The Relationship between Mental Mathematics and Finger Dexterity as Applied in Playing Piano

By

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Thesis

Submitted in partial fulfillment of the requirements for the

Master of Science Degree in Education

Graduate Studies

Martin Luther College

New Ulm, MN

April 2018

Signature Page

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Abstract

This descriptive research study explored the relationship between mental math and finger dexterity as applied in playing piano. The participants were piano students who had played piano while taking piano lessons for at least four consecutive years and had taken standardized assessment math computation tests during those same four years.

The data to represent the mental math was taken from the standard assessment tests concentrating on the math computation scores, since it was the mind that had processed the answers to the assessment questions with no help from calculators.

The data was recorded for the tests given after the first, second, third, and fourth year of piano lessons to better understand the relationship of the mental math each year with the finger dexterity gained while playing piano during those same recorded years.

Acknowledgments

First and foremost: To God be the glory! All thanks, honor, and praise go to God my Father, Savior, and Faith-Enricher. What a joy it is to humbly enjoy the many blessings given to me so generously and yet undeservingly. Thank you, God, for all that you have done and continue to do for my soul and body and life. May my life and actions move in the direction as Christ's love compels me to follow – always giving of my best in service to Him.

I would like to give my sincere heartfelt thanks to my very supportive husband, Randy, who understands what it means to do our best in service to God. Throughout my graduate work and life as a called worker, he has been so encouraging, patient, and understanding of the extra time needed to follow-through to do my best in this exciting endeavor. It is a joy being part of a supportive marriage team with Christ as our center.

As a continuation of that team, I would also give special thanks to our daughters. Cindy is responsible for planting the beginning seed of inquiry for this project by commenting on how she had noticed that people with fluent computer keyboarding skills were also good in mental math skills. With a lack of written references to back up keyboarding skills, I chose to pursue the importance of finger dexterity as applied to piano playing instead. Cindy and Nancy were both so encouraging and helped immensely with proof-reading of the final drafts of the proposal and thesis. My family has been such a blessing and an encouragement as they use their gifts of music, academics, and Christian love to encourage others in service in praising God.

As a continuation of team support, I would like to thank the members of my Capstone Committee: Dr. Cynthia Whaley, Dr. Paul Boehlke, Prof. Daryl Hanneman, and

Dr. John Meyer. They have been so helpful with constructive guidance throughout this whole process. I also want to thank the teachers I had for the graduate courses. I have enjoyed and have gained a wealth of productive and applicable methods for teaching in my own classroom. It has been an exciting adventure of learning.

I would also like to thank Trinity Lutheran Church in Nicollet, Minnesota, for providing financial support for my continued education throughout the years while teaching at Trinity. The staff and members of Trinity were also such a blessing as they were personally encouraging me to follow-through on this endeavor, since we do offer piano lessons during the day and after school for our students and children in the community. The results were interesting to many families and teachers interested in the best education for our students.

I would also take the time to thank all the piano teachers, principals, parents and students who have given me a part of their time, referrals, and life experiences to help me gather the data needed for the research of this thesis. May God continue to bless the important work they do in using their gifts to God's glory.

I pray that the information you may gain from reading this thesis is helpful to you in understanding how the stimulating areas of the brain can interact and promote different skills to benefit the child overall. Then let us pray for our children to be "*filled with the Spirit of God, with wisdom, with understanding, with knowledge, and with all kinds of skills*" (Exodus 31:3).

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Chapter I: Introduction

Statement of the Problem/ Purpose

"I just don't get it!" may be heard from a child struggling while attempting to finish a math assignment. Some children find it difficult to work with numbers and to recognize their connections and applications in math, while some children can easily think of many ways to see the patterns and to connect that knowledge to understanding. Mathematical understanding and comprehension work when children are exposed to math in a way that makes sense to them; otherwise, they forget what was learned (Regelski, 1978). Regelski continues by also emphasizing that math concepts should be learned at a young age and that giving children a strong foundation is key to the success of working with numbers in mental math. What is meant by *mental math*? According to Collins English Dictionary (2003), *mental math* is "calculations involving addition, subtraction, multiplication or division carried out in the mind only rather than on paper or using a device such as a calculator." For this study, *mental math* will mean all calculations involving addition, subtraction, multiplication or division carried out by using brain-related processing skills without the use of a device such as calculators.

One may also hear comments such as "Look at how fast her fingers move!" about a child who is able to easily play piano at a children's piano recital. The observer is actually commenting on the child's *finger dexterity*. According to *Oxford Dictionary* (2016), *finger dexterity* is "the skill of using fingers to perform a task." Examples of using finger dexterity would be playing the piano or piecing together a LEGO set.

The purpose of this study is to explore the relationship between the ability to work with numbers in mental math and finger dexterity as applied in playing piano. Beilock states that "fingers and numbers share common neural real estate in the brain; the parietal cortex is involved in both" (Beilock, 2015, p. 42). This is evidence which suggests that there is a relationship between mental math and finger dexterity, but more research needs to be done. This study will investigate the possible link between mental math and finger dexterity as it is applied in playing piano.

Significance of the Study

Working with numbers and their connections to each other is part of everyday life. In the grocery store, a child can know how many apples he can buy by estimating and thinking how much for each apple and then taking that number and multiplying it by the number of apples he wants to buy. Children can know the number of blocks in all the piles set up in a center by thinking mentally of learned number patterns to get an accurate final number.

In a similar way, children can be seen using their finger dexterity to accomplish complex tasks that may appear not to take any effort or extra brain-processing time. Children can make it look so easy. Examples of this would include a child quickly typing up an email or playing *The Entertainer* on the piano.

There are people who have an affinity for mental math. There are people who play the piano well. Is there a relationship between the two?

This study will help to explore the relationship that mental math has or does not have with finger dexterity as applied in playing piano. The significance of this study

would be to apply the data results about this relationship to everyday learning involving math and playing piano. Since this appears to be a newly developing concept, there is a need for more research on this topic.

This short-term study is not meant to discover cause and effect, but rather seeks to establish a correlation. It is a description of a relationship between mental math and finger dexterity as applied when playing piano.

Specific Research Question

This study seeks to answer the following research question:

Is there a relationship between mental math and finger dexterity as applied in playing piano?

Definition of Terms

Mental math – "All calculations involving addition, subtraction, multiplication or division carried out by using brain-related processing skills without the use of a device such as calculators" (*Collins English Dictionary*, 2003). The reason why the math computation percentiles/scores were chosen is because they provide reliable statistics of math done using brain-related processing skills without the use of calculators. It has been acknowledged that the standard assessment tests that will measure the math computation percentiles do allow scratch paper to be used. This study will still recognize the percentiles to represent mental math, since it is the mind that has processed the answers to the assessment questions with no help from calculators.

Finger dexterity - "The skill of using fingers to perform a task" (*Oxford Dictionary,* 2016). Examples of using finger dexterity would be playing the piano or piecing together a LEGO set. The four consecutive years of playing piano for piano lessons given by experienced piano teachers will be the relationship factor for finger dexterity for this research.

Finger agnosia – "When someone touches one of the fingers on a hand, that person is not able to tell which one was touched" (Blakeslee and Blakeslee, 2007).

TMS – "Transcranial Magnetic Stimulation of the brain" (Chieffo et al., 2016)

tDCS – "Transcranial direct current stimulation of the brain" (Furuya et al., 2013)

Cortical motor system or cortex – "Areas of the brain not only involved in motor functions, but also play a role in functions formerly attributed to higher order associative cortical areas" (Rizzolatte and Luppino, 2001)

Kinematics – "The study of the motion of bodies without reference to mass or force" (*Collins English Dictionary*, 2003)

Brain plasticity, or neuroplasticity – "The brain's abil-i-ty to change through-out life" (Michelon, 2008)

Assumptions and Limitations of the Study

General implications and assumptions to keep in mind when analyzing the data are that 1) the study uses quantitative data for determining the results, 2) the math computation percentiles from the standard achievement tests are representative of mental math, because all math is done using brain-related processing skills without the use of

calculators and 3) after each year of applied finger dexterity while playing piano for piano lessons, an observation can be made in relation to the corresponding math computation percentiles/scores.

