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Utilizing Technology to Increase Math Achievement

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Author Note

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Abstract

The purpose of this quantitative study was to investigate technology use for differentiation to boost achievement in math. Fourth grade students were assigned intervention activities based upon their fall NWEA scores. The interventions were for twenty minutes each for twelve lessons in both IXL and Khan Academy. Students were observed for their engagement every five minutes during these interventions. Students were also given pre and post tests from their current Pearson math curriculum. Findings indicated that over 50% of the students did meet their projected RIT scores when they took their winter NWEA math test. The greatest growth was found in two of the subcategories - Operations and Algebra and Numbers and Operations. Students had more success with Khan Academy interventions, and this resource may be beneficial to others looking to use technology to differentiate interventions.

Keywords: math achievement, differentiation, technology, fourth grade, intervention

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Literature Review

Introduction

With the release of the Common Core State Standards (CCSS) and as the industrial aged model of education has turned to more of a proficiency based model of education, schools have been rethinking the way they have traditionally taught mathematics in the classroom. Students have increasingly been asked to use critical thinking skills to solve real world math problems. The Common Core State Standards outlined that students should be able to understand the number sense behind the problems they are solving in addition to arriving at the correct answer. Math textbooks have evolved since the release of the CCSS but must be supplemented with additional materials for students to receive a full understanding of mathematical concepts.

In their study, Doabler, Fien, Nelson-Walker, and Baker (2012) showed the shortcomings of textbooks by reviewing three different popular mathematics textbooks for the presence of the eight instructional principles of mathematics. The eight principles of mathematics as outlined by the researchers were prerequisite skills, math vocabulary, explicit instruction, instructional examples, math models, practice opportunities and cumulative review, academic feedback, and formative feedback loops. The researchers aimed to discover if the newer textbooks met the needs of students with diverse instructional needs. The researchers used a rubric to assess the textbooks and found that they were weak in all areas of teaching students the eight core principles of math instruction. Doabler, Fien, Nelson-Walker, and Baker (2012) found that the math textbooks are an inadequate foundation for teaching effective core math instruction. The researchers found that textbooks were missing key pieces for teachers to explicitly and

systematically teach core academic material to students. Textbooks have offered limited support in linking assessment data to instructional decision making which could save teachers time. Doabler, Fien, Nelson-Walker, and Baker's (2012) research supported the research of Kiger, Herro, and Prunty (2012) who found that students who received traditional instruction along with using a textbook and flashcards to practice their math facts versus a group that used technology to enhance instruction found those students were outperforming their peers more than those who were just using traditional methods. One way a teacher can supplement the math textbook is to use technology. Technology has become much more available in classrooms to help differentiate and meet the needs and challenges of all learners.

The shortcomings of the traditional system were also demonstrated in a qualitative research study conducted by Ulu (2017). Within the study, twenty-two fourth grade students were interviewed. They were required to read a real life math problem that asked them to solve whether some students should buy some cardstock paper at a closer store for more or at a store further away for less. The interviews were recorded and later coded. Most students said to buy the paper at the further away store because it was cheaper, and they would save money. The four students who answered the question correctly inferred that there would be the added cost of a bus or taxi to get them to the store furthest away so it may not necessarily be a savings. There was also a time factor of if the students had enough time to get to this store and back during lunch time. The students needed to read for more than just a literal interpretation of the problem. Most students wanted to solve it procedurally using simple math computation and be done. This is an example of where students needed to spend more time evaluating real life math problems and not just solving them based on literal knowledge. Teachers have needed to put forth extra efforts in

math to improve inferential comprehension and critical reading skills and model these to students even more with the adoption of the Common Core Standards. In addition, Higgins, Crawford, Huscroft-D'Angelo and Horney (2016) conducted a study where they stated math reasoning can be taught and technology can be used to enhance this reasoning.

Higgins, Crawford, Huscraft-D'Angelo and Horney (2016) used a mixed methods research approach to investigate the use of electronic support tools to increase mathematical reasoning. The researchers gave a Math Reasoning Inventory (MRI) to the students before and after the implementation of the Math Learning Companion (MLC) supplemental math reasoning computer program. The students worked outside of their regular math class on this program for ten weeks. The students were able to select electronic support tools or help buttons as needed. Some tools they frequently used were the audio button, calculator, notepad, and the need more help button was used the least. The researchers concluded that the post test scores showed the students did increase their math reasoning skills by using the MLC program. The researchers showed that support tools embedded in technologies can be used to positively impact reasoning skills. This is important because it showed that technology can be utilized to help meet the various needs of the students in the classroom to show increased achievement. The results also demonstrated how technologically-based programs can enhance students' mathematical reasoning using technology support tools as needed. The researchers aimed to show that math reasoning can be taught by using technology to enhance mathematical reasoning.

