing that demonstrating credibility will ensure dependability.[288] The researcher is capable of dependability by listing all of the processes within the study in detail, empowering a future researcher to repeat the work. Readers of the study will understand the methods utilized and evaluate, checking for proper research practices.[289] Confirmability and dependability are closely linked and refer to the neutrality and accuracy of the data.[290] Shenton emphasizes that triangulation must be utilized in studies to reduce investigator bias.[291] The researcher will clearly show data gathering and desired results reached and outline the decisions made during the

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[284] Adler, "Trustworthiness" *Journal of Human Lactation* 38, no. 4 (2022), 601.

[285] Catherine Houghton, Dymona Casey, David Shaw, and Kathy Murphy, "Rigour in Qualitative Case-Study Research," *Nurse Researcher* 20, no. 4 (03, 2013): 13.

[286] Ibid.

[287] Andrew K. Shenton, "Strategies for Ensuring Trustworthiness in Qualitative Research Projects," *Education for Information* 22, no. 2 (2004): 71.

[288] Ibid.

[289] Ibid.

[290] Houghton et al., "Rigour in Qualitative Case-Study Research," *Nurse Researcher* 20, no. 4 (03, 2013): 13.

[291] Shenton, "Strategies for Ensuring Trustworthiness," *Education for Information* 22, no. 2 (2004): 72.

research process, even if the reader needs to draw the same conclusions.[292] According to Leininger, transferability refers to whether or not particular findings can be transferred to another similar study while maintaining the inferences from the completed research.[293]

Ethical Considerations

This study will follow ethical considerations, the first being the University's Institutional Review Board (IRB) and the school principal where data is collected. The researcher gave consent forms to all participants and parents, and the Educational Specialists gathered forms at the school. The researcher will provide an overview of the study and the requirements of the participants, as well as preserve privacy. The level of risk in the study is low as the participants are utilizing computer applications on iPads and percussion instruments in the school setting. Participants and parents understood that they can remove themselves from the study without consequences.

Concerning privacy, the researcher did not refer to the participants by name but to each participant as Student A, Student B, etcetera, and the school as School 1. Records are maintained at the researcher's home office and on a password-protected computer. The researcher will destroy all data after a set timeline from the university and advise all participants and parents.

Educational Specialists at the school were present with the researcher at each meeting. When conducting the exit interviews (see Appendix L), more than one person was able to cross-check each other's analysis to ensure the reliability of the data collected. The Educational Specialists and the researcher will meet briefly without the participants after the exit interviews

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[292] Houghton et al., "Rigour in Qualitative Case-Study Research," *Nurse Researcher* 20, no. 4 (03, 2013): 14-15.

[293] Ibid., 13.

to ensure the researcher presents accurate information from the participants. Investigator triangulation utilized in this way increases the reliability of the case study.[294]

Summary

This qualitative case study aims to identify adolescent beginning band students with ASD choice of applications to explore and demonstrate an increased understanding of music literacy. This study will follow a case study design where the researcher will recruit five to six participants from a high school to collect data through computer applications and exit interviews. The researcher will follow specific ethical guidelines to maintain privacy. This chapter focused on research questions and hypotheses that will guide the study and the study's setting, participants, instrumentation, and procedures.

[294] Adler, "Trustworthiness" *Journal of Human Lactation* 38, no. 4 (2022), 601.

Chapter 4: Presentation of Findings

Introduction

The use of technology to assist ASD students has been acknowledged in the research literature.[295] This qualitative case study aims to identify ways in which utilizing computer applications of the high school student's choice can demonstrate an understanding of music reading for percussionists with autism spectrum disorder. After permission forms were returned, meetings occurred at the participant's high school. During meetings, computer applications were accessed on iPads with participants maintaining scores, participants could select which computer applications to experience, and exit interviews were conducted after each meeting. Each exit interview consisted of 8 Likert Scale questions and 2 short answer questions. This chapter will address the study's results and the major themes.

Results

Computer application scores were collected, and a graph was created for each student to analyze the scores. A series of responses to 8 Likert Scale questions and 2 short answer questions were analyzed with Delve Tool, which utilizes text analysis; the text analysis included extracting concepts based on coding participants' words and phrases. Classification entailed descriptive coding, topical coding, and analytical coding.[296] General themes were developed along with the interpretation of emergent themes to interpret. The source for all data discussed in this chapter is collected from Fieldwork 2024.

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[295] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 1.

[296] Victoria Elliot, "Thinking about the Coding Process in Qualitative Data Analysis," *The Qualitative Report* 23, no. 11 (11, 2018): 2850-2861.

Description of Participants

The study is based on data collected from 14-17-year-old high school students with ASD. Not all participants presented with a diagnosis of autism. Still, the school's Educational Specialists helped identify that all the participants were on the spectrum and were high functioning. Two males and four females participated in the study. Data collection occurred in the school's resource and band rooms. Participants enjoyed learning about music; one participant was enrolled in beginning piano lessons, two played the piano in third grade, and only one had been previously involved in the band program.

Research Question One

Discussions with the participants, watching them enjoy the computer applications, exit interviews, observations, and experiencing the mallets and snare drum form the basis of subthemes to research question one. Along with gathering the scores from the computer applications and exit interviews, observations were made from conversations the researcher wrote down. Gaining an understanding of each participant was important to the researcher. All but one participant (Student D) engaged in discussions with the researcher and other participants, which is not unusual with individuals with ASD. Student D is a new student at the school, joining in January 2024. Student D did not say anything during discussions with the researcher and other students, but one-on-one, Student D talked about a favorite book being read, *Crown of Feathers*. Student D liked the book so much that this was their second time reading it.

Computer Application Scores

Analyzing the computer application scores by plotting them on a line graph (see below) shows that all participants' scores went up (Students A-F). There were fluctuations up and down, but all in all, the scores went higher. In Student B's case, the levels got increasingly more

difficult, so it looks like their score went down as the levels progressed. It may be that their scores would improve if they had more time to play the computer application. Student B was frustrated or stressed twice during the eight meetings because the levels became increasingly more difficult. Student B stated their frustration one day in this way, “Ughh! I really like this game, but it can be frustrating!”

Four participants played a game one or two times; those scores were also placed on the graph, but there was no significant difference in the scores. It is possible to see a significant difference in the scores of the computer applications as the applications need to be utilized over several days or weeks.

The participants were eager to use the touch-screen school-issued iPads. Each participant could choose which computer applications were the most enjoyable for them. Studying the participants' choice of computer applications, all six were represented. The following is which computer application was utilized most by each participant: Student A, Music Tutor; Student B, Beat Sneak Bandit; Student C, FlashNote & Staff Wars; Student D, Staff Wars; Student E, Planet Quest; Student F, Noteworks.

Figure 5. Student A Computer Application Scores from Music Tutor, Flashnote, and Planet Quest

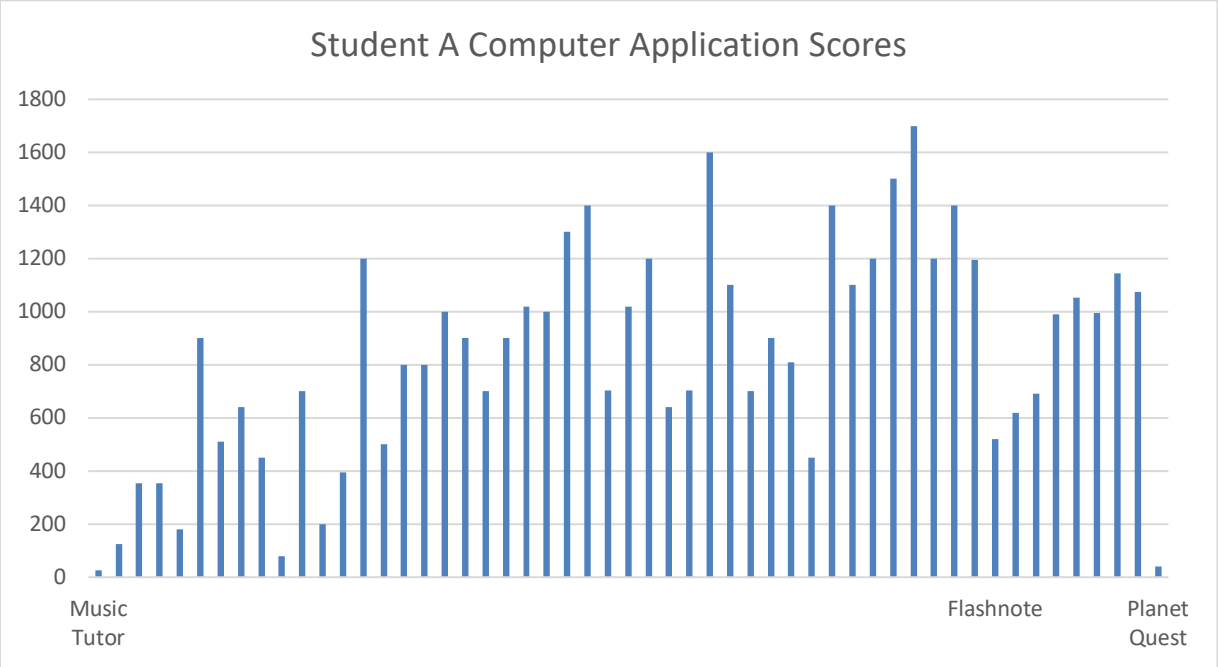


Figure 6. Student B Computer Application Scores from Beat Sneak Bandit

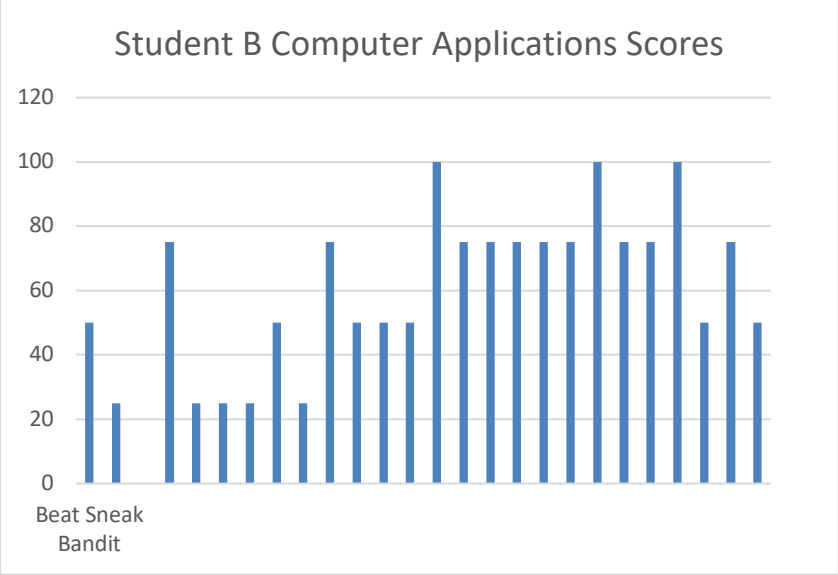


Figure 7. Student C Computer Application Scores from Music Tutor, Flashnote, Staff Wars, and Planet Quest

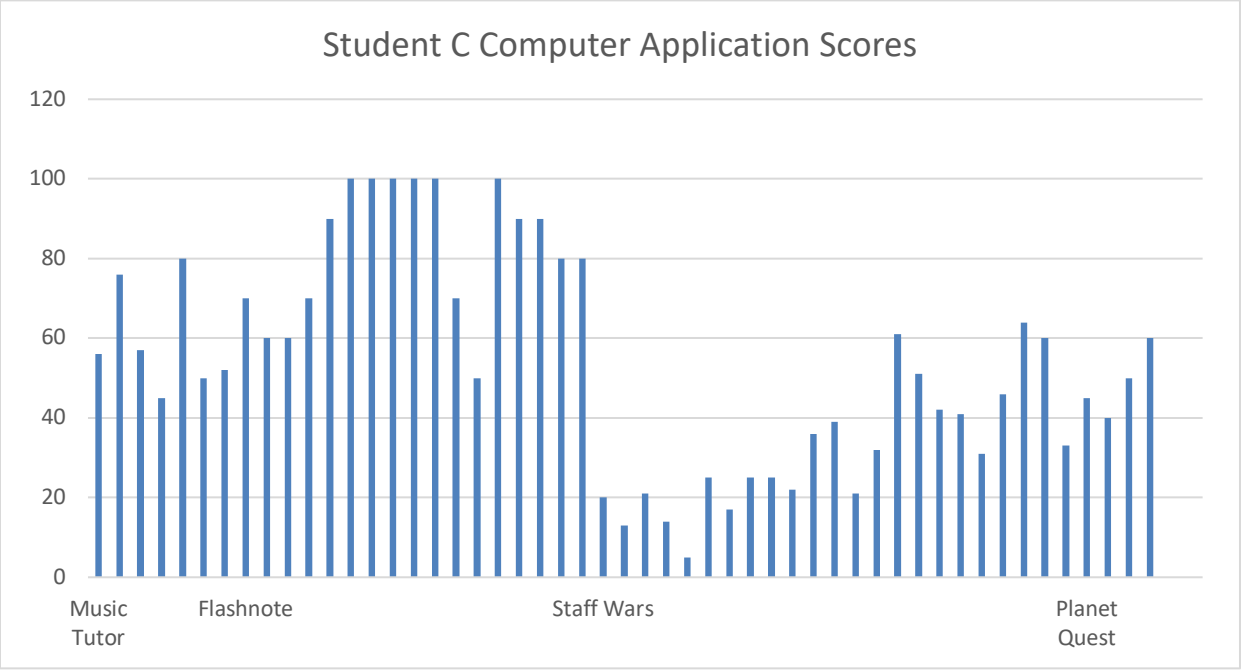


Figure 8. Student D Computer Application Scores from Staff Wars, Planet Quest, Flashnote, and Music Tutor