There are a few limitations involved in this study.

Sample attrition - This study relied on the number of information letters returned. An effort was made to alleviate that limitation by personally contacting the schools and teachers to develop a trust connection. A personal meeting and/or consistent email responses to collect the information and to thank them for the time in collecting information for this research helped.

Level variance - When looking at the data for playing piano under the column of level and series, a question could be asked, “What constitutes the “level” when using different series and different authors with different guidelines?” or “Is it the beginning of that level C or the end of that level C?” There is a big difference in skills within levels, but an exact pinpoint of skill level was not needed for this study. It was simply an observation of the amount of applied finger dexterity acquired during those corresponding years of playing piano. To help with this limitation, the amount of years applying finger dexterity while playing piano for piano lessons given by an experienced piano teacher was used.

Attitudes - Though it was not part of the results gained from this research about the relationship between mental math and finger dexterity as applied to playing piano, attitude may have placed a limitation to the design of this research. To help give a better

understanding about the attitudes of playing piano and math, direct questions concerning this had been addressed on the Student Information Letter.

Distractions - The day the student took the achievement test may have introduced many variables. The child may have been sick or may have been troubled with personal issues. The child may have been feeling hot after recess or hungry. The test score taken from just one day in that student's life may have held many variables which could have made a difference in the validity of the test score. To help with this limitation, the test scores for the corresponding four years of finger dexterity while playing piano (not just one year) were used.

Confidentiality - To be sure that student and teacher names remained confidential, identification numbers for the students and identification letters for the schools and teachers were used. The math percentiles were only given after parent permission and attached to the identification number given to insure that this information was considered guarded information for privacy security.

Overview

To continue the process of this study, a literature review will focus on the written research that may support the relationship between mental math and finger dexterity as applied in playing piano. This descriptive study will also include a methodology section, as well as the results and a summary with conclusions and recommendations.

Chapter II: Literature Review

Introduction

Since this appears to be a newly developing concept, information gained from past research is limited. Recent research indicates more of an interest in this developing concept.

Learning Begins at a Young Age

As stated earlier, mathematical understanding and comprehension work when children are exposed to math in a way that makes sense to them; otherwise, they forget what was learned (Regelski, 1978). Regelski continues by also emphasizing that math concepts should be learned at a young age and that giving children a strong foundation is key to the success of working with numbers in mental math. This same emphasis is endorsed by Furuya, Nitsche, Paulus, & Altenmuller (2013), who recommend that children begin playing piano at a young age.

So how can children be exposed to math in ways that make sense to them? Previous research suggests that music may enhance spatial-temporal reasoning (Bilhartz, 2000; Rauscher, 1993 (as cited in Jenkins, 2001, p. 170); & Rauscher, 1997). Hetland continues the research concerning this thought by asking the question: “Does active instruction in music enhance preschool and elementary students’ performance on spatial tasks?” (Hetland, 2000, p. 179). Researchers, such as herself, are interested in these results, because spatial abilities and reasoning are thought to be important in the discipline of mathematics as discussed in depth by Dehaene and Spelke (as cited in Hetland, 2000, p. 227). Research studies done in 2008 also suggest that there appear to

be specific links between the practice of music and skills in geometrical representation (Spelke, 2008) and correlations exist between music training and sequence learning (Wandell, Dougherty, Ben-Schachar, Deutsch, & Tsang, 2008). So it appears that there is a relationship between mental math and music. As to how much, that is yet to be determined by more research.

Burton and Taggart (2011) report on a three-year research study that was done from 2004-2007 where experimental music and movement curriculum were introduced. The specific activities incorporated during these classes were singing, moving, rhythmic and tonal matching and improvising, and instrument play. The research was done to verify school readiness (which included reading/language arts) through music training. The results of the research found a maintaining of reading/language arts skills rather than an enhancement. Thoughts to consider: 1) Would the results be different if the music was incorporated every day, and not just rhythmic movement but playing piano as part of their instrumental play? 2) Would the results be different if music was taught more than once-a-week with more than thirty-minute music lessons? 3) Would the results be different in showing a noticeable increase in a child's school readiness if focused on the number/mathematical skills? That is why more research is needed.

Music and Higher-Order Cognition

Herholz and Zatorre (2012) recognize that several sensory systems, along with the motor system of the brain, are involved when playing music. Playing music provides an excellent opportunity to study how these systems are challenged with the complexity of a wide variety of higher-order cognitive processes. Another part of this opportunity is to study how different types of training influence these interactions. They further note that

musical training is a useful framework for the study of training-related plasticity in the human brain. Hyde et al. agree with those same findings in recognizing that "long-term instrumental music training is an intense, multi-sensory, and motor experience and offers an ideal opportunity to study structural brain plasticity in the developing brain in correlation with behavioral changes induced by training" (Hyde et al., 2009, p. 3019).

Brain Plasticity Changes with Learning

Michelon (2008) refers to brain plasticity, or neuroplasticity, as the brain's abil-i-ty to change through-out life. The human brain has the amaz-ing abil-i-ty to reor-ga-nize itself by form-ing new con-nec-tions between brain cells. Research shows that the brain nev-er stops chang-ing through learn-ing. Michelon states that plas-tic-i-ty is the capac-i-ty of the brain to change with learn-ing. When you become an expert in a spe-cif-ic domain, the areas in your brain that deal with this type of skill will grow. Gas-er and Schlaug (as cited in Michelon, 2008) com-pared plasticity changes in pro-fes-sion-al musi-cians (who prac-tice at least one hour per day) to ama-teur musi-cians and non-musi-cians. They found that gray mat-ter (cor-tex) vol-ume is high-est in pro-fes-sion-al musi-cians in sev-er-al brain areas involved in play-ing music: motor regions, ante-ri-or supe-ri-or pari-etal areas and infe-ri-or tem-po-ral areas.

Mental Math and Playing Music Connected to the Same Regions of the Brain

Since mental math is connected to these same regions of the brain (Vale, 2013) as playing music, could there be a relationship between the two? Vale suggests that scientists affirm that highly gifted creative mathematical thinkers make extensive use of the parietal and frontal areas on both parts of the brain. The neuroscientist, Stanislaw

Dehaene, affirms “you would need the synchronization of eight separate parts of the brain for the different arithmetic operations. For example, for identifying written digits, you activate the left and right visual cortices (at the rear). For understanding quantities - the left and right parietal cortices (at top rear side). To solve word problems - the left temporal cortex (above your left ear) and for complex mathematical reasoning - the left and right frontal areas of the brain” (as cited in Vale, 2013, p. 5) (see Appendix A).

Lakoff and Nunez point out that “experience of sensorimotor activities using fingers during number acquisition makes up part of our numerical knowledge. In particular, the fingers are closely related to numerical ability” (as cited in Asakawa & Sugimura, 2014, p. 189). It is Noel (2005) that shows that the calculation skill is predicted more strongly by finger dexterity than by rhythmic movement, although both are included in hand movements. Noel was also working with rhythmic movement at about the same time as Burton and Taggart (2011) were working with the 2004-2007 experimental research, also using rhythmic movement, but he had the focus on its effects on calculation skills and finger dexterity. Since then, Barsalou, (as cited in Asakawa & Sugimura, 2014, p. 189) shows support from both the behavioral and neuroscientific investigations for the hypothesis at that time (2008) that sensorimotor processes (finger dexterity) are an underlying element of human cognition (mental math).