Integrating technology into the classroom

The research of Oliver and Corn (2008), Hsu (2015), and Hsu (2016) suggested that technology usage has been on the rise across most subject areas. Students' self-reported technology skills have become higher, new tools are being used by students, and student-centered classroom activities are emerging, albeit inconsistently across teachers. They also suggested that these inconsistencies could be spared through better training and collaboration among teachers to create high-level learning for students.

Oliver and Corn (2008) conducted a mixed-methods research study over the course of two years on the differences in technology skills and use after the implementation of one-to-one computing in a private middle school. Students completed an online survey in late May at the end of each school year consisting of fifty-one open-ended and Likert-scale items designed to capture information on student satisfaction with technology use at the school, classroom experiences with technology, technology use across subject areas, and student technology skills. About sixty random teachers were observed each year to look at instructional strategies and technology use. After two years of one-to-one implementation, the researchers found that certain classroom structures did not change. Traditional methods including direct instruction and worksheets were still commonly used amongst teachers.

Another team Kiger, Herro, and Prunty (2012) also found that students who utilized traditional methods paired with technology outperformed those who used only traditional methods. In addition, the research of Oliver and Corn (2008) suggested that technology was not being integrated at an adequate level that would enable students to remain on the same level as their peers using technology. In the research, some students reported increased skill with email, wikis, recording audio, creating multimedia presentations, and using scanners. At the same time,

some teachers were classified as being in the beginning stages of using technology for project based learning. The researchers claimed that to speed the rate of change from instructor-to student-centered classrooms, professional development is needed to ensure teachers are appropriately trained and comfortable using technology.

Hsu (2015) made similar connections in a mixed methods research study that stated that professional development activities about technology integration for teachers should focus on more subjects and practices for high-level learning for all students. Professional development is critical in the success of technology integration. It is important to differentiate professional development to meet the needs of all teachers. Time also needs to be given to teachers for collaboration so teachers can learn from one another the various technological resources they are using instead of sticking to one app that all students and teachers are using.

Hsu (2016) later conducted a mixed-methods research study that used surveys, interviews, and observations. One hundred fifty-two K-6 grade teachers were selected from eight different school districts in diverse areas from a range of grade levels and a range of years of teaching experience for follow-up interviews and observations. The teachers filled out an online survey about technology resources available to them in their school and classrooms. They were asked about their instructional use of technology in the classroom. From this information, Hsu selected eight teachers to interview about integrating technology into their classrooms. The teachers were then asked to pick two lessons where they were already integrated technology into their lessons that they were to be observed by Hsu. The surveys, interviews, and observations were coded to look for emerging patterns and themes. The 75% of K-6 teachers interviewed believed technology integration aided their students in developing higher order thinking skills

such as problem solving and collaborating with peers. The teachers who held these beliefs were the teachers who tended to highly value the use of technology in their classrooms. Hsu built on his previous research by demonstrating that professional development was critical in the shift from teacher-centered pedagogical beliefs to more effective constructivist pedagogical beliefs. Professional development activities involving technology integration should focus on more subjects and practices to develop the higher order thinking skills of all students.

Enhancing instruction in the classroom through technology

The use of technology holds the potential to enhance the learning of students at all levels while increasing the effectiveness of teaching. Kaur, Koval, and Chaney (2017) conducted a qualitative study by using ten teacher candidates to provide five weeks worth of tutoring sessions to ten fourth grade students. The students were selected due to their not meeting proficiency on the Measures of Academic Progress math test. The teacher candidates created lesson plan each week and found iPad apps that corresponded with the areas that each student was weak in. The teacher candidates filled out weekly reflections and an open-ended survey at the end of the five weeks. The researchers analyzed these for common themes and meanings. Kaur, Koval, and Chaney (2017) found that using iPads along with traditional teaching methods improved the students' conceptual understanding of math skills. The iPads allowed for differentiation based on learning styles and abilities. The iPads, along with traditional teaching methods, improved the students' conceptual understanding of numbers and skills. The apps kept the students engaged, focused, and motivated on the skills being taught. The teacher candidates were easily able to individualize instruction due to the ease of using the iPads and their apps. Like Hsu (2016)

concluded, the researchers determined that technology, specifically iPads, has the potential to help students with learning disabilities to understand the math content better when used in addition to the traditional teaching methods.