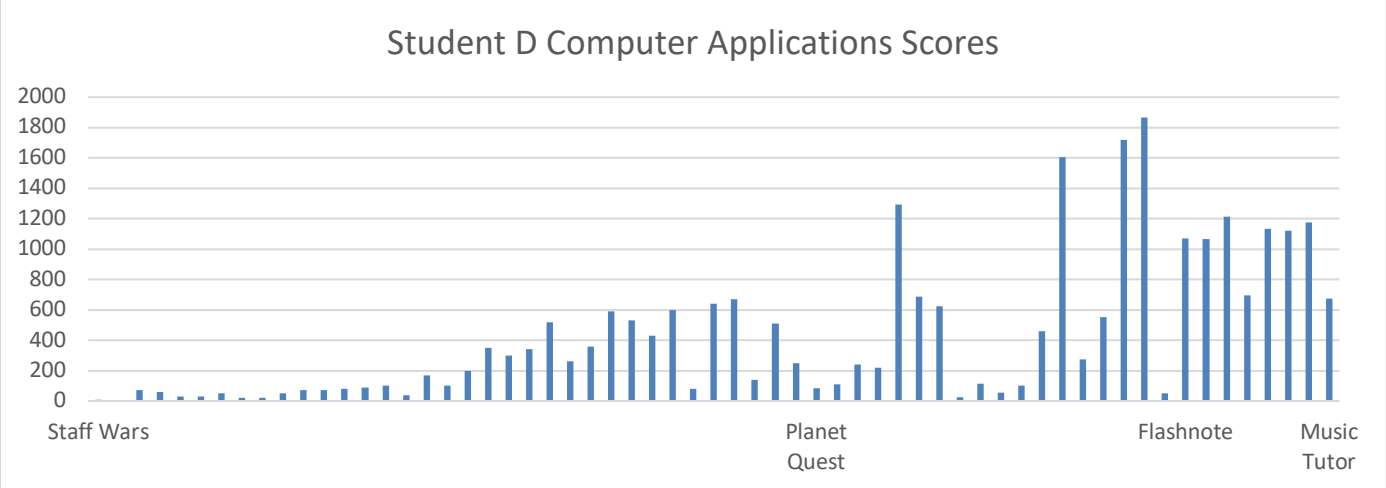


Figure 9. Student E Computer Application Scores from Planet Quest, Flashnote, and Beat Sneak Bandit

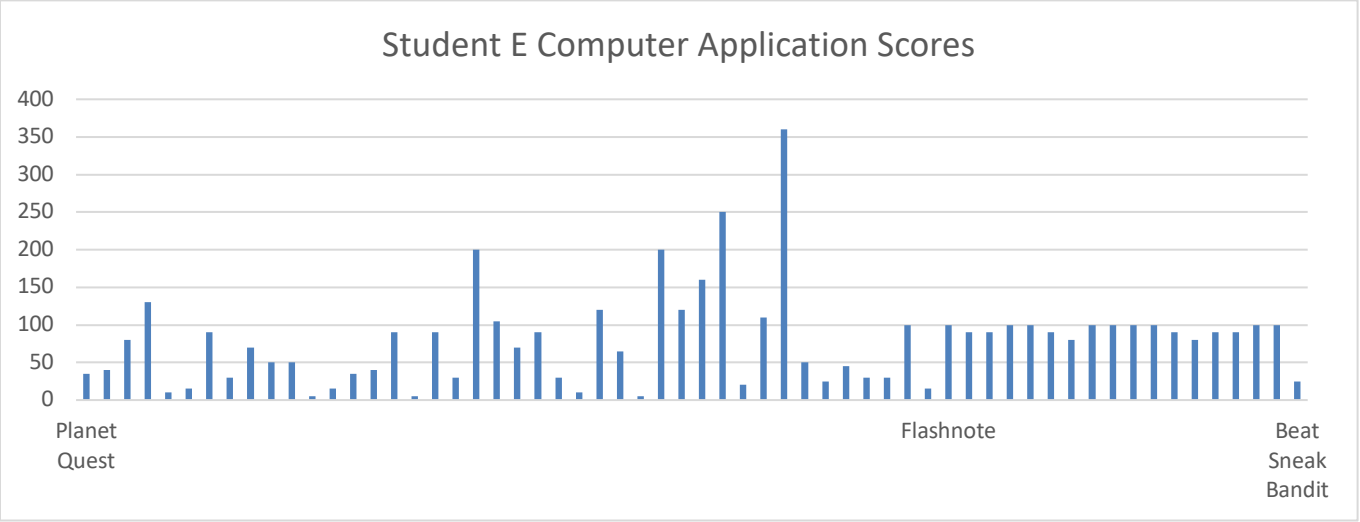
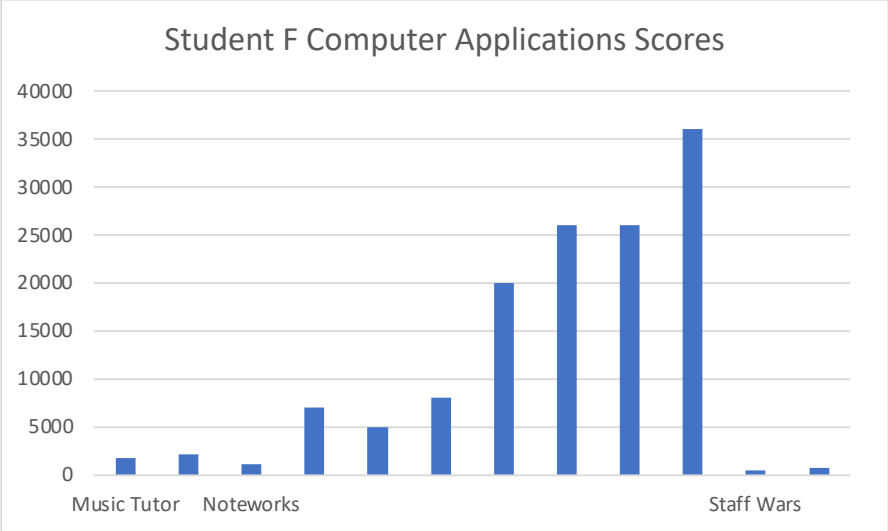


Figure 10. Student F Computer Application Scores from Music Tutor, Noteworks, and Staff Wars



Transfer to Mallet and Snare Drum Percussion

Another subtheme for research question one was assessing whether participants could transfer what they encountered in the computer applications to the mallet and snare drum. Participants could choose three mallet exercises out of 8 on the page (see Appendix J) and three snare drum exercises to try out of 8 on the page (see Appendix K). The mallet exercises listed five notes, middle C, D, E, F, and G. The snare drum exercises had the following rhythms: quarter, half, and whole note, quarter, and half rest. Giving participants a choice on which percussion exercises to try relates to allowing the participants to choose the computer applications they wanted to utilize in research question 1.

Participants were given a short tutorial on the mallets, such as how to hold the sticks and where middle C was located. The researcher and the participants talked through the five notes on the score sheet for the mallet exercises before participants began to play. Participants were also given a short tutorial for the snare drum, such as how to hold the sticks and where to hit the drumhead. The researcher and the participants talked through the rhythm of the notes and rest.

Participants did very well on the mallet and snare drum assessments. All participants scored 2 or 3 on the assessments (see Appendix I below). A score of 2 = response after being prompted/given hints leading to the answer, and a score of 3 = response with no prompt/hints.

Observations from discussions with the participants that the researcher wrote down during the percussion assessments which may show confidence in transferring what they encountered in the computer applications to the percussion instruments, from Student B, “I’m going to try the more difficult mallet examples otherwise you will think I’m a slacker,” and from Student E, “Playing the mallets is difficult, but I liked learning something new.”

Transfer to Mallets and Snare Drum	**Appendix I Using Drum and Mallet after Computer Applications Assessment of Understanding of Notes and Rhythms**					
	Playing Drum Assessment 1	Playing Drum Assessment 2	Playing Drum Assessment 3	Playing Mallet Assessment 1	Playing Mallet Assessment 2	Playing Mallet Assessment 3
Student A	3	3	2	2	3	3
Student B	3	2	3	3	3	3
Student C	3	2	3	3	2	3
Student D	3	2	3	3	3	3
Student E	3	2	3	3	3	3
Student F	3	3	3	3	3	3

0 = no response, regardless of the number of prompts with the answer
1 = response after being prompted with the answer
2 = response after being prompted/given hints leading to the answer
3 = response with no prompt/hints[297]

Research Question Two

Participant's Perspective on Computer Applications

Exit interviews were conducted (see Appendix L) after each meeting. The same questions were asked each time: 8 Likert Scale questions and two short answers. The Educational Specialists and the researcher met without the participants to review the short answer questions to make sure the researcher understood what the participants wrote down. Exit interviews were conducted to assess how well the participants received the program and to encourage communication, a subtheme for research question 2.

F. Xin and Deborah A. Leonard conducted research employing iPads with ten-year-olds with ASD to assist these students in learning communication skills.[298] During the intervention, results showed an increase in the students' requests indicating their needs or self-advocacy by

[297] Kimberley VanWeelden and Julia Heath-Reynolds, "Steps to Designing Authentic Assessments for Students with Disabilities in Music Classes," *Music Educators Journal* 104, no. 2 (2017): 30.

[298] Xin and Leonard, "Using iPads to Teach Communication Skills," 4154.

touching the icon on the device with reduced prompts from the teacher. Self-advocacy among people with an intellectual disability presents opportunities for these students to develop skills to influence change in activities and decisions for themselves.[299] Applying the investigation results employing computer applications in music literacy, which the student with ASD highly prefers, communication may be improved in music literacy and with peers, parents, and teachers, a subtheme of research question two.[300]

Short Answer Question 1 – Can you tell me what you enjoyed about the program today? (All quotes from students are precisely as they wrote them down.)

Positive Statements:

It was nis to tack some time to do music relod stuf; I was homing along; it was fun x3; it was fun but frustrating; fun x2; it was fun but stressful; it was easy; It was fun to learn about drums; It was testing what I can and can't read on the bass clef; It was getting the form turned in.; consistency of timing x2

Noting Progress:

I tried a new game it was more colifull; Playing something new; I am getting better at reading the bass clef; I am getting so much better at the bass clef; I am improving on how much I know about the bass clef notes; I did better at the planet quest program today; I did better on the planet quest program.; I felt that I got better at rhythms; today we used the bells, and it was interesting to read the music, it was hard, but good to do it.; I enjoyed FlashNote, and how it tested my piano skills; Staff Wars game, because it was testing my music skills; I like knowing Im giting bater a reid mosixc;

Enjoyment/Relaxation:

I like reeding music so it was rilasing; I love larning about the cies; Quiet; the games; games x2; game; the mallet; the snare; I enjoyed playing the Planet Quest game.; I liked playing the Planet Quest game.; I liked learning more about the name of lines and spaces.; I liked playing more of the flashnote program.; I enjoyed playing the snar drumb.; Continuity

Communication/Relationships:

I like that we can talk wall playing; It was very nice to chat; I shared the rhythm game that I play on my own

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[299] Mallander et al., "Self-Advocacy for People with Intellectual Disability in Sweden," 2.

[300] Xin and Leonard, "Using iPads to Teach Communication Skills," 4154.

Analyzing the comments from short answer question one, the largest group, 42%, of the participants wrote positive comments about what they liked or enjoyed. The items enjoyed in the participants' words were the games, the fun, the mallets and snare drum, and the quiet. The next largest group, 25%, wrote about what was being improved with the computer applications, such as trying a new game, reading notes, and doing better on a game. Positive comments made up 23% of the comments, such as it was relaxing, it was nice to take time for music-related stuff, and I was humming along. The smallest group, 6%, showed interest in communication, a subtheme of research question two. Two individuals expressed that the computer applications were "fun but frustrating" and " it was fun but stressful."

Analysis of Likert Scale Questions on Exit Interviews

During each meeting, participants were assessed using a Participation Rubric (see Appendix G). The researcher utilized a ranking system to determine participation. These included: 1. Advanced, 2. Proficient, 3. Developing, and 4. Emerging. All participants were a pleasure to work with and received a score of 1. Advanced, for each meeting. For all Likert Scale percentage scores to all exit interview questions, except short answer, see Appendix M.

The first questions on the exit interview (see Appendix L) dealt with stress. Stress is a factor for exceptional students when attending and being at school. Adolescents with ASD participate 25% less in cooperative interactions during inclusive schooling. They have a higher score for loneliness, are often bullied, and commonly experience social anxiety.[301] Studying Figure 11, participants answered that 67% of the time, their stress levels are high or moderate

[301] Beate Krieger, et al., "Supporting and Hindering Environments for Participation of Adolescents Diagnosed with Autism Spectrum Disorder," 2-30.

daily. Studying Figure 12, participants answered that by participating in the music program, the stress level 50% of the time Felt Much Better or Felt Somewhat Better.