Studies of the Developmental Relationship of Calculation Skill and Finger Dexterity

Asakawa and Sugimura (2014) report about a two-year longitudinal study of thirty-three children aged four to six years conducted to clarify the developmental relationship between calculation skill (mental math) and finger dexterity. They examined individual developmental changes in the relationship between addition performance and

finger dexterity and observed whether children fit a linear developmental pattern. Many assessments consistently showed that the participants' performance on addition tests was strongly enhanced by their finger dexterity. However, their performance on vocabulary tests was not strongly increased by their finger dexterity. These findings suggest a relationship between calculation skill (mental math) and finger dexterity. This article gives an overwhelming amount of evidence of researched information about the strength of these findings and what it means to the relationship of mental math and finger dexterity.

According to Beilock (2015), in the past several years, scientists have tuned in to the link between the ability to control fingers (which is usually highly developed in musicians) and mathematical performance. He states that fingers and numbers share a common neural real estate in the brain and that the parietal cortex is involved in both. So what happens if this relationship is considered from a different perspective? Blakeslee and Blakeslee (2007) have done research to show that when someone has brain damage to the left parietal lobe, the fingers become fused and undifferentiated and unable to move. When someone touched one of the fingers, that person was not able to tell which one was touched (finger agnosia). It has been found that when that happens, that person is also unable to do simple arithmetic. Is this more evidence which suggests that there is a relationship between mental math and finger dexterity?

Another study was made (Chieffo et al., 2016) explaining the brain research behind the ability to control fingers. Their research concludes that "converging evidence suggests that motor training is associated with early and late changes of the cortical motor system. TMS (transcranial magnetic stimulation) was used to characterize long-term

changes in upper limb motor cortical representation and interhemispheric inhibition associated with bimanual skill training in pianists who started playing in an early age. Findings suggest a more symmetrical motor cortex organization in pianists and that motor training in piano players leads to bimanual hand dexterity. These data have been interpreted as the result of a long lasting change in the functional properties and connectivity in sensorimotor cortex after extensive hand training" (Chieffo et al., 2016, p.1,2). What this all means is that there appears to be a link between the ability to control fingers using both hands (which is usually highly developed in musicians) and connectivity in areas such as found in both the sensory and motor parts of the brain.

What is meant by cortical motor system or cortex as just described by Chieffo et al. (2016)? According to Rizzolatte and Luppino (2001), these areas are not only involved in motor functions, but also play a role in functions formerly attributed to higher order associative cortical areas. Could this be where mathematical performance can be found? This study will help to provide more information and quantitative data about the relationship between mental math and finger dexterity as applied in playing piano.

Reports from the University of Regensburg (2017) add new data to findings in developmental science linking preschool finger dexterity and numerical skills. Research states that "Finger counting is widely considered to be an important step in children's early mathematical development. Children's ability to move their fingers during early counting experiences to aid number representation depends in part on their early fine motor skills. Specifically, fine motor skills should link to children's procedural counting skills through consistent repetition of finger-counting procedures" (University of

Regensburg, 2017, p. 1275). This research could be further applied to the repetitive finger dexterity as applied in playing piano.

After more research, increased information can be given to the question posed back in 1997, “Is there value in more development of and more practice using the connection between mathematics and music?” (Campbell, 1997). Taking it one step further in connection with that question, one can ask: Is there and can we practice using the relationship between mental math and playing piano – a more specific type of music training that uses the skill of finger dexterity? Not much is really known about that. In fact, it appears no one has really done any research on this part of music and its relationship to mental math. The research that will be done for this study should help to better determine the relationship that has been proposed – the relationship between mental math and finger dexterity as applied in playing piano.

According to Sousa (2006), around the age of three, most toddlers have sufficient manual dexterity to play a piano. He continues on to say that brain imaging reveals that creating instrumental music excites the same regions of the left frontal lobe responsible for mathematics and logic. Sousa (2009) extends his research by not only describing the thought processes of children and how their brains operate, but also provides teaching strategies that would match the learning processes of the children specifically designed for their mathematical and musical talents. There is a chapter specifically focused on the application of his brain imaging as it applies to math and another chapter that applies to musical talent. This study will help uncover more of this relationship between mental math and finger dexterity as applied in playing piano.

Study of Specific Finger Kinematics in Piano Performance and Sequence Learning

Bella and Palmer (2011) admit that few studies of finger movement in piano performance have been done, so they did a study rating the finger kinematics in piano performance. What is meant by *kinematics*? According to *Collins English Dictionary* (2003), *kinematics* is "the study of the motion of bodies without reference to mass or force." Bella and Palmer examined the effect of rate on finger kinematics in goal-directed actions of pianists. They found that classification success was higher in pianists with more extensive musical training. "The specificity of these kinematic patterns was demonstrated by successful network classifications of performers, based on trajectories in the attack and keypress events as compared to at-rest portions of performance." (Bella & Palmer, 2011, p. 8) Though this study was geared specifically toward the specific finger kinematics in piano performance, the authors found that as the musicians' performance skill increased, their ability to anticipate upcoming sequence events increased.

Sequence is a mental math concept. "Finger movements are subject to constraints of fine spatial and temporal control, which require performers to produce correct pitches and accurate timing." (Bella & Palmer, 2011, p.1) Questions to consider: 1) Does this research validate the findings of Wandell et al. (2008), recognizing that correlations exist between music training and sequence learning. 2) Does this research that focuses on the rate of finger kinematics in goal-directed actions of pianists also validate the findings from the University of Regensburg (2017) that fine motor skills link to children's procedural counting skills through consistent repetition of finger counting procedures? This study will add to the pool of data and help uncover a relationship between mental math and finger dexterity as applied to playing piano.

Furuya et al. (2013) assessed the effect of transcranial direct current stimulation (tDCS) on dexterity of finger movements in healthy adult pianists. The study suggests that the age at which pianists started piano training positively correlates with the improvement of the finger movements by practice combined with stimulation. Could there be a relationship between the data from the University of Regensburg (2017) linking finger dexterity and numerical skills (mental math) and the data from Furuya et al. (2013) linking finger dexterity and playing piano?

Summary

Research began only around 2008 to see if there was a link between the practice of music and skills in geometrical representation and then in sequence learning. More studies done in 2011 and 2013 affirm with brain research that mathematical thinkers and ones who play music engage the same regions of the brain. In 2014 studies were done to clarify the developmental relationship between the calculation skill and finger dexterity. From 2015 to 2017 scientists tuned in to the link between the ability to control fingers and mathematical performance. With more and more research done lately about the relationship between mental math and finger dexterity, adding the data from this research project, as applied to playing piano, will be useful.

Chapter III: Methodology

Introduction

Some children find it difficult to work with numbers and to recognize their connections and applications in math, while some children can easily think of many ways to see the patterns and to connect that knowledge to understanding. In a similar way, children can be seen using their finger dexterity to accomplish complex tasks that may appear not to take any effort or extra brain-processing time. There are people who have an affinity for mental math. There are people who play the piano well. Is there a relationship between the two?

This study is a descriptive research project. This study will not tell "Why?" something happened. It will not tell the cause and effect of the results. It simply will describe the relationship between mental math and finger dexterity as applied to playing piano.

This chapter will include the criteria for selecting subjects, instrumentation, data analysis procedures, limitations, and summary.

Specific Research Question

This study seeks to answer the following research question:

Is there a relationship between mental math and finger dexterity as applied in playing piano?

Research Design and Procedures

This research design was set up to be a descriptive research project. To proceed in collecting data, information letters were sent to the piano teachers, parents, students, and principal/teachers of the students and returned back to the researcher.