Additionally, Musti-Rao and Plati's (2015) research also showed greater gains among students using the iPad versus paper pencil tasks when learning their math facts. Similarly, Rosen and Beck-Hill (2012) found that their experimental group using the Time to Know program showed increased student learning achievement, reduced students' unexcused absences, and improved student discipline. The study also showed that the program promoted differentiated teaching and learning in the classrooms by effectively implementing technology.

Huang (2015) discovered through his research that when teaching math vocabulary, math reasoning and problem solving skills could be enhanced. Huang's (2015) mixed methods research study consisted of quantitative data where he gave students pre and post tests using the Expressive Vocabulary Test 2 to measure their expressive language and vocabulary skills. The qualitative data consisted of students being interviewed about their reading interests and vocabulary skills. The research included traditional vocabulary instruction versus utilizing technology to enhance vocabulary instruction. First, results of the quantitative study indicated after using technology for intervention purposes, the experimental class's posttest scores were significantly higher than those of the control group. "The qualitative findings indicated that vocabulary-technology strategies and the use of intervention programs effectively provided meaningful, purpose-driven vocabulary instruction and engagement in the learning environment" (p. 19). The students in the experimental group were more willing to spend time in these intervention programs than the students in the control group were. The findings of the study have

noted that technologies can provide many opportunities for students to hear, see, and use words in meaningful ways which can connect to math vocabulary instruction utilizing technology to help enhance mathematical reasoning.

In addition to Huang's (2015) research, Rosen and Beck-Hill (2012) also found that their experimental group using the Time to Know program showed increased student learning achievement, reduced students' unexcused absences, and improved student discipline. The study also showed that the program promoted differentiated teaching and learning in the classrooms by effectively implementing technology. When teaching math vocabulary, math reasoning and problem solving skills may be enhanced through the use of technology. Students are finding technology to be more engaging than traditional teaching methods due to the high access to technology everywhere nowadays.

Using technology to increase mathematical reasoning while raising test scores

Technology can be utilized to increase mathematical reasoning, ultimately leading to higher test scores. Ysseldyke and Bolt (2007) conducted a quantitative study to see if there was a significant improvement on standardized math test scores for students in classrooms where teachers implemented a progress monitoring and instructional management system into the elementary and middle schools. Pre-tests were given to all students. Students were then split into experimental groups and control groups. The experimental group used technology to differentiate lessons for the students. The students received their regular curriculum instruction with additional differentiated lessons that were progress monitored by their teacher using the Accelerated Math program. The students worked on objectives until mastery and then moved

onto the next one. Students in the control group received their regular instruction without the additional differentiated Accelerated Math lessons. The researchers concluded that "students whose teachers use continuous progress monitoring and instructional management systems significantly outperformed those whose teachers solely use the math curricula being used in their district." (p. 464) Therefore, the researchers found that continuous progress monitoring and data-driven decision making enhanced progress toward meeting standards and resulted in higher test scores.

Higgins, Crawford, Huscraft-D'Angelo and Horney (2016) also proved that math reasoning can be taught and technology can be used to enhance mathematical reasoning. A third study that related to Ysseldyke and Bolt's (2007) research is Rosen and Beck-Hill's (2012) study that showed students in their experimental group using the Time to Know program showed increased student learning achievement, reduced students' unexcused absences, and improved student discipline. The study also showed that the program promoted differentiated teaching and learning in the classrooms by effectively implementing technology.

Utilizing one-to-one technology in the classroom

Schools have provided many classrooms with one-to-one computers. These computers are utilized by many teachers to help differentiate to meet the needs of all students in their classrooms. Rosen and Beck-Hill (2012) conducted a mixed-methods research study comparing the effects of one-to-one computing in a differentiation experimental group using the computer program Time to Know versus the control groups with the more traditional teaching methods being used. Time to Know is a computer generated math and ELA program that has three tiers of

differentiated activities already included within the program. For the quantitative research part, Rosen and Beck-Hill looked at pre and post standardized assessment scores comparing the control group versus the experimental group scores. Attendance records were also used prior to and at the end of the study. Qualitative data focused on student and teacher questionnaires about using technology and observations conducted within the classrooms. Rosen and Beck-Hill found the experimental group using the Time to Know program showed "increased learning achievement, reduced students' unexcused absences, and improved student discipline. The study also showed that the program promoted differentiated teaching and learning in the classrooms by effectively implementing technology" (Rosen & Beck-Hill, 2012, p. 236).