Figure 11. Responses from Exit Interviews Daily Stress Level

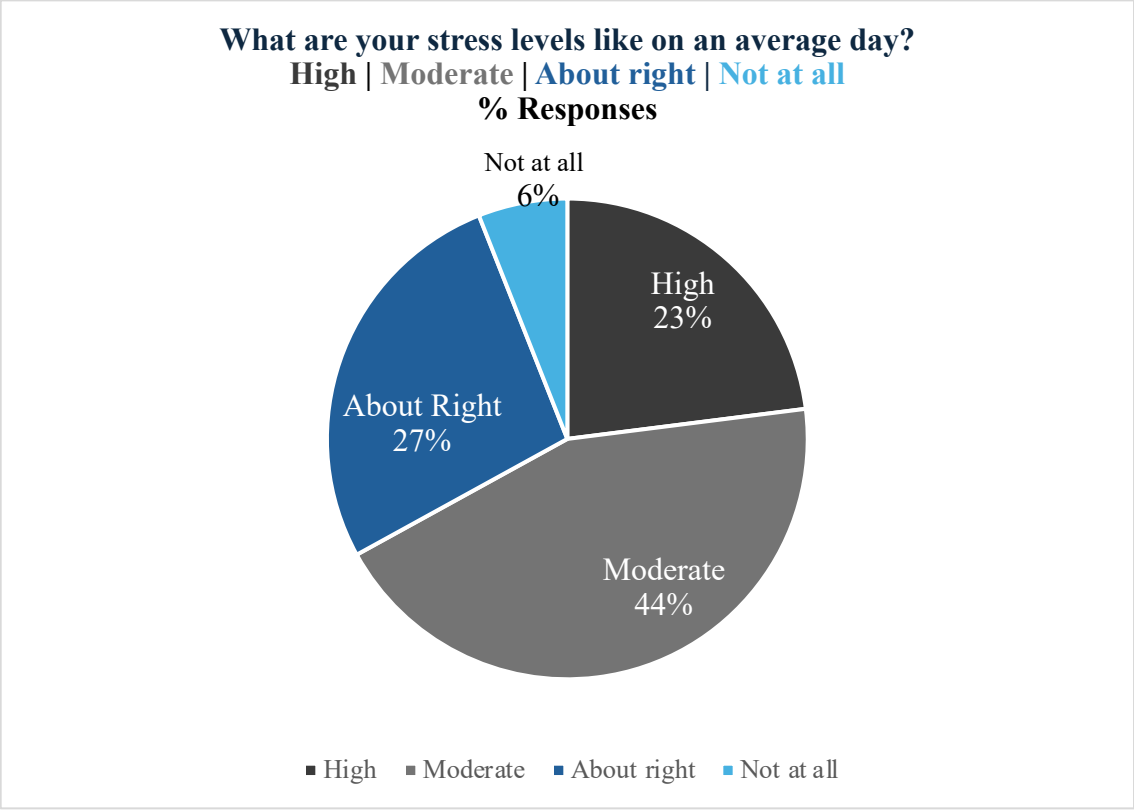
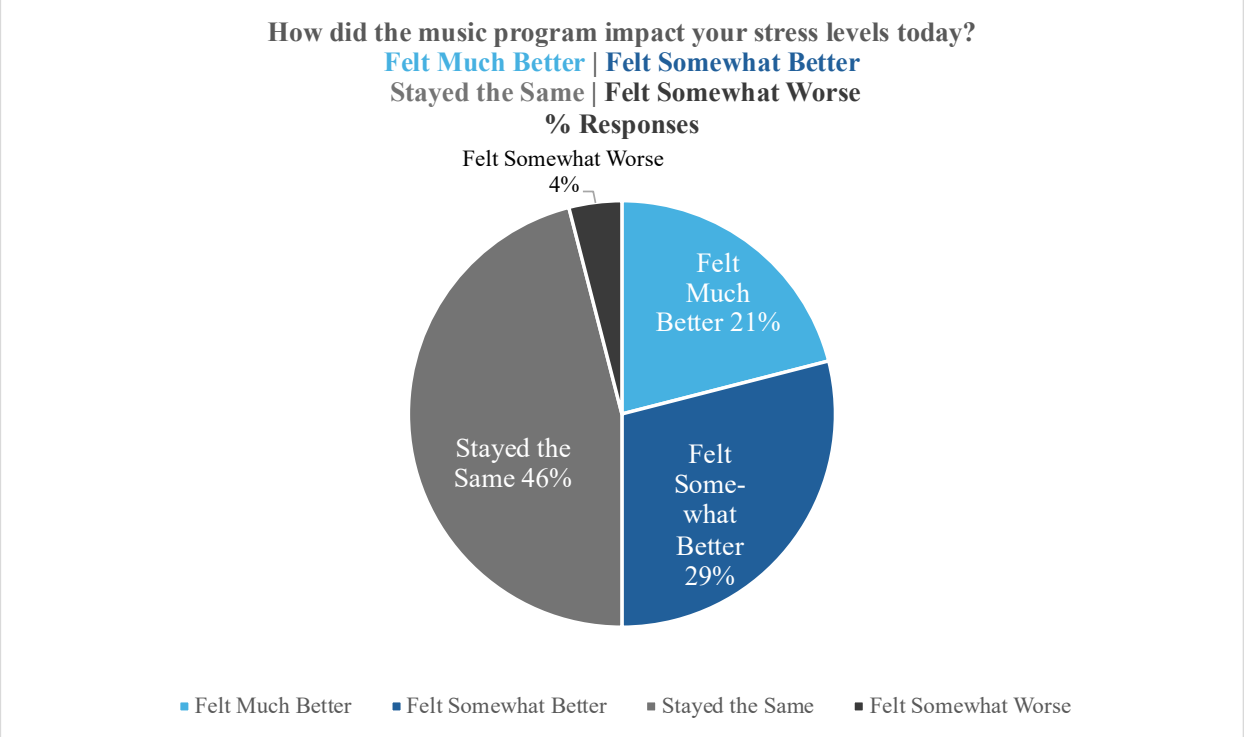


Figure 12. Responses from Exit Interviews Impact on Daily Stress Level



In conversations with participants, Student A had this to say about stress:

"My stress level is very high on a regular basis. Just getting work done and taking care of my younger siblings by picking up and dropping off at their schools is enough. I have a disease where my bones are soft, and I need to be careful if I fall. I also black out on occasion. I walked around on a broken ankle once when I was younger. I'm always in some sort of pain so I didn't realize the ankle was hurting more than it should. The disease also makes me extremely tired."

Student B was stressed with doing items they disagreed with:

"Sometimes I do not see the point in writing my assignment in the planner if I'm going to complete it that day. I don't like that when I'm made to do it."

Student E dealt with stress like this:

"I am stressed that I will not finish my homework. I have my planner color-coded with different color pens to help me keep track better. Did you set your timer today? I want to be sure to use my extra time for homework."

Student F talked about stress in this way:

"My mind is often on my family issues, it is very hard to concentrate on school work because of that. I try and pay attention in class, but sometimes I think about my mom's problems, and then teachers yell at me because they think I'm not listening, or they think I'm not trying enough. I love to play *Hatsune Miku,* but I use the Japanese version, *Project Sikai,* as a distraction, and it helps calm me. I use the Japanese version because I like the music a lot."

The following three exit interview questions asked participants how engaging the computer applications were, what opinions they had on them, and what impact they had on their musical understanding. To those questions, 33% - 42% answered Very Good/Above Average, 45% - 54% answered Good/Average, 2% - 18% answered Acceptable/Below Average, and 0% - 2% answered Poor. The Poor rating came from one participant using the mallets: they stated they were "boring." From analyzing these questions, participants received the computer applications very positively.

Two more exit interview questions dealt with the social aspect of the program. The questions asked if participants benefited socially and if they made friends. Regarding benefiting socially, 17% answered A Great Deal, 19% answered Much, 29% responded Somewhat, and 35% answered Little. When asked if friends were made, 19% answered Yes, and 81% answered No.

Watson and Brown present one reason, among three others, why music therapy is vital when working with autistic individuals: implementing music can promote social relationships.[302] It was encouraging to note that 36% of the exit interview responses stated participants benefitted socially A Great Deal and Much. It was positive to note that 19% of the exit interview responses answered Yes if any friends were made that day.

[302] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 2-3.

The following three questions on the exit interview asked if one's ability to pay attention, memory ability, and everyday life items improved while utilizing computer applications. 31%-54% answered To a great extent or Definitely; 20%-58% responded Somewhat or Very Probably; 6%-23% answered Very Little or Possibly; and 2%-14% responded Not at all or Probably Not. Analyzing these questions, it seemed participants answered that 50% of the time, abilities to pay attention, memory, and everyday life items were improved by utilizing computer applications.

The second short answer on the exit interview relates to whether anything in everyday life was improved. The following are answers from the participants:

Short Answer Question 2 – Can you tell me what you think the computer applications improved in everyday life? (All quotes from students are precisely as they wrote them down.)

Positive Statements:

It helps your mind to focus on something else besides school; my depression; gives me a good reason to push on and be better with other aspects of life; distraction from life; it will help people pay attention better in school and in our personal life

Skills:

my ander standing of instrmits; hand eiy calashin; learning?; learning sheet music by memory and names of the lines + spaces; Playing the games, bells, and snare.; It strengthened my rhythm skills; learning sheet music; playing the mallet; I think they can further help with your misical knowlage; the ability to think logically and chronologically; fast reactions?; Reaction time x2; Multy tasking; not these specifically, but others help reaction time

Memory:

I nodis that my mimory has inproved; memory x4; It will help strengthening my memory, and what I can and can't remember; possibly memory; memory, beat; memory, playing the mallet; The games could help with helping your memory; They might help with your memory; I think it would help with your memory; It can help with your memory x2; the snar drumb helps with memory;

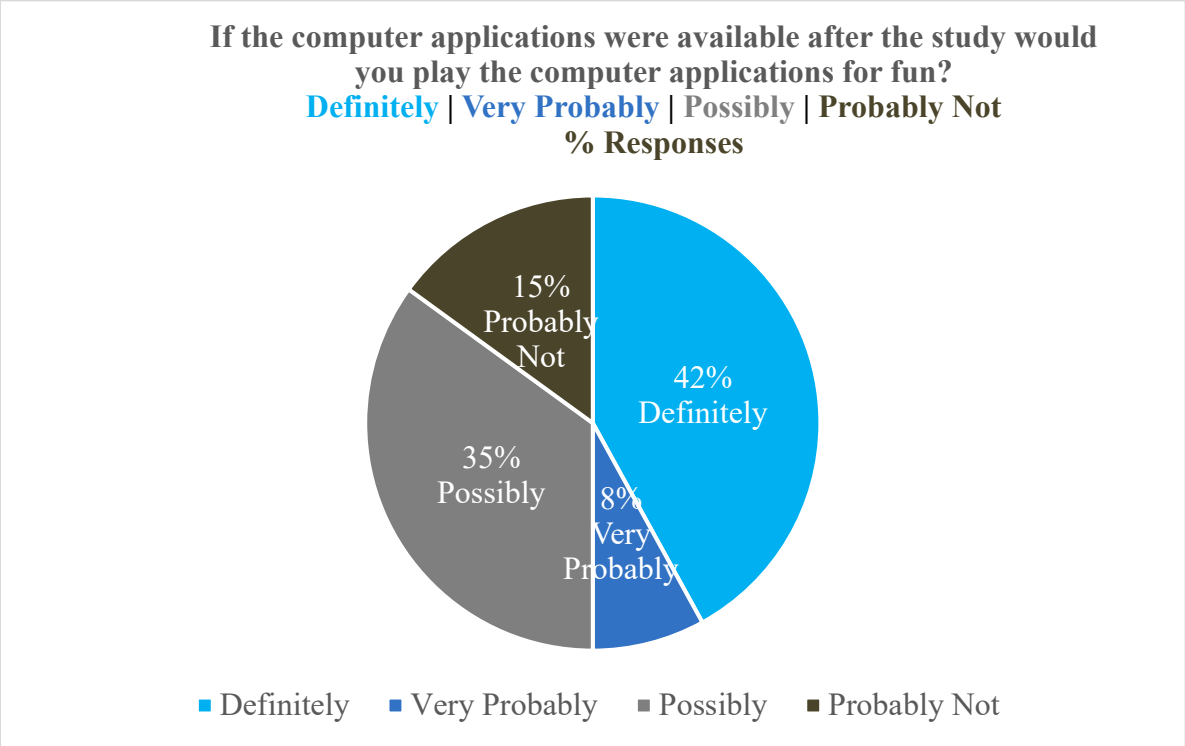
Attitude/Stress:

win the volum wint up it stard me so I need to com down a git bak in to the game. I think the same tay can hup in life you gust have to cip gowing; It will help with maintaining stress; It will help to relieve my stress that someone is going through; I get to help at night to shine tomorrow, and helping me with stress; My last meeting is on Wednesday and it decreased my stress level; To go for it not to over thing

Analyzing the comments from short answer question two, the largest group, 35%, of the participants felt improved or strengthened memory from accessing the computer applications. This was something other than the study's investigation, but it is worth noting. The next largest group, 10%, wrote about maintaining and relieving stress. From what was discussed previously, this topic is essential to students, especially students with ASD. Three additional "improved in everyday life" comments that stuck out to the researcher were, "Gives me good reason to push on and be better with other aspects of life," "I needed to come down a bit and get back in the game. The same thing can help in life, you just have to keep going," and "It helps your mind to focus on something else besides school." Other participants wrote about strengthening rhythm skills, furthering their musical knowledge, understanding of instruments, hand/eye coordination, and helping with depression. Studying the comments, participants felt positive experiences were occurring, other than demonstrating an understanding of notes and rhythms.

The last question on the exit interview asked if participants would continue to play computer applications after the study concluded if available. 8% answered Definitely, 42% answered Very Probably, 35% responded Possibly, and 15% answered Probably Not (see Figure 13). It was positive to note that 50% of the time participants would Definitely/Very Probably utilize the computer applications after the study. Student C appreciated the applications, "I have a lot of trouble reading the bass clef. I think I'll use my time on this game to try and get better at that," and Student E said, "I really enjoy the Planet Quest game."