Subjects

The students who had taken piano lessons for at least four consecutive years were the actual subjects, but the parents and principals/teachers of these children were also involved in the giving of permission and verification of years/levels of playing piano for piano lessons and math computations (mental math) percentiles/scores taken from standard achievement tests. The reason why students with at least four years of experience in playing piano while taking piano lessons were chosen as subjects for this study was because it allowed time for the students to become proficient with skills for playing piano (thus developing finger dexterity) and to also be proficient test takers from which math computation (mental math) results were taken.

The students selected as subjects for the study were from schools where standard achievement tests were regularly administered that measured ability in mental math (using no calculators) and where the students had also taken piano lessons during the same time period. The goal was to determine if there was a correlation between the two abilities.

The criteria for the subjects were

- had at least four years of experience in playing piano while taking piano lessons
- had piano lessons with experienced piano teachers

- had taken standard achievement tests measuring mental math

Instrumentation

To verify the qualifications set as needed characteristics for this study, a personal contact was made with several schools, piano teachers, and parents of piano students. Once the schools and piano teachers had confirmed that they had students who met the criteria needed for the research, the corresponding forms were sent out by email: the Parent Information Letter (see Appendix B), the Teacher Information Letter (see Appendix D), the Student Information Letter (see Appendix E) and the Principal Information Letter (see Appendix G). Consistent responses and ongoing invitations were tried to help to maintain the flow of information and data for the research. Google-generated forms with automated graphing capabilities were also sent by email: Parent Information Survey Questions (see Appendix C), Student Information Survey Questions (see Appendix F), and Principal Information Letter for Math Scores (see Appendix H) for those who preferred the avenue of technology for ease of giving information. They were colorful and had an inviting background to set the mood of enjoyment and yet they had a presentation equipped with quick responsive capabilities on the actual Google forms.

Data Analysis Procedures

The steps of instrumentation as described in the previous paragraph were engaged. The personal email and personal picture sent along with a Teacher Information Letter helped to explain who was conducting the research and the nature and purpose of the study. The Parent Information Letter asked for permission to conduct this study involving both the child and parent and asked such questions as: What are the initials of your child's name? (to allow the principal/teacher specifics as to which child for whom

permission was being given) How many years has your child taken piano lessons? What were the years of those piano lessons? Who is the piano teacher? At what level is your child currently playing piano? What is the name of the series currently being used? The Student Information Letter also asked permission from the child to conduct this study and asked such questions as: Do you enjoy playing piano? Why or why not? Do you like math? Why or why not? Are you able to figure out math problems in your head? Is it easy or hard for you to do? The Principal Information Letter was emailed out after permission was given by the parent asking for the specific math computation assessment percentiles/scores for the corresponding years requested. Google-generated forms with automated graphing capabilities were also sent by email to help design pie graphs for visual representations: Parent Information Survey Questions Student Information Survey Questions and Principal Information Letter for Math Scores.

The reason why the level of piano and series was requested on the Parent Information Letter was because a child could have taken four years of piano without practicing very much – as compared to a child who had practiced and within a year was at the same level as the child who had taken piano lessons for years, but without practicing very much. This was an important component to better understand the relationship of the finger dexterity gained by each subject while playing piano and that same subject's mental math abilities. (The subject's level and series were not graphed or included in the relationship segment of this research.) The four years of playing piano for piano lessons given by experienced piano teachers was the relationship factor for this research. The use of several experienced piano teachers showed that the results were not dependent on one teacher's style of teaching.

The Principal Information Letter requested the standard math computation percentiles/scores from the tests given after the first, second, third, and fourth year of piano lessons to better understand the relationship of the mental math each year with the finger dexterity gained while playing piano during those same recorded years.

The quantitative data received was recorded as descriptive statistics on a Results form (see Table 1). On this form were two parts for recorded data: certified playing piano for piano lessons for four years justifying the amount of applied finger dexterity (with added information of student, school, and teacher with security identification number and letters, as well as current level and piano series) and certified measurable math computation percentiles/scores from standard achievement tests corresponding to those same four years.

The quantitative data from the results were set up so that a relationship could be seen between the four years of playing piano (finger dexterity) and the percentiles/scores of the math computation (mental math) during those same four years. The data of math computation percentiles/scores was transferred to make a Graph of Math Computations for the Four Years of Playing Piano (see Figure 1). The Google-generated forms with automated graphing capabilities were used to see how much the limitations of level variance and attitude might affect the results of this study.

Limitations

There were a few limitations involved in this study.

Sample attrition - This study relied on the number of information letters returned. An effort was made to alleviate that limitation by personally contacting the

schools and teachers with a personal meeting and/or several, consistent email responses to develop a trust connection, to remind them of the importance of collecting the information, and to thank them for the time in collecting information for this research. Despite these genuine efforts, sample attrition became a strong limitation concerning the number of information letters returned for several reasons.

First, it was difficult finding students who had taken piano lessons for four years. An assumption was made that there would be an abundance of students from which to receive data, but when approaching the teachers, many confessed that many students start and then when sports start, they drop piano lessons. So most of the piano teachers that were contacted had many students with 0-3 years of experience, which did not qualify them for the research to show the benefits of continued finger dexterity practice. Even though, those teachers referred the requests to other piano teachers, the same story continued, in that, they, too, only had a handful of qualifying students. Piano teachers agreed that a piano student taking piano lessons for four years were probably playing piano because they "wanted to" play, (which may have led to "wanting to" practice and engaging finger dexterity for a longer time) rather than for the reason of "my parents are making me take piano lessons" (which may have led to less engaging of finger dexterity in practice time). Many resources were explored to find qualifying students to help gather needed data.

Second, the researcher unexpectedly found that there were a limited amount of piano teachers in a geographical area. For example, one piano teacher was engaged in teaching at a different town for each day of the week. That one teacher covered a large geographical area. In a larger city, the same piano teacher taught at one music store

location for the first part of the week and at the other music store location for the last part of the week. The researcher checked with a large contemporary music studio up in the Twin Cities and the owner said that he had no students that qualified with over three years of experience, but he referred another teacher from another studio farther away. The researcher checked with Martin Luther College piano teachers and other teachers in the surrounding area for qualifying students. Very few students were processed for several reasons. A continued effort was made to find trustworthy piano teachers from the resource of Linkedin online service. A piano teacher was found from the state of Maryland and was invited to participate. She had three possibilities and would contact them. Despite encouraging invites for the need of data of only a simple verification of four years of piano lessons and corresponding math computation percentiles, no responses came from that resource either.

Third, once a piano teacher was found, it was assumed that teacher would be willing to participate and extend the invitation to the piano students. So when the teacher who covered the large geographical area and taught in another town every day of the week declined the request for helping to gather data and would not pass on the invitation to participate to the piano students, that had an effect on the amount of data that would be received.

Fourth, the factor of time clinched the reason for few responses. Everyone was so busy and felt they had no time to respond. The piano teachers were excited about the research and tried to convey the importance of the data response to the parents and students. Despite the excitement of the value of the research, very few responses were gathered due to the “time” they felt it may take to fill out even the simplified request of a

verification of the years of taking piano lessons and the percentiles from the math computation assessment tests corresponding to those years of lessons.

Level variance - When looking at the data for playing piano under the column of level and series, a question could be asked, "What constitutes the "level" when using different series and different authors with different guidelines?" or "Is it the beginning of that level C or the end of that level C?" There is a big difference in skills within levels, but an exact pinpoint of skill level was not needed for this study. It was simply an observation of the amount of applied finger dexterity acquired during those corresponding years of playing piano. To help with this limitation, the amount of years applying finger dexterity while playing piano for piano lessons given by an experienced piano teacher was used. It was interesting to note that many qualified students were extending their piano experiences by generating personal choices rather than using a specific series.

Attitudes - Though it was not part of the results gained from this research about the relationship between mental math and finger dexterity as applied to playing piano, attitude may have placed a limitation to the design of this research. To help give a better understanding about the attitudes of playing piano and math, direct questions concerning this had been addressed on the Student Information Letter (see Table 2 and Table 3).

Distractions - The day the student took the achievement test may have introduced many variables to the results. The child may have been sick or may have been troubled with personal issues. The child may have been feeling hot after recess or hungry. The test score taken from just one day in that student's life may have held many variables which could have made a difference in the validity of the test score. To help with this

limitation, the test scores for the corresponding four years of finger dexterity while playing piano (not just one year) were used. This is where it was important to see the relationship of the years of playing piano and how it relates to the math computation percentiles/scores consistently (see Figure 1).

Confidentiality - To be sure that student and teacher names remained confidential, identification numbers for the students and identification letters for the schools and teachers were used. The math percentiles were only given after parent permission and then were attached to the identification number given to insure that this information was considered guarded information for privacy security.

Summary

This study was a descriptive research project to discover if there was a relationship between mental math and finger dexterity as applied in playing piano. The subjects had at least four years of experience in playing piano while taking piano lessons and were able to provide the math computation percentiles for those corresponding consecutive years of piano. To gather the data, an Information Letter was sent to the piano teacher, the parent, the student, and the principal/teacher of the student. The researcher awaited the responses to be returned. The limitation of sample attrition played a major role in determining the amount of data that was received. So despite the strong effort of gathering data for this research, the total amount of responses received was a limitation factor. Documented, consistent responses and emails were sent indicating a persistent schedule to open and encourage responses with new and ongoing searches for resources.

Chapter IV: Results

Introduction

This descriptive research study simply described the relationship between mental math and finger dexterity as applied to playing piano. The quantitative data from the results were set up so that a relationship could be seen between the four years of playing piano (finger dexterity) and the percentiles/scores of the math computation (mental math) during those same four years. The data of math computation percentiles/scores was transferred to make a Graph of Math Computations for the Four Years of Playing Piano (see Figure 1).

Concerning the collection of data for the results to be more descriptive, twenty-eight teachers were contacted to help gather data by extending the invitation to their piano students. One third of them did not respond back after the first request and second reminder. Two of them no longer taught piano lessons and so felt they had no access to students nor did they want to give out information concerning their past students. One teacher politely declined to extend the invitation to participate in the research and did not give out information concerning her students. Six teachers were excited about the research and were eager to participate, but had no qualifying students who had taken piano lessons for four years. The remaining ten had qualifying students and had sent out the invites to their students who qualified, but only a total of eight responses were received back from those prospects. So despite the strong, consistent, out-reaching effort of gathering data for this research, the total amount of responses received was an unexpected limitation factor. The four reasons for the limitation were 1) lack of qualifying students, 2) lack of piano teachers in a geographical area, 3) unwillingness to

participate, and 4) willingness, but no time or strong desire to follow through in returning the important data back to the researcher.

Data Analysis

By looking at the graph, the data shows, that on average, over half of the students were going up or maintaining a high percentile in math computation across the four years. For some, the percentiles already had a ceiling effect, because of it reaching the 99% already. Those students could not go any higher. However, it should be clear that to maintain the same percentile rank in a following year the student would have to be increasing in mathematical ability. Seven of the students show that. Even the one that lost rank still is at a very commendable percentile for the grade level.

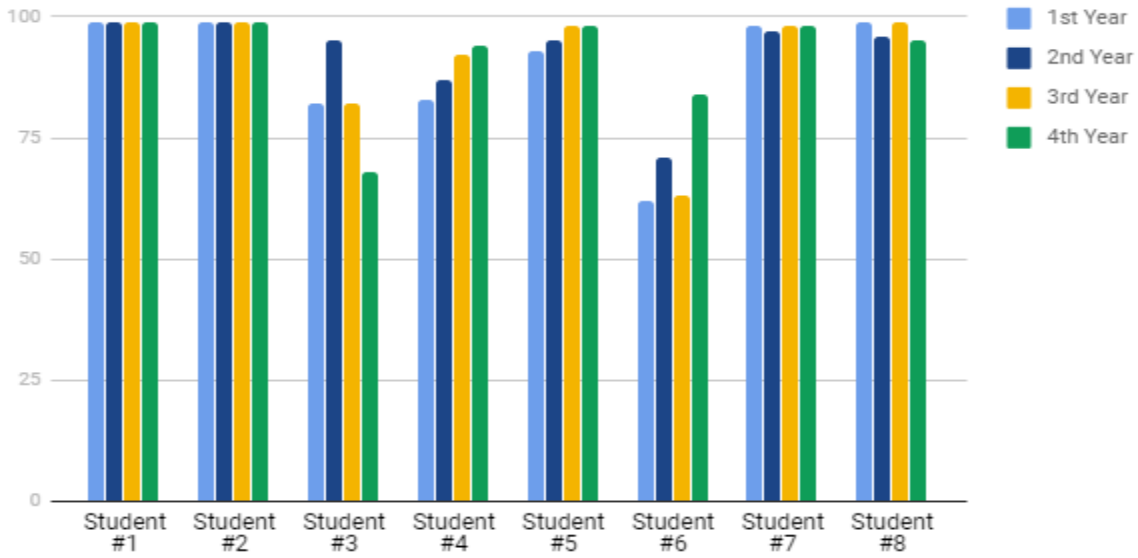
From the data received, the results revealed that 37.5% of students maintained high percentiles across the four years, while 25% showed improvement in percentiles throughout the years. 25% fluctuated in percentiles and 12.5% actually decreased significantly. The information given on the Parent Information Letter indicated that the issue of the turnover of academic teachers during those years had an effect on the math computation skills for that student.

Table 1

Results of Playing Piano for Four Years or More and Math Computation Percentiles

Playing Piano					**Math Computations**			
Stud	**Sch/Tea**	**Yrs.**	**Lev/Series**	**After**	**Yr.1%**	**Yr.2%**	**Yr.3%**	**Yr.4%**
#1	**A A**	**9**	**Early Advanced**		**99%**	**99%**	**99%**	**99%**
#2	**A A**	**10**	**Early Advanced**		**99%**	**99%**	**99%**	**99%**
#3	**B B**	**4**	**3 Alfred**		**82%**	**95%**	**82%**	**68%**
#4	**C C**	**5**	**4 Alfred**		**83%**	**87%**	**92%**	**94%**
#5	**D D**	**4**	**5 Faber**		**93%**	**95%**	**98%**	**98%**
#6	**E D**	**5**	**2 Faber**		**62%**	**71%**	**63%**	**84%**
#7	**F A**	**4**	**Early Advanced**		**98%**	**97%**	**98%**	**98%**
#8	**F A**	**7**	**Adv. Orig. Com.**		**99%**	**96%**	**99%**	**95%**

Figure 1. Graph of Math Computations for the Four Years of Playing Piano



The researcher did calculate the data with a Pearson r score to test how strong the relationship would be to 1, but it was determined that there was not enough data to use a Pearson r formula. The researcher also entered the data by using a t-test paired with 2 samples for means taking the first percentile from the first year listed and the last percentile from the last year listed to find the degrees of freedom, but again there was not enough data. Same reason was used to determine that the data received was not enough to show a bell curve in an ANOVA statistical test.

The researcher then determined to use the Mann-Whitney U test – a nonparametric test that would allow the two groups of data, using the first and the fourth years of playing piano, to be compared without making the assumption that values are normally distributed. After entering the data, the u value = 30 and the $p < .05$ is 15. The

result is that there is no significant difference between the math computation scores from year 1 to year 4 of engaging finger dexterity while playing piano. However, it should be noted that the students in the study all started and ended with high percentile rankings and also persisted in their piano studies for four or more years. This suggests that there is a relationship between mental math and finger dexterity.