Figure 13. Responses from Exit Interviews Play Computer Applications for Fun



Summary

In summary, scores from computer applications, transfer to mallets and snare drum, the findings from the exit interviews, and the percentage of responses to the Likert Scale questions in the study were received very positively by all participants. The higher percentages on the Likert Scale ranged from 58% Somewhat to 54% A Great Extent, mainly on the positive end of the assessments. The lower percentages from 2% Poor to 14% Probably Not were much smaller and on the negative end of the evaluations. The participants had great attitudes, were very polite and pleasant, and were a joy to work with. All scored the highest score on the Participation Rubric for each meeting.

Participants' scores from the computer applications increased. There were some fluctuations up and down, but in studying the bar graphs (see Figures 5-10), one can see that the

scores went higher. Because the computer application scores went up, it seems that the musical understanding of notes and rhythms among the participants also increased somewhat. The participants enjoyed being able to choose which computer applications they wanted to utilize instead of the researcher telling them what to choose. Participants were excited to use the touchscreen school-issued iPads, and it took little time to figure out each of the six computer applications.

Interestingly, each participant gravitated to one computer application out of the six, representing each as a favorite. The transfer to mallets and snare drum was also positive. Participants could figure out notes and rhythms on the percussion instruments, applying what was learned with the computer applications. The researcher briefly introduced the mallets and snare drum, but the participants could figure out what to do while reading the exercise examples with 0 or 1 hint/prompt.

Two short-answer questions during the exit interview gave more insight into participants' thoughts on what they enjoyed that day with the computer applications and what they perceived to be improving in their everyday lives. The questions aimed to encourage conversation with the researcher and other participants. All but one of the participants engaged in dialogue with the researcher and other participants. It was encouraging to see the positive statements from the participants when prompted. Other participants wrote about improving their musical skills or how they enjoyed using the percussion instruments. Some participants wrote about how the study was relaxing and enjoyable for them. Most participants wrote about how their memory was improved by reading the notes on the staff utilizing the computer applications. Prompting conversations with ASD individuals about their learning may transfer to other disciplines by enhancing communication skills, social engagement, and self-confidence.

While not included in this study, this topic is worth noting for the individual with ASD. About 50% have no peer relationship outside of prearranged settings, and friendship level is reportedly low.[303] A portion of the exit interview dealt with the social aspect of the program; one of the questions asked if participants made friends. Regarding whether friends were made, 19% answered Yes and 81% answered No. Since individuals with ASD have difficulty making friends, it is favorable to note that 19% of the responses reported that friends were made during the study.[304]

The researcher and the participants hoped for more age-appropriate computer applications for ages 14 and older. Many music games on the App Store are geared for much younger children. Six games could be utilized without being too "babyish" for adolescents, however, a few more choices of games would have been enjoyed.

An exit interview for the participant's parents/guardians was developed to assess the positive or negative aspects of the study on the participants from the parent/guardian point of view (see Appendix N). Parents/guardians were contacted by email and asked to participate in the exit interview if desired. No parents/guardians chose to fill out the parent/guardian exit interview.

[303] Beate Krieger, et al., "Supporting and Hindering Environments for Participation of Adolescents Diagnosed with Autism Spectrum Disorder," 2-30.

[304] Ibid.

Chapter 5: Conclusion

Introduction

This study focused on high school beginning band students utilizing computer applications to demonstrate an understanding of music reading for percussionists with ASD. Research shows that those with ASD have cognitive strengths, including piecemeal processing and attention to detail.[305] The mind works differently in an individual with autism, and technology seems to be particularly accessible for learning new concepts and sharing new ideas.[306] Yerys et al. propose that the findings suggest that digital treatments are a highly feasible approach to addressing cognitive control impairments in children with ASD.[307] This research engaged 14-17-year-old adolescents, high functioning, with ASD, in analyzing the high school beginning band students' choice of computer applications to demonstrate an understanding of music reading for percussionists with autism spectrum disorder. The research also seeks to explain how high school beginning band students with ASD can learn to self-advocate in other disciplines by improving communication skills, social engagement, and self-confidence.

The research design enabled the researcher to conduct eight meetings with six participants in a high school educational setting. During the meetings, participants used computer applications, kept track of their scores, filled out exit interviews, and experienced using mallets and snare drums. The study's limitations were that only six participants met the criteria and were available to participate.

This qualitative case study investigated 14-17-year-old beginning band adolescents using computer applications to demonstrate musical note reading and rhythm understanding. The

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[305] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 277.

[306] Ibid.

[307] Yerys, "Pilot Study of a Novel Interactive Digital Treatment," 1733.

qualitative research explored scores from computer applications, the transfer to mallets and snare drum after utilizing computer applications, the findings from the exit interviews, and the percentage of responses to the Likert Scale exit interview questions. This was achieved by collecting a significant volume of data by meeting the participants at the participant's school two or three times per week, recording computer application scores, collecting data from exit interviews, writing observations, and utilizing the percussion instruments to check for transfer of knowledge from the computer applications. The purpose of the research was to collect first-hand data, triangulate it with prior research, and develop a broad account of how participant choice of computer applications, instead of teacher choice, can demonstrate an understanding of the reading of music for the adolescent beginning band percussion student with ASD.

The focal point of the research was to see if students' choice of computer applications demonstrated an understanding of music reading. Additionally, the study attempted to show ASD students may be able to show evidence to self-advocate in other disciplines while focusing on the choice of instructional materials in music class. Choosing one's instructional materials may improve communication skills, social engagement, and self-confidence. Additionally, this research attempted to show that engaging in music-related activities may decrease stress for the ASD individual and promote social engagement.

This study explains how the high school beginning band student's choice of computer applications demonstrated an understanding of music reading for percussionists with ASD. A secondary part of this study attempted to show that the high school beginning band student with ASD may be able to demonstrate evidence of self-advocacy in other disciplines while focusing on the choice of instructional materials in music class.

Discussion

Many studies have examined the benefits of using technology with ASD individuals; however, individuals 13 years and older have not been robustly studied. No specific research was found that investigated using computer applications to increase musical understanding of notes and rhythms for the beginning adolescent band percussionist. After analyzing three data sources in the study, computer application scores, exit interviews, and observations of participants, different themes emerged. The themes are computer application scores, confidence, transfer to percussion instruments, choice of computer applications, memory, stress, and making friends.

Hillier et al. explore the wide range of intuitive music computer applications that allow individuals who may need to be trained on an instrument to have access to music and the ability to be creative with music in a new way.[308] Scores from each computer application collected went higher as each participant utilized the applications from meeting to meeting. There were some fluctuations up and down, but the computer application scores went higher, which can be interpreted as musical understanding increasing. This was evident when participants transferred to mallet and snare drum. Participants' confidence in transferring to the percussion instruments came from what each encountered in the computer applications.

The researcher chose computer applications based on the information shared by Esposito, who found successful games for autistic children that foster motivation and learning utilizing four elements.[309] The fourth element is providing student choice in research.[310] By studying Hillier et al.'s research, with technological-based approaches, allowing for student choice may

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[308] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 277.

[309] Esposito et al., "Using Tablet Applications for Children with Autism," 201.

[310] Ibid.

improve student learning of reading notes and rhythms.[311] Each participant enjoyed being able to choose which computer application would be utilized for each meeting.

Analyzing the comments from short answer question two (see Appendix L), the largest group, 35%, of the participants felt improved or strengthened memory from accessing the computer applications. This was something other than the study's investigation, but it is worth noting. Pasqualotto et al. focused on interventions with ASD children and adolescents that directly train executive function to improve cognitive function, increasing executive function, particularly regarding cognitive flexibility, problem-solving, and emotion regulation utilizing non-computerized training.[312] Through computerized training, Pasqualotto et al. conducted interventions employing virtual tools with results showing significant improvement in performing administrative tasks, including attention, working memory, and inhibitory control.[313]

The next largest group, 10%, wrote about maintaining and relieving stress. As discussed previously, this topic is essential to students, especially students with ASD. Additionally, this research attempted to show that engaging in music-related activities may decrease stress for the ASD individual and promote social engagement. The review supports Hillier's findings that computer applications gave creative freedom, reducing stress for non-music students.[314] Hillier's consideration for future research, "greater exploration of the student's choice of applications seems a fruitful avenue for future research," was the research inquiry guiding the current study.[315]

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[311] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 277.

[312] Pasqualotto et al., "Effects of Cognitive Training Programs," 1294.

[313] Ibid., 1296.

[314] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 275-276.

[315] Ibid., 278.

Studying Figure 11, participants answered that their stress levels are high or moderate daily 67% of the time. Studying Figure 12, participants responded that participating in the music program made their stress levels feel much better or somewhat better 50% of the time.

Two more exit interview questions dealt with the social aspect of the program. The questions asked if participants benefited socially and if they made friends. Regarding benefiting socially, 17% answered A Great Deal, 19% answered Much, 29% responded Somewhat, and 35% answered Little. When asked if friends were made, 19% answered Yes, and 81% answered No. About 50 percent of individuals with ASD have no peer relationship outside of prearranged settings, and friendship levels are reportedly low.[316] A portion of the exit interview dealt with the social aspect of the program; one of the questions asked if participants made friends. Regarding whether friends were made, 19% answered Yes, and 81% answered No. Since individuals with ASD have difficulty making friends, it is favorable to note that 19% of the responses reported that friends were made during the study.[317]

Watson and Brown present one reason, among three others, why music therapy is vital when working with autistic individuals: implementing music can promote social relationships.[318] It was encouraging to note that 36% of the exit interview responses stated participants benefitted socially A Great Deal (17%) and Much (19%). It was positive to note that 19% of the exit interview responses answered Yes if any friends were made that day.

One last question asked if participants would play the computer applications for fun if they were available after the study. 8% answered Definitely, 42% answered Very Probably, 35%

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[316] Beate Krieger, et al., "Supporting and Hindering Environments for Participation of Adolescents Diagnosed with Autism Spectrum Disorder," 2-30.

[317] Ibid.

[318] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 2-3.

responded Possibly, and 15% answered Probably Not (see Figure 13). Even though 50% of the responses were that participants would play the computer applications if available, more applications need to be developed for individuals aged 14 and older. Individuals would grow bored with the choices after the applications had been utilized.

Conclusion

Research Question One

The analysis results indicated that participants' scores on computer applications increased the longer they were utilized. Participants felt the study was enjoyable and noted progress. When utilizing the percussion instruments, participants were nervous but still eager to try reading the notes and rhythms. It seems utilizing the computer applications gave the participants the confidence to try something new with music learning. Giving participants a choice on which computer applications to utilize was important. Student E stated, "We do not get a lot of choices during the school day." The researcher allowed participants to choose which computer applications, within parameters, grant motivation to participate in computerized training to improve executive function and working memory. Participants felt that their ability to pay attention, memory ability, and everyday life items improved 50% of the time while utilizing computer applications, which can relate to a demonstration of understanding of the reading of music.

After researching, Pasiali, LaGasse, and Penn suggest that teaching rhythm can improve attention and motor skills in adolescents with ASD.[319] Following the findings of Hardy and LaGasse and Sota et al., students with ASD had lower musical ability but preserved

[319] Janzen and Thaut, "Rethinking the Role of Music," 10.

rhythm.[320],[321] Hardy and LaGasse found that when intervening with students with ASD, a primary agent can be rhythm, as supported by evidenced effects of rhythmic cueing for the motor functioning of individuals with neurological impairment.[322]

Allowing ASD adolescent students to learn reading rhythm and notes through computer applications could transfer to learning how to play rhythmic percussion instruments in the beginning band. Observations from this research supported a demonstration of understanding of the reading of music for the percussion instruments. When transferring to the mallets and snare drum, all participants preferred the snare drum over the mallets. Student C verbalized why in this way, "It's much easier to play the snare drum; I do not need to look up and down the whole time." Participants established an excellent rhythmic pulse when playing the snare drum. These findings were similar to those of Sota et al. who found that the children he worked with who presented with ASD demonstrated significantly lower musical ability but preserved rhythm.[323]

Students with Autism Utilizing Technology and Percussion Instruments

Utilizing gamification to teach music literacy and musical concepts may aid not only ASD students but all students. Studying the findings of the researchers below technology can be a tool to make learning notes and rhythms more enjoyable than a band method book. Xin and Leonard suggest employing highly preferred objects and activities in instruction with individuals with ASD.[324] Hillier et al. discovered that adolescents with ASD preferred activities involving technology like iPads and synthesizers to produce creative and meaningful pieces.[325] Putnam and

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[320] Yoo, "Rhythm-Mediated Music Therapy," PhD diss., 38.

[321] Sota et al., "Musical Disability in Children with Autism Spectrum Disorder," 358.

[322] Yoo, "Rhythm-Mediated Music Therapy," PhD diss., 37.

[323] Sota et al., "Musical Disability in Children with Autism Spectrum Disorder," 358.

[324] Xin and Leonard, "Using iPads to Teach Communication Skills of Students with Autism, 4158.

[325] Clements-Cortés and Yip, "Benefits of Community Music Experiences," 35.

Chong conducted a review that concluded that informal and natural interactions with multi-touch devices deliver a simple interaction mechanism that is especially beneficial to those on the autistic spectrum.[326] Goldsmith and LeBlanc discuss that, as in typical teen populations, technology is a draw for adolescents with ASD.[327]

All participants in the study were eager to utilize iPads, mainly since they utilize Chromebooks for school, which, in their own words, "They do not like as well." Technology was a draw for these participants: no one needed assistance when beginning each computer application. The only limitation to the computer applications was that there were only 6. The researcher feels more computer applications need to be developed for learning notes and rhythms in music for the 14 and older age group.

Whyte, Snyth, and Scherf found what elements effectively fostered motivation and learning during computer application games for individuals with neuropsychiatric disorders, such as autism.[328] The first is the creation of a storyline that explains the game's goals. Another essential element is the help provided by the mentor. Third, the levels of the game should have a gradual increment of difficulty with clear final goals. Lastly, giving choices to players is essential to promote motivation and enjoyment.[329] The findings from Whyte, Snyth, and Sherf were accurate in this research case study. Not all computer applications had a strong storyline, but all applications gradually increased in difficulty, which the researcher believes held the participant's interest. The participants' choice of computer applications promoted motivation to keep meeting and be involved in the study.

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[326] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 9.

[327] Hillier et al., "Positive Outcomes Following Participation in a Music Intervention," 203.

[328] Esposito et al., "Using Tablet Applications for Children with Autism," 201.

[329] Ibid.

Kagohara et al. reviews the research that examined the application of iPads to teach new skills to individuals with developmental disabilities, including autism.[330] Specifically, targeted skills included academic skills, communication skills, developing employment skills, leisure skills, and transitioning. Limitations of the findings from Kagohara et al. include small sample sizes, a wide range of participants' ages, and supporting computer application effectiveness.

Studying Kagohara et al.'s findings, the researcher also observed the limitation of the small sample size. Another limitation was the analysis that supported the effectiveness of the computer application. The computer application scores increased, supporting increased musical understanding, but an extended period may be needed to see increased musical understanding results.

Students with Autism Utilizing Technology to Improve Working Memory

Through computerized training, Pasqualotto et al. conducts interventions employing virtual tools, showing significant improvement in performing administrative tasks, including attention, working memory, and inhibitory control.[331] Jiménez-Muñoz et al. explores the effectiveness of video games in increasing academic performance in individuals with ASD.[332] The findings showed significant pre/post-test improvement in the following areas investigated with autistic students: sixteen percent improvement in non-verbal skills, 85.9% in mathematics, 50.5% in reading comprehension, and 81.5% in copying rate. Utilizing technology to support training activities to improve administrative functions with ASD students may be effective as ASD students enjoy learning through gamification. Technology-based training allows for a safe

[330] Samantha D. Jaminez, "An Exploration of Teaching Music to Individuals with Autism Spectrum Disorder," PhD diss., Antioch University, Seattle, 2014.

[331] Pasqualotto et al., "Effects of Cognitive Training Programs," 1294.

[332] Laura Jiménez-Muñoz, "Video Games for the Treatment of Autism Spectrum Disorder," 183.

and secure environment where ASD individuals can commit errors with minor consequences and less social anxiety.[333]

Working memory is the limited-capacity storage system that maintains and manipulates information over short periods.[334] Working memory is an essential predictor of academic aptitude and a critical bottleneck underlying higher-order cognitive processes, including controlled attention and reasoning.[335] In previous studies, musical ability relates to many aspects of cognitive functioning. Musical training at an early age develops general IQ, verbal memory, executive function, working memory, and visuospatial ability.[336]

The analysis of the exit interviews revealed that participants felt their memory improved or strengthened. When asked what they thought computer applications improved in everyday life, participants mentioned improved or strengthened memory 35% of the time. This analysis was a pleasant surprise to the researcher. Strengthening or improving memory was not an expected outcome of this research.

Research Question Two

The analysis of the exit interviews demonstrated that participants perceived items as improved in everyday life, but communication was not listed. Participants noted that computer applications enhanced skills such as rhythm, eye-hand coordination, musical knowledge, and logical thinking. Also, improved or strengthened memory was discussed, as was decreased stress. Student A said, “To go for it and not overthink.” Student F said, “It gives me a good reason to push on and be better in school and personal life.” The participants showed evidence of

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[333] Pasqualotto et al., “Effects of Cognitive Training Programs,” 1283.

[334] Takeuchi et al., “Training of Working Memory Impacts Structural Connectivity,” 3297.

[335] Au et al., “Improving Fluid Intelligence with Training on Working Memory,” 366.

[336] Molnar-Szakacs and Heaton, “Music: A Unique Window into the World of Autism,” 322.

improving communication skills, social engagement, and self-confidence from these observations.

Student F expressed that depression improved after being involved in the study. Allen et al. found that those with ASD benefit from music in many ways, including reducing depression, changing mood, having a restorative healing effect, and providing feelings of belonging and social connectedness.[337] Molnar-Szakacs and Heaton state that in these cases, music may become increasingly important to alleviate loneliness and suffering and improve communication and cognitive abilities.[338]

The study's limitations were that the time allowed for each meeting only allowed for a few conversations. When the computer applications were utilized, the percussion instruments were experimented with, and the exit interview was completed, participants needed to get back to their schedules. Not all participants were very verbal, and more extended conversations could not be initiated.

Using Music to Learn to Self-Advocate and Communicate in Individuals with ASD

As a form of nonverbal communication, music constitutes a domain of preserved skills and interests. It is a powerful and accessible affective stimulus that captures and emotionally rewards individuals with ASD.[339] LaGasse discusses and recommends that music therapy is an effective treatment intervention for social interaction, verbal communication, and socioemotional collaboration.[340] The specific stimulus of music provides an engaging way for individuals with ASD to interact socially and work toward nonmusical social outcomes. Kern and Alridge, Starr

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[337] Hillier et al., "Positive Outcomes Following Participation in a Music Intervention," 202.

[338] Molnar-Szakacs and Heaton, "Music: A Unique Window into the World of Autism," 318.

[339] Ibid., 322.

[340] LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder," 23.

and Zenker, and Wilgram and Gold state that music offers structure and predictability, which those with ASD prefer.[341]

Johnston et al. report that extensive evidence in the literature supports the implementation of music therapies for individuals with ASD.[342] Music promotes communication, social-emotional, motor, and neurological development. Analyzing the data, music in treatment may provide a solid basis for learning social skills and integrating into a non-musical context.[343] Reports on social skills in ASD are complicated to learn, and educational objectives should focus on developing social skills because of lifelong implications.[344]

The researcher hoped the exit interviews would encourage more verbal communication than what occurred. In the future, different questions could be asked during the exit interview to promote participant communication. Because individuals with ASD have difficulty communicating with others in social situations, the researcher did not want to force communication and tried to keep items open-ended during the exit interviews.

More communication occurred when the researcher and the participants utilized the mallets and snare drum, which aligned with LaGasse's findings that music therapy is an effective treatment intervention for social interaction, verbal communication, and socioemotional collaboration.[345] The researcher has concluded that a more extended study should focus on ASD adolescents participating in the beginning band, focusing on those students' choice of

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[341] Hillier et al., "Positive Outcomes Following Participation in a Music Intervention," 202.

[342] Johnston et al., "Innovative Computer Technology in Music-Based Interventions," 2.

[343] LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder," 25.

[344] Ibid., 24.

[345] Ibid., 23.

instructional materials, such as computer applications and communication with ASD individuals, to gather data for research question two**.**

Teaching Students with Autism Utilizing Music Therapy to Develop Social Skills

LaGasse points out that there are several reasons that musical stimuli may help with developing social skills.[346] Research has demonstrated that music can activate neural networks and the ability to optimize target behaviors through synchronized neural firings. Research has shown that individuals with ASD are uniquely attracted to musical stimuli and enhanced musical ability. Analyzing the data, music in treatment may provide a solid basis for learning social skills and integrating into a non-musical context.[347]

Focus should be made on lifelong implications for activating neural networks, reducing depression, improving mood, and providing the enjoyment of belonging to a group. Studying the gap in the literature working with adolescents with ASD, who may have heightened feelings of distress associated with social impairments, participating in music may improve communication and cognitive abilities for these exceptional students. Analyzing the short answer exit interview questions, participants felt positive about participating in the study. Moods improved, depression was reduced, students enjoyed meeting together, and some communication about what they enjoyed or did not enjoy was encouraged.

In the exit interviews, participants expressed their feelings about the music program as follows: “It was fun; It was nice to take the time to do music-related stuff; It was fun to learn about drums; It helped our minds focus on something else besides school; It helps with the ability to think logically and chronologically; It will help with maintaining stress; and I was

[346] LaGasse, “Social Outcomes in Children with Autism Spectrum Disorder,” 25.

[347] Ibid.

humming along with the game." Practical data analysis for whether participants learned to self-advocate in other disciplines was a limitation. The researcher could not be with the participants outside the study meeting time. It seems communication skills and social engagement were improved in some participants, but assessing improved self-confidence was difficult without spending more time with the participants.

Implication for Practice

Practical

These findings may have practical significance for music teachers, administrators, Educational Specialists, and individuals who provide additional services for ASD individuals. The experiences of the study's participants may offer recommendations for considering changes, modifications, and adaptations for music-based education for beginning band students with ASD. The relationship between music teachers, Educational Specialists, and students with disabilities relies on a solid relationship to support these exceptional students with positive academic and non-academic outcomes.

One significant result of this study is that utilizing computer applications can help individuals with ASD develop their musical understanding. Despite this study's findings, analyzing the computer applications was challenging. Music educators can utilize computer applications to provide opportunities to improve music education, not only for ASD individuals but for all students. Collaborating with other students using computer applications can improve musical understanding, reduce stress, and increase social interaction. Notably, musical learning transferred from computer applications to mallets and snare drums.

The insights emerging from this research demonstrate that self-advocates who engage in new activities make new friends, develop more confidence, and assume new and positive social

identities and roles.[348] More research can be done on encouraging ASD individuals to learn to self-advocate in other disciplines, focusing on the choice of instructional materials. The consensus of the findings in this research and previous studies illustrates that this study was essential to understand how best to observe the adolescent ASD individual and engage in conversation to improve communication and social skills. The specific stimulus of music provides an engaging way for individuals with ASD to interact socially and work toward nonmusical social outcomes.[349]

Theoretical

This study was guided by the theoretical framework of simplified teaching-meaningful learning (STML). Luo and Kalman developed and utilized this model for a qualitative case study.[350] The STML model utilizes two main components: teaching and meaningful learning. Meaningful learning has two segments: the learning process and the learning outcome, shown in Figure 1.[351] The STML model's teaching and learning concepts perspective utilizes a cognitive rather than a behavioral viewpoint.

Experiential learning is the process of making meaning from direct experience and is a student-centered form of instruction.[352] Experiential learning is associated with meaningful learning and involves the learner actively, and students learn through self-directed investigation of topics that the individual finds attractive.[353],[354] The current study included an analysis of the

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[348] Mallander et al., "Self-Advocacy for People with Intellectual Disability in Sweden," 2.

[349] LaGasse, "Social Outcomes in Children with Autism Spectrum Disorder," 23.

[350] Luo and Kalman, "Using STML as a Theoretical Model for a Qualitative Case Study," 13.

[351] Ibid., 12-13.

[352] Cornell et al., "Enhancing Student Experiential Learning," 136-137.

[353] Luo and Kalman, "Using STML as a Theoretical Model," 13.

[354] Cornell et al., "Enhancing Student Experiential Learning," 136-137.

participant's cognitive learning through computer applications of participant choice related to previous knowledge and learning processes.

As stated earlier, the data confirmed that the scores on the computer applications all went up, which can be interpreted as increased musical understanding. Second, participants engaged in the process by choosing the computer applications for their instruction. Third, participants reflected on their experience answering exit interview questions and engaging in additional communication.

Additionally, Hillier et al. guided this study and explored the wide range of intuitive music computer applications that allow individuals who may need to be trained on an instrument to have access to music and the ability to be creative with music in a new way.[355] The researcher also chose computer applications based on the information shared by Esposito. He found successful games for autistic children that foster motivation and learning utilizing four elements.[356] The fourth element is providing student choice in research.[357]

The themes that emerged from the participants' experiences with the choice of computer applications aligned with the STML teaching and learning process. The participants could make meaning from their direct experience with the computer applications of choice. Each participant was involved actively, and the participants learned through self-directed investigation that the individual found attractive. This was evidenced by the high percentage of positive comments from the participants regarding what they learned and enjoyed about the program.

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[355] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 277.

[356] Esposito et al., "Using Tablet Applications for Children with Autism," 201.

[357] Ibid.

Empirical

This study aimed to examine how the high school beginning band student's choice of computer applications demonstrated an understanding of music reading for percussionists with ASD. A secondary part of this study attempted to show that the high school beginning band student with ASD may be able to demonstrate evidence of self-advocacy in other disciplines while focusing on the choice of instructional materials in music class. Unfortunately, the researcher could only reference a few studies that examined computer applications and increased music literacy. In three separate studies with adolescents and young adults with ASD, Hillier et al. (2012),[358] (2016),[359] and (2016), [360] conducted research by observing participants, conducting interviews, and consulting parents/guardians. Results from the 2012 study were decreased anxiety in the participants with ASD, higher self-esteem, and significantly improved attitudes toward peers. Both studies in 2016 showed improvements in individuals with ASD in processing information, responding optimally to the world around them, and benefitting socially and emotionally. This study is of particular interest because it contributes to the body of information associated with bridging the research-practice gap related to music literacy, technology, ASD adolescents, and beginning band percussionists.

The current study identified, just as Hillier et al. discovered, that adolescents with ASD preferred activities involving technology like iPads and synthesizers.[361] One missing literature component was student choice of instructional materials when studying participants. The

[358] Hillier et al., "Positive Outcomes Following Participation in a Music Intervention," 201-215.

[359] Hillier et al., "Increased Physiological Responsiveness to Preferred Music Among Young Adults with Autism Spectrum Disorders," 481-492.