Students were also asked to provide responses to questions portraying their attitudes for piano and math. When looking at the math assessment percentile scores on the graph, only one student did not do as well. That same person did not like math. When comparing the piano levels and years playing piano, that same person had been taking lessons for 5 years and yet was in level 2 in piano. Many of the other students, who had taken piano lessons for 4 years, were already in early advanced levels beyond level 6, and did very well in the math assessments. This was confirmed in the responses written by the students and parents to the survey questions which were to give extra information to test out the limitations. Table 2 portrays the answers given by the students explaining why they did or did not enjoy playing piano. (Numbers were given to the students for privacy protection.) Table 3 portrays the answers given by the students explaining why they did or did not like math. (Numbers were given to the students for privacy protection.)

Table 2

Student Survey Question: Do You Enjoy Playing Piano? Why or Why Not? (Check One or More.)

Student Survey Response	Frequency
It makes me happy.	#3, #5, #6
I like to practice and get better at playing piano.	#7
I want to play for a worship service someday.	#6
I like playing piano for my family and others to hear.	#4, #5, #6
I thank God for giving me the blessing of this talent of playing piano.	#5
My piano teacher makes it fun.	
It is easy for me to do.	#5
It is hard for me to do.	
I do not like to practice.	
I am only playing because I "have to."	
I do not like the teacher.	
Other "I enjoy making sounds"	#1

“It is fun to learn the different styles and touches”	#2, #7
“I like to express how I feel- emotions”	#7

Table 3

Student Survey Question: Do You Like Math? Why or Why Not? (Check One or More.)

Student Survey Response	Frequency
It makes me feel happy and smart.	#4, #5, #7
I like doing math to get better at it.	#4
I like working with numbers.	#1, #4, #5
I want to have a job someday that uses numbers and math concepts.	
I thank God for giving me the blessing of this talent of doing well in math.	#4
My math teacher makes it fun.	#6
It is easy for me to do.	#4, #5
It is hard for me to do.	#3
I do not like the time it takes for me to do math and think about numbers. It takes too much time.	
I only do the math because I "have to."	#3, #6

I do not like the teacher.	
Other "There is a clear right or wrong answer"	#1, #7
"Each successful or unsuccessful answer is enhancing my knowledge."	#2

Summary

The data that was received was graphed as a descriptive research design for which the purpose was to describe the relationship between mental math and finger dexterity as applied in playing piano. The data-collection instruments were the Information Letters sent to the piano teacher, parent, student, and principal. A problem in the study was the lack of enough data to best support the correlational analyses to suggest any relationship.

Two related problems emerged in the study. One was that the investigator expected to see increases in the percentile rankings over the four years. However, the students were already at high rankings in the first year. This was unexpected. Secondly, by choosing students that persisted in their piano studies for four or more years, the pool of students was reduced and may have selected those that benefited from also having higher mental math skills, indicating the expected relationship, but in an unexpected way. Surprisingly to the investigator, the structure of the study apparently may have chosen subjects that were both successful in math and piano. Basically, this supports the relationship hypothesis. But to find subjects that persisted for those four or more years was a problem. A figure, that is too often quoted without source, according to Karen King (2016), is that 80% of the piano students dropout at 2 years. She said that there is no data, but the impression is that teachers agree that the dropout number is high.

From the data received, over half of the students were increasing to or maintaining a high percentile in math computation across the four years. For some, the percentiles already had a ceiling effect, because of it reaching the 99% already. Those students could not go any higher. However, it should be clear that to maintain the same percentile rank in a following year the student would have to be increasing in

mathematical ability. Seven of the students show that. Even the one that lost rank still is at a very commendable percentile for the grade level.

The result of the Mann-Whitney U test on the data was that there was no significant difference between the math computation scores from year 1 to year 4 of engaging finger dexterity while playing piano. However, it should be noted that the students in the study all started and ended with high percentile rankings and also persisted in their piano studies for four or more years. This suggests that there is a relationship between mental math and finger dexterity.

To show, more specifically, the relationship between mental math and finger dexterity as applied in playing piano for four years, students #4 , #5, and possibly #6, who started at the lowest percentile, may have had the greatest gain.

Chapter V: Summary, Conclusions, and Recommendations

Introduction

This project paper began with the specific research question for finding a relationship between mental math and finger dexterity as applied in playing piano. The Literature Review brought out research data that showed the recent growing interest in this concept. The Design and Methodology helped to explain the process and limitations in doing this project. A Parent Information Letter, Student Information Letter, and a Principal Information Letter were used to gather the data for the research and extended into an online survey to chart the results. The Results helped to show the answer to the research question as data results were compared with the use of a bar graph.

Summary of the Results

The results represented the response rate of only 8 entries despite the persistent effort by the researcher to continue to gather needed data. From the data received, over half of the students were increasing to or maintaining a high percentile in math computation across the four years. The results revealed that 37.5% of students maintained a high percentiles across the four years, while 25% showed improvement in percentiles throughout the years. 25% fluctuated in percentiles and 12.5% actually decreased significantly.

The result of the Mann-Whitney U test on the data was that there was no significant difference between the math computation scores from year 1 to year 4 of engaging finger dexterity while playing piano. However, it should be noted that the students in the study all started and ended with high percentile rankings and also persisted

in their piano studies for four or more years. This suggests that there is a relationship between mental math and finger dexterity as applied in playing piano.

To show, more specifically, the relationship between mental math and finger dexterity as applied in playing piano for four years, students #4, #5, and possibly #6, who started at the lowest percentile, may have had the greatest gain.

Conclusions

The collection of data from which results were to be charted for this descriptive research project was unexpected. The researcher set out to discover if there was a relationship between mental math and finger dexterity as applied in playing piano. The researcher assumed there would be more than enough students who would have taken at least four years of piano. It was also assumed that piano teachers, parents, and students alike would be so excited to help provide data for this newly developing concept and to be a part of its research. The needed data would be flowing in in large amounts. Many people were excited about the concept and everyone seemed to know many perfect examples of people who played piano for a longer amount of time and were really good with math computation skills. With that encouragement, it was important for the researcher to keep pursuing other avenues for needed data, because the relationship between mental math and finger dexterity as applied at playing piano could be very beneficial for the students.

This research began only around 2008 to see if there was a link between the practice of music and skills in geometrical representation and then in sequence learning. The years between were also busy with studies about this relationship. From 2015 to

2017 scientists tuned in to the link between the ability to control fingers and mathematical performance. That is why that with more and more research done lately about the relationship between mental math and finger dexterity, adding the data from this research project, as applied to playing piano, was useful.

The results from this research added to the data about this relationship by supporting a link between mental math and persistence in piano playing. Despite the extra engaging of finger dexterity over the four years, there were still 25% who fluctuated percentile scores using mental math between the years and even 12.5% who definitely went down with the mental math computation skills. Previous research, as did this research, showed that there could be a relationship between doing well in math computation and the use of finger dexterity as applied in playing piano.

Recommendations

Using the data from which conclusions could be made, a recommendation from the researcher would be to suggest that schools offer piano lessons to the students whether as a part of the school day or offered as an after-school option. If mental math capabilities and piano playing work together, then more schools should embrace them. Playing piano consistently for at least four years may well develop a way to help encourage students who struggle in math computations, as well the ongoing use of mental math skills may likely encourage growth in piano ability.

King mentions that “a feeling of success is a predictor for persistence in piano” (King, 2016, p. 78,79). If mental math is connected to piano dexterity, it could serve as a predictor of success. The researcher would recommend that further research on this

would be valuable. This study does indicate a possible specific indicator of persistence beyond just general academic achievement. Mental math scores may be a predictor of persistence in piano.