[360] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 269-282.

[361] Clements-Cortés and Yip, "Benefits of Community Music Experiences," 35.

findings of this study are important for music educators and Educational Specialists to consider encouraging more opportunities for students with disabilities to be involved in a beginning band.

Hillier's consideration for future research was the research inquiry guiding the current study.[362] This phenomenological study found that music literacy improves with individual choice of computer applications rather than teacher choice. Playing computer applications transfers to the reading of music for mallets and snare drum, which could transfer to following a score in band class. Engaging in music-related games reduced anxiety and stress by 50% and gave participants the confidence to try playing the mallets and snare drum; see Figure 12.

The analysis of the exit interviews revealed that participants felt their memory improved or strengthened. When asked what they thought computer applications improved in everyday life, participants mentioned improved or strengthened memory 35% of the time. This analysis was a pleasant surprise to the researcher. Strengthening or improving memory was not an expected outcome of this research.

Limitations

The most significant limitation of this study was only six participants met the criteria to be involved in the research and could participate. Studying Kagohara et al.'s findings, the researcher also observed the limitation of the small sample size.[363] Another limitation was the analysis that supported the effectiveness of the computer application. The computer application scores increased, supporting increased musical understanding, but an extended period may be needed to see increased musical understanding results. Another significant limitation was that

[362] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 278.

[363] Samantha D. Jaminez, "An Exploration of Teaching Music to Individuals with Autism Spectrum Disorder," PhD diss., Antioch University, Seattle, 2014.

only six computer applications were available for the 14 and older age group to utilize in the study.

Practical data analysis was limited to determine whether participants learned to self-advocate in other disciplines. The researcher could only be with the participants during the study meeting time. Some participants seemed to improve their communication skills and social engagement, but assessing improved self-confidence was difficult without spending more time with them. The time allowed for each meeting only allowed for a few conversations. When the computer applications were utilized, the percussion instruments were experimented with, and the exit interview was completed, participants needed to get back to their schedules. Not all participants were very verbal, and more extended conversations could not be initiated.

The researcher hoped the exit interviews would encourage more verbal communication than what occurred. In the future, different questions could be asked during the exit interview to promote participant communication. Because individuals with ASD have difficulty communicating with others in social situations, the researcher did not want to force communication and tried to keep items open-ended during the exit interviews.

Limitations of hermeneutic phenomenology are phenomenological documents describing a person's current life, not considering the continually changing reality of a person's lived experiences.[364] As this was a hermeneutic phenomenological study, limitations for the method applied focused on the teacher's perceptions and documentation.[365] In addition, reporting specific difficulties students experienced with other classroom subjects was unknown.[366]

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[364] Jeanne E. Van der Zalm and Vangie Bergum, "Hermeneutic-Phenomenology: Providing Living Knowledge for Nursing Practice," *Journal of Advanced Nursing* 31, no.1 (2000): 214.

[365] Alexandra A. Lauterbach, "Hermeneutic Phenomenological Interviewing: Going Beyond Semi-Structured Formats to Help Participants Revisit Experience," *The Qualitative Report* 23, no. 11 (2018): 2892.

[366] Ibid.

Recommendations for Future Research

Additional computer applications focusing on musical understanding must be developed for individuals 14 and older. Computer applications increased knowledge of reading notes, but the reading of rhythms could have been more robust, however, according to the exit interview analysis, the participants enjoyed the computer applications. A difficulty in the study was measuring the improvement of self-advocacy for participants. Extended research on the participant's choice of accessing computer applications may reveal learning to self-advocate for these individuals in other disciplines. Additional time was needed with the participants during the school day to observe communication skills and social engagement. Other exit interview questions can be created to encourage increased communication with these exceptional individuals. A surprise outcome of the study for the researcher was that participants commented 35% of the time that they felt computer applications improved or strengthened their memory. This could be an area of continued study with ASD individuals.

Drawing from the insights gained in this study, participants appreciated the choice of computer applications to access. Higher scores from the computer applications implied an improvement in musical understanding, especially in reading notes. Learning from computer applications transferred to mallets and snare drum, and self-confidence playing percussion instruments improved. Other analyses from the exit interviews showed improvements in everyday life, including enhanced or strengthened memory, maintaining and relieving stress, strengthening rhythm skills, furthering musical knowledge, understanding of instruments, hand/eye coordination, and helping with depression. Further study could investigate these topics for individuals with ASD utilizing computer applications.

There is also a need for increased advocacy for the ASD individual. These individuals have not learned how to speak up for their interests and needs. Parents and educators can partner on a deeper level to encourage communication between ASD students, educators, educational specialists and parents to plan for the most effective remediation programs and select a personalized program for each child with ASD.[367] Educators must realize that academic performance, no matter how high, does not ensure a degree of independence for a child with ASD. Cognitively, students diagnosed with ASD present at the level of their age and sometimes even a little higher. Emotionally, however, students with ASD experience difficulty relating to those around them and managing emotions, which makes them vulnerable in front of peers.[368]

The insights from this research demonstrated an increasing focus on and need to encourage ASD individuals to participate in music-related groups for social skills, improved communication, social engagement, and self-confidence. Making friends and the enjoyment of belonging to a group may decrease loneliness, depression, stress, and other issues the ASD individual struggles with. Research has revealed the benefits of music for reducing the core symptoms of ASD. Music programs for individuals with ASD have shown improved self-esteem, positive mood regulation, enhanced verbal communication, and reduced stress and anxiety levels.[369] Though not included in this study, two exit interview questions asked about social benefits and making friends. It was encouraging to note from this study that 36% of the exit interview responses stated participants benefitted socially A Great Deal, 17% and Much, 19%, and 19% made new friends. Further study could explore music-related groups to increase social

[367] Pasqualotto et al., "Effects of Cognitive Training Programs," 1299.

[368] Nistor and Dumitru, "Preventing School Exclusion of Students with Autism Spectrum Disorder," 7058.

[369] Hillier et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 270.

skills and improve communication, social engagement, and self-confidence in adolescents with ASD.

Summary

This study aimed to examine how the high school beginning band student's choice of computer applications demonstrated an understanding of music reading for percussionists with ASD. A secondary part of this study attempted to show that the high school beginning band student with ASD may be able to demonstrate evidence of self-advocacy in other disciplines while focusing on the choice of instructional materials in music class. The theoretical framework that guided the study was simplified teaching-meaningful learning (STML). This research attempted to explain how utilizing student's choice of computer applications can result in an understanding of music reading for exceptional students. Additionally, this research aimed to discover if these exceptional students can self-advocate in other disciplines, focusing on the choice of instructional materials in music class.

The most significant finding of this study was the importance of experiential learning. In experiential learning, each participant was involved actively, and the participants learned through self-directed investigation that the individual found attractive. Therefore, experiential learning, or focusing on instructional materials of student choice, should be implemented with all students, but especially for adolescents with ASD. Based on the findings of this research, this intervention could be relevant and influential in future music education practice.

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APPENDICES

Appendix A: IRB Approval

Date: 3-22-2024

IRB #: IRB-FY22-23-1830
Title: A Qualitative Case Study of High School Students with Autism Spectrum Disorder Utilizing Computer Applications to Increase Music Literacy
Creation Date: 6-29-2023
End Date:
Status: Approved
Principal Investigator: Carolyn Rusnak
Review Board: Research Ethics Office
Sponsor:

Study History

Submission Type Initial	Review Type Expedited	Decision Approved

Key Study Contacts

Member Carolyn Rusnak	Role Principal Investigator	Contact [redacted]
Member Carolyn Rusnak	Role Primary Contact	Contact
Member Nathan Street	Role Co-Principal Investigator	Contact

Appendix B: School Permission

September 1, 2023

Dr. Jonathan Butterfield, Principal, jbutterfield@lslancers.org
Lutheran High School South
9515 Tesson Ferry Road
St. Louis, MO 63123

Dear Carolyn Rusnak,

After careful review of your research proposal entitled "A Qualitative Case Study of High School Students with Autism Spectrum Disorder Utilizing Computer Applications to Increase Music Literacy" we have decided to grant you permission to conduct your study at Lutheran High School South.

Check the following boxes, as applicable:

X We will provide our student list to Carolyn Rusnak and Carolyn Rusnak may use the list to contact our students and their parents to invite them to participate in her research study.

☐ We grant permission for Carolyn Rusnak to contact students with autism spectrum disorder, who are high functioning, between the ages of 14 and 25, and their parents, to invite them to participate in her research study.

☐ We will not provide potential participant information to Carolyn Rusnak, but we agree to provide her study information to contact students with autism spectrum disorder, who are high functioning, between the ages of 14 and 25, and their parents, on her behalf.

☐ We are requesting a copy of the results upon study completion and/or publication.
Sincerely,

Official's Name and Title____JONATHAN M. BUTTERFIELD_____,Principal

Official's Organization_____LUTHERAN HIGH SCHOOL SOUTH_____

Appendix C: Recruitment

Dear Student and/or Parent(s),

As a doctoral student in the School of Music at Liberty University, I am conducting research as part of the requirements for a doctoral degree. The purpose of my research is to describe, explore, and identify how the high school beginning band students' choice of computer applications would be implemented to demonstrate increased music literacy for percussion students with autism spectrum disorder. I am writing to invite eligible participants to join my study.

Student participants must be

- on the autism spectrum, high functioning, between the ages of 14 and 25, and it is preferred, but not required, that they have an interest in participating in the high school beginning band as a percussionist.

Parent participants:

- The parents of the above-described students in the study, if willing, will be asked for feedback in a short one-time exit interview survey at the end of the study.

Student participants, if willing, will be asked to participate in two or three 25-35 minutes per week meeting for eight meetings using school-issued iPads or Chromebooks and computer applications. During the eight-meeting study, students can utilize the computer applications and decide which application(s) are the application(s) of choice. Experimentation by playing the mallets and drum will be incorporated while following a score. Students will utilize timed versions of the application(s) if the student participants agree. Before each weekly meeting ends, the researcher will conduct a short exit interview using a notebook and Likert Scale questions with short answer with the student participants. For students, it should take approximately 25-35 minutes with two or three meetings each week for four consecutive weeks to complete the procedures listed.

Parent participants, if willing, will be asked to participate in a one-time exit interview which should take approximately 15 minutes on the last day of the eight-meeting study. The interview will be a short survey given to the parent participants to fill out. The researcher will gather no names from the parent participants on the survey. If parent participants arrive 15 minutes before the end of the last meeting, parent participants will have plenty of time to complete the exit interview survey.

Names and other identifying information will be collected as part of this research, but participant identities will not be disclosed.

To participate, please respond to my email below, or speak with Ms. Atchity, Ms. Harbison, Ms. Erickson, or Mrs. Davis at school, and they can contact me on your behalf.

- For student participants 18+: If you would like to participate a general consent document along with this letter will be emailed to you. Ms. Atchity, Ms. Harbison, Ms. Erickson, and Mrs. Davis will also have copies of this letter and the general consent document for you to take home and sign. The consent document contains additional information about my research. If you choose to participate, you will need to sign the general consent document and return it to Ms. Atchity, Ms. Harbison, Ms. Erickson, or Mrs. Davis at school or email/text it to me using the information below.

- For parents of students under 18: If you choose to allow your student to participate, a parental consent document, along with this letter, will be emailed to you and your student when I learn they are interested in participating. Return the parental consent document to Ms. Atchity, Ms. Harbison, Ms. Erickson, or Mrs. Davis at school or email/text it to me using my contact information below. Additionally, parents, if you choose to participate yourself, you will need to sign the general consent document for parents and return it to Ms. Atchity, Ms. Harbison, Ms. Erickson, or Mrs. Davis at school or email/text it to me. The Educational Specialists listed above will have hard copies of this letter, the parental consent document, and the general consent document for parent participation if that is easier for you to sign.

Student participants will not receive monetary compensation for participating in this study, but a reward of $50.00 in gift cards to Domino's Pizza will we awarded to each participant upon completion of the study and snacks will be served after each meeting.

Sincerely,

Mrs. Carolyn Rusnak
Director for Sanctuary Worship, Concordia Kirkwood
[redacted]

Appendix D: General Consent for Students Aged 18-25

Consent General Document Form

(For Students Aged 18-25)

Title of the Project: "A Qualitative Case Study of High School Students with Autism Spectrum Disorder Utilizing Computer Applications to Increase Music Literacy."
Principal Investigator: Carolyn Rusnak, Doctoral Candidate, School of Music, Liberty University; assistance will be given on occasion from the Educational Specialists, Ms. Erickson, Ms. Atchity, Ms. Haribon, and Mrs. Davis.

Invitation to be Part of a Research Study

You are invited to participate in a research study. Student participants must be on the autism spectrum, high functioning, and be between the ages of 14 and 25. It is preferred, but not required, that your child has an interest in participating in the high school beginning band as a percussionist. Taking part in this research project is voluntary.

Please take time to read this entire form and ask questions before deciding whether to take part in this research.

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

The purpose of the study is to describe, explore, and identify how the high school beginning band students' choice of computer applications would be implemented to demonstrate increased music literacy for percussion students with autism spectrum disorder.

What will happen if you take part in this study?

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

1. Student participants will be asked to participate in one 45-55 minutes per week meeting, in person, for ten weeks using school-issued iPads or Chromebooks and computer applications.
2. Meetings one and two will establish the routines and allow the student participants to become familiar with all computer applications.
3. Meetings three and four will allow the student participants to determine which application(s) are the application(s) of choice. Each student participant will report on which application(s) were enjoyed and why.
4. Meetings five and six will incorporate a timed version of the application(s) if the student participants agree. Applying learning from the computer application(s), student participants could transfer knowledge by using the mallets and snare drum.
5. Meetings seven through ten will focus on more timed versions of the application(s) if the student participants agree and more experimentation by playing the mallets and snare drum while following a score.
6. The computer applications are, but may not be limited to:
   Dr. Suess Band https://www.148apps.com/app/474940131/
   Flashnote Derby, App Store, https://apps.apple.com/us/app/staffwars/id810405576
   GoGoXylo https://apps.apple.com/us/app/go-go-xylo/id504195873
   Music Tutor, App Store, https://apps.apple.com/us/app/music-tutor-sight-reading/id514363426
   NoteWorks https://apps.apple.com/us/app/noteworks/id546003758

Planet Quest, App Store, https://apps.apple.com/us/app/planet-quest/id922848069
Staff Wars, App Store, https://apps.apple.com/us/app/staffwars/id810405576

7. Before each weekly meeting concludes, an audio-recorded and notated exit interview will be conducted with each of the student participants.

How could you or others benefit from this study?

The direct benefits student participants may expect to receive from taking part in this study are encouraging growth in cognitive skills, self-advocacy skills, and communication skills. Other benefits that may occur are lifelong implications to activate neural networks, reduce depression, improve mood, and provide the enjoyment of belonging to a group.

The information from the current study would allow music teachers to adapt their choice of applications to different members of the band with disabilities such as ASD and to individualize instruction and implement student choice.

Benefits to society include: Adolescents with ASD participate 25 percent less in cooperative interactions during inclusive schooling. Studies to further research encouraging high-functioning older adolescents with ASD to participate in the high school beginning band to aid in social engagement with others, build self-esteem, form friendships, and offer a place to belong with peers may encourage cooperative interactions.

What risks might you experience from being in this study?

The expected risks from participating in this study are minimal, which means they are equal to the risks you would encounter in everyday life. The researcher will be watching for signs of overstimulation in the student participants, such as, rocking, tense muscles, irritability, or complaining about sensitivity to noises. In these cases, taking a break from the computer applications will be encouraged, as well as going to get a drink of water.

How will personal information be protected?

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher and potentially the Educational Specialists, if help is needed for comprehension purposes, will have access to the raw data. Members of the researcher's doctoral committee will only have access to de-identified data.

- Student participant responses and data collected via the digital applications will be kept confidential by replacing names and schools with pseudonyms.
- Exit interviews will be conducted in a location where others will not easily overhear the conversation.
- Data collected from you may be used in future research studies or shared with other researchers. If data collected from you is reused or shared, any information that could identify you, if applicable, will be removed beforehand.
- Data will be stored on a password-locked computer. After five years, all electronic records will be deleted, and all hardcopy records will be shredded.
- Recordings will be stored on a password-locked iPhone until a transcription can be made and then deleted.

How will you be compensated for being part of the study?

Student participants will not receive monetary compensation for participating in this study, but snacks will be served after each meeting.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

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

If you choose to withdraw from the study, please contact the researcher at the email address included in the next paragraph. Should you choose to withdraw, data collected from you will be destroyed immediately and will not be included in this study.

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

The researcher conducting this study is Carolyn Rusnak. The Educational Specialists on site, Ms. Erickson, Ms. Atchity, Ms. Haribon, and Mrs. Davis, may also be assisting at various times for comprehension purposes. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact Mrs. Carolyn Rusnak at [redacted] You may also contact the researcher's faculty sponsor, Dr. Nathan Street, at [redacted]

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

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

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

Your Consent

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

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

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

_____
Printed Subject Name

_____
Signature & Date

Legally Authorized Representative Permission

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

I have read and understood the above information. I have asked questions and have received answers. I agree for the person named below to take part in this study.

☐ The researcher has my permission to audio-record the person named below as part of their participation in this study.

_____
Printed Subject Name

_____
Printed LAR Name and Relationship to Subject

_____
LAR Signature Date

Appendix E: Combined Parental Consent and Student Assent for Students Aged 14-17

Combined Parental Consent and Student Assent

(For Students Ages 14-17)

Title of the Project: "A Qualitative Case Study of High School Students with Autism Spectrum Disorder Utilizing Computer Applications to Increase Music Literacy."
Principal Investigator: Carolyn Rusnak, Doctoral Candidate, School of Music, Liberty University; assistance will be given on occasion from the Educational Specialists, Ms. Erickson, Ms. Atchity, Ms. Haribon, and Mrs. Davis.

Invitation to be Part of a Research Study

Your student is invited to participate in a research study. Student participants must be on the autism spectrum, high functioning, and be between the ages of 14 and 25. It is preferred, but not required, that your student has an interest in participating in the high school beginning band as a percussionist. Taking part in this research project is voluntary.

Please take time to read this entire form and ask questions before deciding whether to allow your student to take part in this research.

What is the study about and why are we doing it?

The purpose of the study is to describe, explore, and identify how the high school beginning band students' choice of computer applications would be implemented to demonstrate increased music literacy for percussion students with autism spectrum disorder.

What will participants be asked to do in this study?

If you agree to allow your student to be in this study, I will ask her/him to do the following:

1. Student participants will be asked to participate in one 45-55 minutes per week meeting, in person, for ten weeks using school-issued iPads or Chromebooks and computer applications.
2. Meetings one and two will establish the routines and allow the student participants to become familiar with all computer applications.
3. Meetings three and four will allow the student participants to determine which application(s) are the application(s) of choice. Each student participant will report on which application(s) were enjoyed and why.
4. Meetings five and six will incorporate a timed version of the application(s) if the student participants agree. Applying learning from the computer application(s), student participants could transfer knowledge by using the mallets and snare drum.
5. Meetings seven through ten will focus on more timed versions of the application(s) if the student participants agree and more experimentation by playing the mallets and snare drum while following a score.
6. The computer applications are, but may not be limited to:
   Dr. Suess Band https://www.148apps.com/app/474940131/
   Flashnote Derby, App Store, https://apps.apple.com/us/app/staffwars/id810405576
   GoGoXylo https://apps.apple.com/us/app/go-go-xylo/id504195873
   Music Tutor, App Store, https://apps.apple.com/us/app/music-tutor-sight-reading/id514363426
   NoteWorks https://apps.apple.com/us/app/noteworks/id546003758

Planet Quest, App Store, https://apps.apple.com/us/app/planet-quest/id922848069
Staff Wars, App Store, https://apps.apple.com/us/app/staffwars/id810405576

7. Before each weekly meeting concludes, an audio-recorded and notated exit interview will be conducted with each of the student participants.

How could participants or others benefit from this study?

The direct benefits student participants may expect to receive from taking part in this study are encouraging growth in cognitive skills, self-advocacy skills, and communication skills. Other benefits that may occur are lifelong implications to activate neural networks, reduce depression, improve mood, and provide the enjoyment of belonging to a group.

The information from the current study would allow music teachers to adapt their choice of applications to different members of the band with disabilities such as ASD and to individualize instruction and implement student choice.

Benefits to society include: Adolescents with ASD participate 25 percent less in cooperative interactions during inclusive schooling. Studies to further research encouraging high-functioning older adolescents with ASD to participate in the high school beginning band to aid in social engagement with others, build self-esteem, form friendships, and offer a place to belong with peers may encourage cooperative interactions.

What risks might participants experience from being in this study?

The expected risks from participating in this study are minimal, which means they are equal to the risks your student would encounter in everyday life. The researcher will be watching for signs of overstimulation in the student participants, such as, rocking, tense muscles, irritability, or complaining about sensitivity to noises. In these cases, taking a break from the computer applications will be encouraged, as well as going to get a drink of water.

How will personal information be protected?

The records of this study will be kept private. Published reports will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher and potentially the Educational Specialists, if help is needed for comprehension purposes, will have access to the raw data. Members of the researcher's doctoral committee will only have access to de-identified data.

- Student participant responses and data collected via the digital applications will be kept confidential by replacing names and schools with pseudonyms.
- Exit interviews will be conducted in a location where others will not easily overhear the conversation.
- Data collected from your student may be used in future research studies or shared with other researchers. If data collected from your student is reused or shared, any information that could identify your student, if applicable, will be removed beforehand.
- Data will be stored on a password-locked computer. After five years, all electronic records will be deleted, and all hardcopy records will be shredded.
- Recordings will be stored on a password-locked iPhone until transcribed. After transcription, the recordings will be deleted.

How will participants be compensated for being part of the study?

Student participants will not receive monetary compensation for participating in this study, but snacks approved by parents/guardians will be served after each meeting.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether to allow your student to participate will not affect your or his/her current or future relations with Liberty University. If you decide to allow your student to participate, your student is free to not answer any question or withdraw at any time or you are free to withdraw your student at any time without affecting those relationships.

What should be done if a participant wishes to withdraw from the study?

If you choose to withdraw your student from the study or your student chooses to withdraw, please contact the researcher at the email address included in the next paragraph. Should you choose to withdraw her/him, or should your student choose to withdraw, data collected from your student will be destroyed immediately and will not be included in this study.

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

The researcher conducting this study is Carolyn Rusnak. The Educational Specialists on site, Ms. Erickson, Ms. Atchity, Ms. Haribon, and Mrs. Davis, may also be assisting at various times for comprehension purposes. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact Mrs. Carolyn Rusnak at [redacted] You may also contact the researcher's faculty sponsor, Dr. Nathan Street, at [redacted]

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

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

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

Your Consent

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

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

☐ The researcher has my permission to audio-record my child as part of his/her participation in this study.

_____
Printed Child's/Student's Name

_____
Parent/Guardian's Signature Date

_____
Student's Signature Date

Appendix F: Consent General Document Form for Parents of Student Participants

Consent General Document Form

(For Parents of Student Participants)

Title of the Project: "A Qualitative Case Study of High School Students with Autism Spectrum Disorder Utilizing Computer Applications to Increase Music Literacy."
Principal Investigator: Carolyn Rusnak, Doctoral Candidate, School of Music, Liberty University

Invitation to be Part of a Research Study

You are invited to participate in a research study. Parent participants need to have a student participating in the above-discussed study.

Please take time to read this entire form and ask questions before deciding whether to take part in this research.

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

The purpose of the study is to describe, explore, and identify how the high school beginning band students' choice of computer applications would be implemented to demonstrate increased music literacy for percussion students with autism spectrum disorder.

What will happen if you take part in this study?

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

- Participate in a one-time exit survey, which should take approximately 15 minutes on the last day of the ten-week study. If parents arrive 15 minutes before the end of the last meeting, you will have plenty of time to finish the exit survey.

How could you or others benefit from this study?

Some direct benefits ASD students may receive would be to benefit in other discipline areas to encourage growth in cognitive skills, self-advocacy skills, and communication skills.

The information from the current study would allow music teachers to adapt their choice of applications to different members of the band with disabilities such as ASD and to individualize instruction and implement student choice.

Benefits to society include: Adolescents with ASD participate 25 percent less in cooperative interactions during inclusive schooling. Studies to further research encouraging high-functioning older adolescents with ASD to participate in the high school beginning band to aid in social engagement with others, build self-esteem, form friendships, and offer a place to belong with peers may encourage cooperative interactions.

What risks might you experience from being in this study?

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

How will personal information be protected?

The records of this study will be kept private. Research records will be stored securely, and only the researcher, and potentially the Educational Specialists, if help is needed for comprehension purposes will have access to the raw data. Members of the researcher's doctoral committee members will only have access to de-identified data.

- Parent participant survey responses will be kept confidential because the researcher will not collect identifying information on the survey.
- Data will be stored on a password-locked computer. After five years, all electronic records will be deleted, and all hardcopy records will be shredded.

Is study participation voluntary?

Participation in this study is voluntary. Your decision whether to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

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

If you choose to withdraw from the study, please contact the researcher at the email address included in the next paragraph. Should you choose to withdraw, data collected from you, if it is possible to link that data to your identity, will be destroyed immediately and will not be included in this study. Otherwise, because no identifying information will be collected on the survey, it may be impossible to identify your responses and remove your data from the study.

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

The researcher conducting this study is Carolyn Rusnak. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at [redacted]
You may also contact the researcher's faculty sponsor, Dr. Nathan Street, at [redacted]

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

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

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

Appendix G: Computer Application Participation Rubric[370]	
Advanced – 1.	Routinely provided helpful ideas to the group and emerged as a group leader Follows the rules/procedures Supports class learning with positive behavior and self-control Participates willingly
Proficient – 2.	Provided helpful ideas and supported the work of others while staying on task Generally follows the rules/procedures Generally supports class learning with positive behavior and self-control Generally participates
Developing – 3.	Rarely contributed to group efforts Makes a conscious effort to follow the rules/procedures Showing consistent improvement in supporting in-class learning Makes a conscious effort to improve participation
Emerging – 4.	Criticized the work of others while rarely on task and contributed very little Usually needs reminders to follow the rules/procedures Sometimes supports class learning Participates very little during class

[370] Dr. Nathan Street, "Chorus Music Exemplar Plan" (example in MUSC 846 at Liberty University, Lynchburg, VA, July 19, 2021).