Further research should also be done in finding the relationship between mental math and finger dexterity as applied in other areas such as in computer keyboarding skills or finger dexterity as it is used in putting several LEGO sets together.

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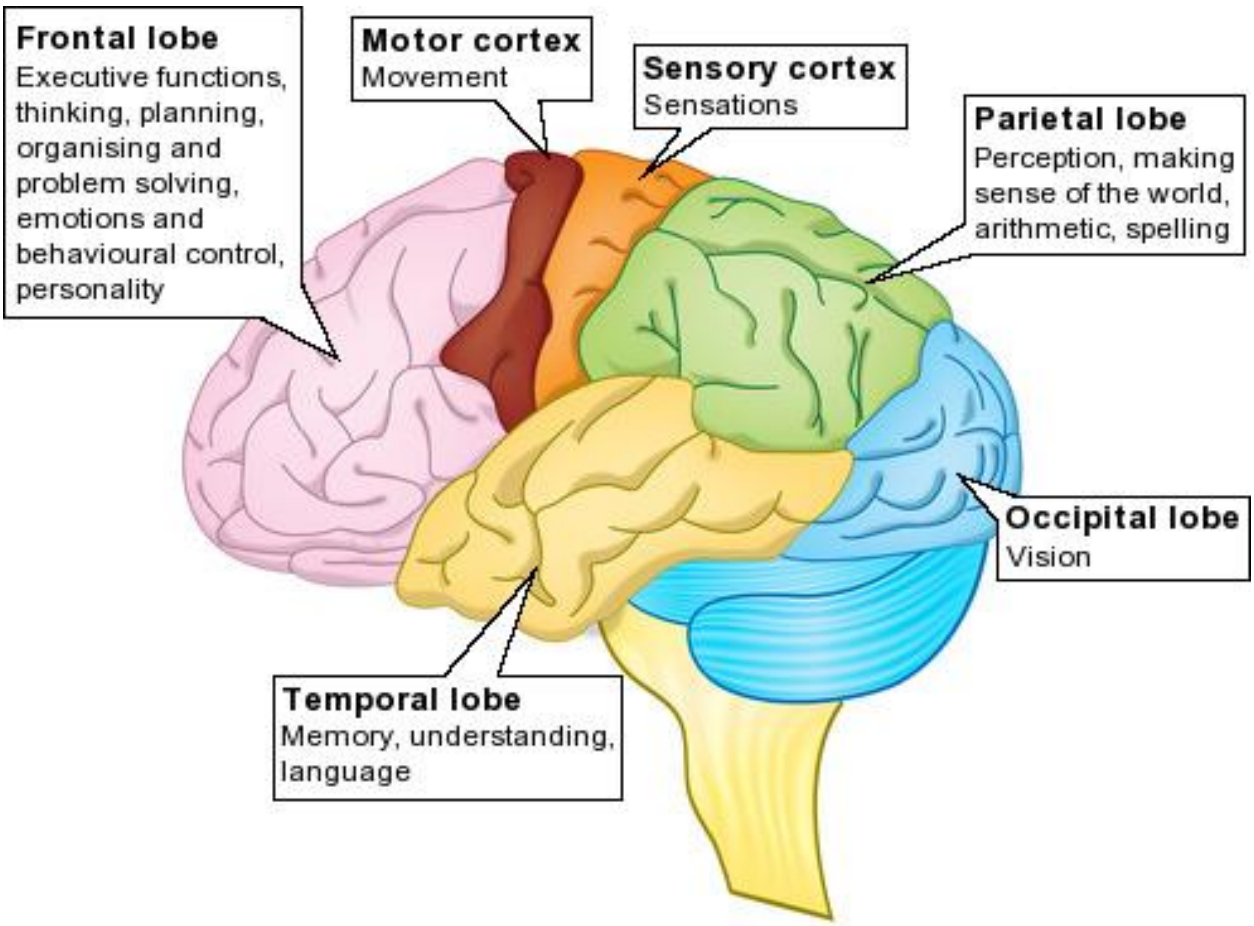
Appendix A: Brain Graphic

Brain Graphic



Appendix B: Parent Information Letter Consent Form

Parent Information Letter

Consent Form

Hello! My name is Mrs. Joyce Lendt, a first and second grade teacher. This letter is designed to collect information for a research project. The results will give more information as to whether or not there is a relationship between children who play piano and brain-related processing skills in math.

Permission is being asked for your child to be part of this research which involves children who play piano. It is important to know your child's piano level/years of lesson experience and your child's math computation percentiles (math test scores) after those first four years of piano lessons. Your child's teacher/principal will record the math computation percentiles for you through an email that I will send separately once I have your permission. Since only identification numbers will be used instead of names, your child will remain anonymous.

Your child will also be asked to fill out his/her responses to feelings toward piano and math on their Student Information Letter which will be sent to be filled out electronically to your email once I have your permission. Participation is voluntary and no compensation will be given. This information will help with the research question: Is there a relationship between mental math and finger dexterity while playing piano?

First of all, I need your permission before I can do any more research. Please sign and return back to your piano teacher as soon as possible, so that I may send you an email survey directly to be filled out.

I give permission for my child, _____, to participate in this research by answering the questions about my child's piano experience, math computation percentiles, and child's personal feelings about piano and math.

Signature_____ Date_____

Parent's email address_____

Principal's name and email address_____

I, _____, (student's name) want to participate in this research and give my permission to use my answers.

Signature_____ Date_____

Sample of Parent Information Letter to be filled out electronically once I receive your email address.

What are the initials of your child's first and last name only? _____

(This is only for the piano teacher and principal to know whose permission they have to give out specific information.)

How many years has your child taken piano lessons?_____

Years: Started - Fall of 20____,and have played piano during 20____, 20____, 20____, 20____

Who is the piano teacher?_____

At what level is your child currently playing piano?_____

What is the name of the series currently being used?_____

Please return for this portion to be filled out by the teacher/principal:

What are the percentiles from the math computation on the standard achievement tests (taken in the fall or spring) during the years of taking piano lessons?

_____% _____% _____% _____%

(After 1 year) (After 2 years) (After 3 years) (After 4 years)

Thank you for your time in answering my questions.

Sample of Student Information Letter to be filled out electronically

I am curious how you feel about playing piano and math:

Do you enjoy playing piano? _____

Why or why not?_____

Do you like math?_____

Why or why not?_____

Are you able to figure out math problems in your head?

Is it easy or hard for you to do?_____

What are your initials (first and last name only)? _____

Appendix C: Parent Information Survey Questions

Parent Information Survey Questions

(Google generated form for graphing capabilities)

I have received your permission for you and your child to participate in this research by answering the questions about your child's piano experience, math computation percentiles, and child's personal feelings about piano and math.

Participation is voluntary and no compensation will be given.

This information will help with the research question:

Is there a relationship between mental math and finger dexterity while playing piano?

Thank you for your time in answering the survey questions.

(Email responses are requested to reconfirm information into a Google generated form.)

Email address

Principal's email address for math percentiles

What are the initials of your child's first and last name only? (This is only for the piano teacher and principal to know whose permission they have to give out specific information.)

How many years has your child taken piano lessons?

---- 4 years

---- 5 years

---- 6 years

---- 7 years

---- more than 7 years

Piano Lessons: Started in the…

---- Fall

---- Winter

---- Spring

---- Summer

Piano Lessons: Started in

---- 2013

---- 2012

---- 2011

---- 2010

---- earlier than 2010

Piano Lessons: Consecutive years of playing piano for piano lessons

---- 2013-2017

---- 2012-2017

---- 2011-2017

---- 2010-2017

---- earlier than 2010

---- years of playing piano were not “consecutive years”

Who is your piano teacher?

At what level is your child currently playing piano?