Appendix H: How Students Demonstrated on Computer Applications[371]						
	Name of Computer Application	Correct with No Prompts/Hints	Correct with Teacher Prompts/Hints	Correct after Teacher Modeled/Echoing	No Response/Not Correct	Score on Computer Application
Student A Week 1						
Student A Week 2						
Student A Week 3						
Student A Week 4						
Student A Week 5						
Student A Week 6						
Student A Week 7						
Student A Week 8						
Student B Week 1						
Student B Week 2						
And so on						

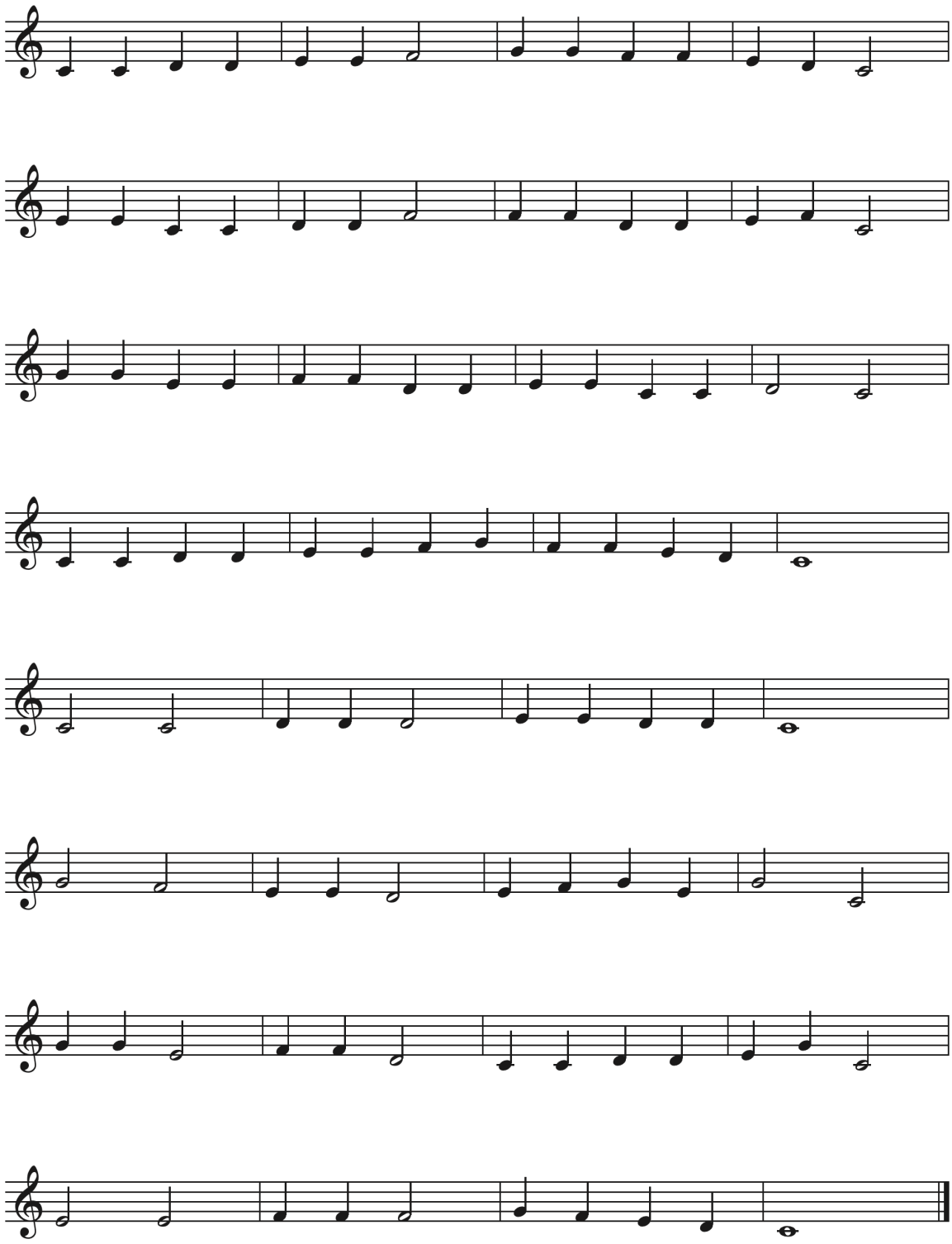
[371] Kimberley VanWeelden and Julia Heath-Reynolds, "Steps to Designing Authentic Assessments for Students with Disabilities in Music Classes," *Music Educators Journal* 104, no. 2 (2017): 30.

	Appendix I: Using Drum and Mallet after Computer Applications Assessment of Understanding of Notes and Rhythms		
	Playing Drum/Mallet Assessment 1	Playing Drum/Mallet Assessment 2	Playing Drum/Mallet Assessment 3 (and so on)
Student A			
Student B			
Student C (and so on)			

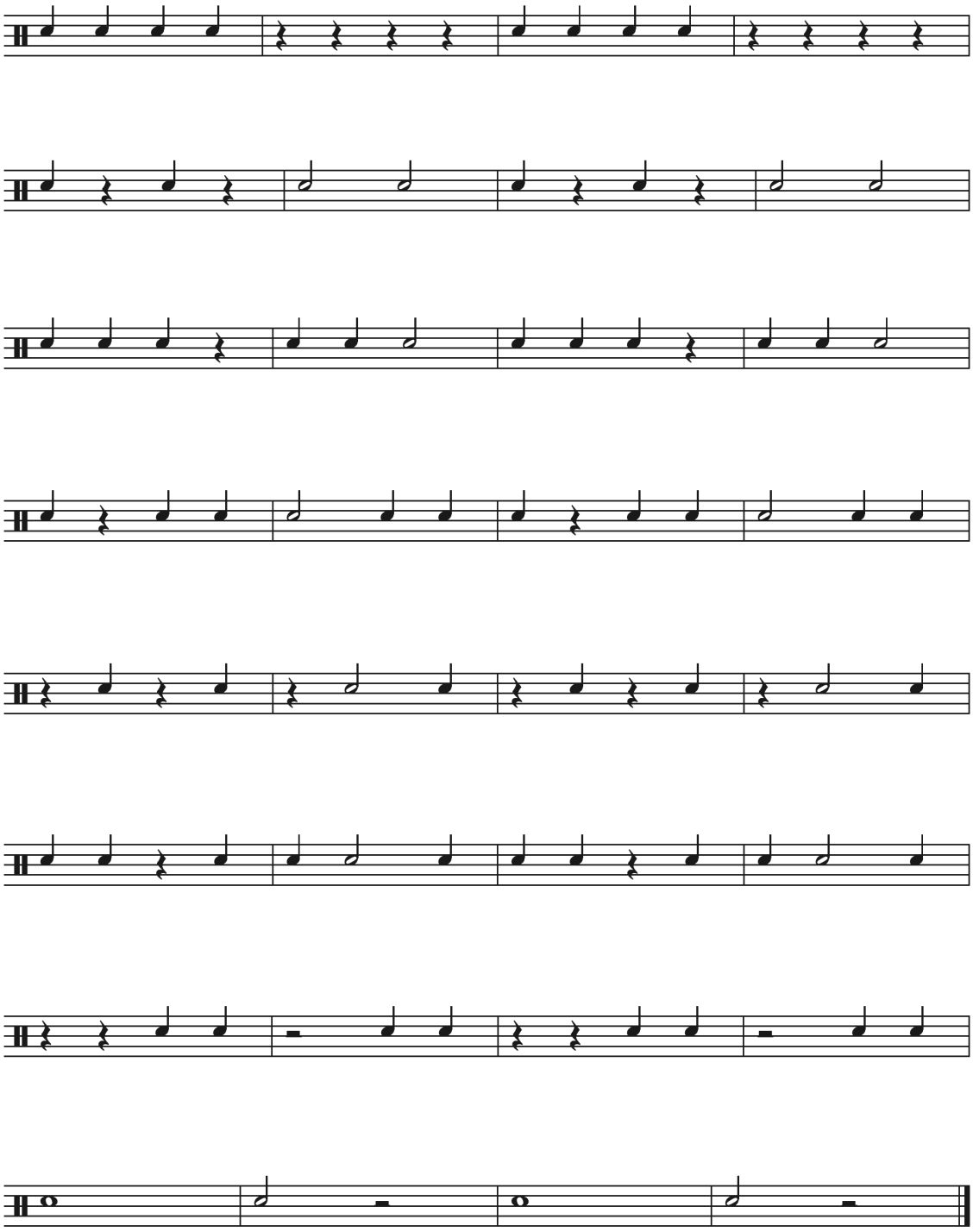
0 = no response, regardless of the number of prompts with the answer
1 = response after being prompted with the answer
2 = response after being prompted/given hints leading to the answer
3 = response with no prompt/hints[372]

[372] Kimberley VanWeelden and Julia Heath-Reynolds, "Steps to Designing Authentic Assessments for Students with Disabilities in Music Classes," *Music Educators Journal* 104, no. 2 (2017): 30.

Appendix J: Mallet Percussion Practice



Appendix K: Snare Drum Practice Sheet



Appendix L: Exit Interview Questions for Student Participants[373] [374] [375]

What are your stress levels like on an average day? (Circle one answer)

1. High
2. Moderate
3. About right
4. Not at all

How did the music program impact your stress levels today? (Circle one answer)

1. Felt Much Better
2. Felt Somewhat Better
3. Stayed the Same
4. Felt Somewhat Worse

Can you tell me what you enjoyed about the program today?

How engaging was the program today? (Circle one answer)

1. Very Good
2. Good
3. Acceptable
4. Poor

What did you think about the computer applications used today? (Circle one answer)

1. Very Good
2. Good
3. Acceptable
4. Poor

How did the computer applications impact your understanding of musical concepts? (Circle one answer)

1. Above Average
2. Average
3. Below Average
4. Poor

(over)

[373] Hillier, et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 274.

[374] Yerys, "Pilot Study of a Novel Interactive Digital Treatment," 1732.

[375] Carolyn Boyce and Palena Neale, "Conducting In-Depth Interviews: A Guide for Designing and Conducting In-Depth Interviews for Evaluation Input," *Pathfinder International Tool Series* no. 2 (2006): 1-12.

How much have you benefited socially from the program today? (Circle one answer)

1. A Great Deal
2. Much
3. Somewhat
4. Little

Did you make any friends in the program today? (Circle one answer)

1. Yes
2. No

Do you think playing computer applications improved your ability to pay attention? (Circle one answer)

1. To a great extent
2. Somewhat
3. Very Little
4. Not at all

Do you think playing computer applications improves your memory ability? (Circle one answer)

1. To a great extent
2. Somewhat
3. Very Little
4. Not at all

Do you think playing computer applications helped you improve anything in everyday life? (Circle one answer)

1. Definitely
2. Very Probably
3. Possibly
4. Probably Not

Can you tell me what you think the computer applications improved in everyday life?

If the computer applications were available after the study, would you play the computer applications for fun? (Circle one answer)

1. Definitely
2. Very Probably
3. Possibly
4. Probably Not

Appendix M: Data Analysis of Exit Interview Questions[376] [377] [378]
(Short Answer Not Included Here)

What are your stress levels like on an average day?

1. High	22.92%
2. Moderate	43.75%
3. About right	27.08%
4. Not at all	6.25%

How did the music program impact your stress levels today?

1. Felt Much Better	20.83%
2. Felt Somewhat Better	29.17%
3. Stayed the Same	45.83%
4. Felt Somewhat Worse	4.167%

How engaging was the program today?

1. Very Good	33.33%
2. Good	47.92%
3. Acceptable	16.67%
4. Poor	2.083%

What did you think about the computer applications used today?

1. Very Good	35.42%
2. Good	45.83%
3. Acceptable	18.75%
4. Poor	0%

How did the computer applications impact your understanding of musical concepts?

1. Above Average	41.67%
2. Average	54.17%
3. Below Average	2.083%
4. Poor	2.083%

[376] Hillier, et al., "Music, Technology, and Adolescents with Autism Spectrum Disorders," 274.

[377] Yerys, "Pilot Study of a Novel Interactive Digital Treatment," 1732.

[378] Carolyn Boyce and Palena Neale, "Conducting In-Depth Interviews: A Guide for Designing and Conducting In-Depth Interviews for Evaluation Input," *Pathfinder International Tool Series* no. 2 (2006): 1-12.

How much have you benefited socially from the program today?

1. A Great Deal	16.67%
2. Much	18.75%
3. Somewhat	29.17%
4. Little	35.2%

Did you make any friends in the program today?

1. Yes	18.75%
2. No	81.25%

Do you think playing computer applications improved your ability to pay attention?

1. To a great extent	31.25%
2. Somewhat	58.23%
3. Very Little	6.25%
4. Not at all	2.083%

Do you think playing computer applications improves your memory ability?

1. To a great extent	54.17%
2. Somewhat	35.42%
3. Very Little	6.25%
4. Not at all	2.083%

Do you think playing computer applications helped you improve anything in everyday life?

1. Definitely	39.85%
2. Very Probably	20.83%
3. Possibly	22.9%
4. Probably Not	14.85%

If the computer applications were available after the study, would you play the computer applications for fun?

1. Definitely	41.67%
2. Very Probably	8.333%
3. Possibly	35.42%
4. Probably Not	14.85%

Appendix N: Exit Interview for Parents/Guardians of Study Participants for Feedback[379]

1. On a scale of 1 to 10 (with 10 being the highest) how much did your child enjoy playing the study computer applications?

2. On a scale of 1 to 10 how challenging were the study computer applications for your child?

3. How would you rate the time your child spent in playing the study computer applications?

Very worthwhile
Somewhat worthwhile
Not worthwhile

4. Did your child have any frustration with the study computer applications?

Yes
No

5. If the study computer applications were available to you after the study, would you want your child to continue to play?

Yes
Maybe
No

6. Do you think that playing the study computer applications helped your child improve anything in the real world?

Yes
Unsure
No

7. Do you think that playing the study computer applications improved your child's ability to pay attention?

Yes
No

8. Please add any additional thoughts you might have relating to the questions above:

_____

[379] Yerys, "Pilot Study of a Novel Interactive Digital Treatment," 1733.