---- Level Two (Level B)

---- Level Three (Level C)

---- Level Four (Level D)

---- Level Five (Level E)

---- Level Six (Level F)

---- Higher than Level Six (Level F)

What is the name of the series currently being used?

Appendix D: Piano Teacher Information Letter

Piano Teacher Information Letter

Hello! My name is Mrs. Joyce Lendt, a first and second grade teacher. This letter is designed to collect information for a research project. The results will give more information as to whether or not there is a relationship between children who play piano and brain-related processing skills in math. This research involves children who have played piano for at least four years for piano lessons given by an experienced piano teacher and have taken standardized math assessment tests during those four consecutive years of playing piano for piano lessons.

You are my resource person. I am looking for piano students who have played piano for piano lessons for at least four years. If you would please make a list of such students who qualify, and then please give the Parent Information Letter/Consent Form and Student Information Letter/Consent Form to those students and their parents. Note: Qualifying students should be under the age of 18. I need the consent forms returned to you before anything else can be set up for further research. So it is very important to get the consent forms out to the right people and back again within these next two weeks. If it is easier to email it to them or to sign it right there at lesson time, I leave it up to you. Thank you so much for your quick response.

After the signed consent forms have been returned to you, I ask that you please scan the forms as you receive them to my email joyce.lendt@trinitynicollet.org. After parent permission and child permission have been given, along with their email address, I

will immediately email them the Parent Information Letter and Student Information Letter to be filled out electronically.

Also after the signed consent forms have been returned to you, I ask that you give the information as to what level each qualified student is and name of the series currently being used to the parent so the information they give is accurate. Thank you.

I am excited about the data that will be gleaned from this research. Your time is appreciated in carrying out this request quickly for it will provide data for the research question: Is there a relationship between mental math and finger dexterity while playing piano?

Sample of Parent Information Letter

What are the initials of your child's first and last name only? _____

(This is only for the piano teacher and principal to know whose permission they have to give out specific information. For privacy, your child will be given a reference number in the research paper)

How many years has your child taken piano lessons?_____

Years: Started - Fall of 20____, and have played piano during 20____, 20____, 20____, 20____

Who is the piano teacher?_____

At what level is your child currently playing piano?_____

What is the name of the series currently being used?_____

This portion to be filled out by the teacher/principal:

What are the percentiles from the math computation on the standard achievement test (taken in the fall or spring) during the years of taking piano lessons?

_____% _____% _____% _____%

(After 1 year (After 2 years) (After 3 years) (After 4 years)

Sample of Student Information Letter

I am curious how you feel about playing piano and math:

Do you enjoy playing piano? _____

Why or why not?_____

Do you like math?_____

Why or why not?_____

Are you able to figure out math problems in your head?

Is it easy or hard for you to do?_____

What are your initials (first and last name only)? _____

Thank you for your time in answering my questions.

Appendix E: Student Information Letter Consent Form

Student Information Letter

Consent Form

Hello! My name is Mrs. Lendt, a first and second grade teacher. This letter is designed to collect information for a research project. The results will give more information as to whether or not there is a relationship between children who play piano and math. You are to complete the information for the research by answering the questions on this Student Information Letter and share your feelings about playing piano and math. Your participation is voluntary and no compensation will be given. It is okay to say no if you do not want to participate. It is up to you.This information will help with the research question: Is there a relationship between mental math and finger dexterity while playing piano?

I am curious how you feel about playing piano and math:

Do you enjoy playing piano? _____

Why or why not?_____

_____

Do you like math?_____

Why or why not?_____

_____

Are you able to figure out math problems in your head?

_____

Is it easy or hard for you to do?_____

What are your initials (first and last name only)? _____

Thank you for your time in answering my questions.

I, _____, want to participate in this research and give my permission to use my answers.

Signature_____ Date_____

Appendix F: Student Information Survey Questions

Student Information Survey Questions

(Google generated form for graphing capabilities)

I have received permission for you to participate in this research by answering the questions about your personal feelings about piano and math.

Participation is voluntary and no compensation will be given.

This information will help with the research question:

Is there a relationship between mental math and finger dexterity while playing piano?

Thank you for your time in answering the survey questions.

I am curious how you feel about playing piano and math. Do you enjoy playing piano?

---- yes

---- no

Why or why not?

---- It makes me happy.

---- I like to practice and get better at playing piano.

---- I want to play for a worship service someday.

---- I like playing piano for my family and others to hear.

---- I thank God for giving me the blessing of this talent of playing piano.

---- My piano teacher makes it fun.

---- It is easy for me to do.

---- It is hard for me to do.

---- I do not like to practice.

---- I am only playing because I “have to.”

---- I do not like the teacher.

---- Other

Do you like math?

---- yes

---- no

Why or why not?

---- It makes me feel happy and smart.

---- I like doing math to get better at it.

---- I like working with numbers.

---- I want to have a job someday that uses numbers and math concepts.

---- My math teacher makes it fun.

---- It is easy for me to do.

---- It is hard for me to do.

---- I do not like the time it takes for me to do math and think about numbers. It takes too much time.

---- I only do the math because I “have to.”

---- I do not like the math teacher.

---- Other

Are you able to figure out math problems in your head?

---- yes

---- no

Is it easy or hard for you to do?

---- Easy

---- Hard

Appendix G: Principal Information Letter

Principal Information Letter

Hello! My name is Mrs. Joyce Lendt, a first and second grade teacher. This letter is designed to collect information for a research project. The results will give more information as to whether or not there is a relationship between children who play piano and brain-related processing skills in math.

This research involves children who have played piano for four years for piano lessons given by an experienced piano teacher. The piano teacher has made such a list and has sent out the parent information and consent forms. The consent forms that have been returned by the parents are now allowing me to gather the needed data from the student's math computation percentiles for the years he/she has taken piano lessons.

(Note: It is important for consistency in collecting results, that the percentiles that are given are from standard achievement tests taken **after** the first, second, third, and fourth year of taking piano lessons.) Since identification numbers will be used, the children will remain anonymous.)

Your time is appreciated in carrying out this request for it will provide data for the research question: Is there a relationship between mental math and finger dexterity while playing piano?

The percentiles recorded should be from the math computation section of the standardized tests taken each year. These are the percentiles given from math problems done without the use of a calculator, and by using only the student's mind. (The use of

paper is allowed during these tests, because it is still the processing with the mind without the use of a calculator or any other device.)

The child's initials: _____

What are the percentiles from the math computation on the standard achievement tests (taken in the fall or spring) during the years of taking piano lessons?

_____% _____% _____% _____%

(After 1 year) (After 2 years) (After 3 years) (After 4 years)

Appendix H: Principal Information Letter for Math Scores

Principal Information Letter for Math Scores

(Google generated form for graphing capabilities)

The percentiles recorded should be from the math computation section of the standardized tests taken each year. These are the percentiles given from math problems done without the use of a calculator, and by using only the student's mind. (The use of paper is allowed during these tests, because it is still "processing with the mind" without the use of a calculator or any other device.) Since identification numbers will be used, the children will remain anonymous.

Note: It is important for consistency in collecting data, that the percentiles that are given are from standard achievement tests taken AFTER the first, second, third, and fourth year of taking piano lessons.

Your time is appreciated in carrying out this request for it will provide data for the research question:

Is there a relationship between mental math and finger dexterity while playing piano?

What is the student's identification number? (Found on the Parent Consent Form)

What is the percentile from the math computation on the standard achievement tests (taken in the fall or spring) AFTER the first year of taking piano lessons?

What is the percentile from the math computation on the standard achievement tests (taken in the fall or spring) AFTER the second year of taking piano lessons?

What is the percentile from the math computation on the standard achievement tests (taken in the fall or spring) AFTER the third year of taking piano lessons?

What is the percentile from the math computation on the standard achievement tests (taken in the fall or spring) AFTER the fourth year of taking piano lessons?