Additionally, Kiger, Herro, and Prunty (2012) and Musti-Rao and Plati (2015) both showed increased academic achievement using technology versus the traditional teaching practices. Kiger, Herro, and Prunty (2012) showed greater fact growth using the iPods versus the traditional flash card practices. Musti-Rao and Plati (2015) showed the students having greater gains using the iPad versus paper pencil tasks when learning their math facts.

Kiger, Herro and Prunty (2012) conducted a quantitative research study which focused on four classrooms of third grade students. Two teachers were assigned to teach their Everyday Math (EM) curriculum and the traditional flashcard math fact practice. The other two teachers taught the same EM curriculum but students used iPod Touch's to do math fact practice. Ten apps were downloaded and introduced once per day. Students in all four classes practiced their math facts for ten minutes.The researchers concluded from the post test scores that the students using the iPod Touch devices outperformed their peers on the post intervention test by more than 8%. The MLI group also answered more questions correctly on their posttest than the traditional

group. “This finding suggests that in-class mobile learning may foster and sustain productive student-teacher learning interactions” (Kiger, Herro, & Prunty, 2012, p.77). The researchers stated that combining your traditional teaching methods with mobile technology may be a cost effective way to improve student achievement. The researchers also noted that buying the iPod Touch devices was more fiscally responsible for schools because they were cheaper and required less hardware, software, and technical support than other forms of technology.

Differentiation within the regular classroom

Students placed in the regular classroom often have varying achievement levels of which teachers need to differentiate for. Ritzema, Deunk and Bosker (2016) conducted a qualitative research study to observe how teachers in their daily practice adapted their teaching to students of different performance levels during mathematics and reading comprehension lessons. The researchers observed the teachers for one minute and then coded their observations the following minute. The observers looked at teacher talk, position of the teacher, how the class was organized, and how the teacher addressed each student. The students were grouped according to ability. The researchers found that the relatively lower or weaker students were addressed most often, mainly using content-related questioning or explanations. The relatively advanced students were not targeted by additional teacher guidance and teachers did not shorten the length of whole-class teaching for these students. The researchers found that they weaker students did not receive enough support while the advanced students did not get challenged enough. This would support research projects that looked at using technology to help differentiate for all needs of the students to increase their math problem solving skills.

Conclusion

Schools are rethinking the way they have traditionally taught mathematics in the classroom. Students are increasingly being asked to use critical thinking skills to solve real world math problems. With the increase of technology available to students in the classroom, it may be utilized to help differentiate to meet the needs of all learners in the classroom. Students' self-reported technology skills are higher, new tools are being used by students, and student-centered classroom activities are emerging, albeit inconsistently across teachers. Once the devices are given to the classrooms, the burden most often falls on the teacher to incorporate the technology into their classrooms. The research of Oliver and Corn (2008) claimed that to speed the rate of change from instructor- to student-centered classrooms, professional development is needed to ensure teachers are appropriately trained and comfortable using technology. Hsu (2015) made similar connections in a mixed methods research study that stated that professional development activities about technology integration for teachers should focus on more subjects and practices for high-level learning for all students. Professional development is critical in the success of technology integration. It is important to differentiate professional development to meet the needs of all teachers and students.

Ritzema, Deunk, and Bosker's (2016) research stated that more research is needed in the area of using technology and the effects of it on higher-order math skills. In this study, the following research question will be explored: "How can technology be utilized to differentiate for each student based upon their NWEA scores to help raise their scores in math?

Method

Purpose of the Research

The purpose of this quantitative research study was to investigate how technology can be utilized to help differentiate for each student's unique learning needs in a rural fourth grade classroom. Many resources available at school can be utilized to help students improve their scores. In this research study, students used IXL and Khan Academy as an intervention to help improve their overall math achievement scores in NWEA. The study was based on prior research such as Ysseldyke and Bolt's (2007) study where they performed a quantitative study to see if there was a significant improvement on standardized math test scores for students in classrooms where teachers implemented a progress monitoring and instructional management system into the elementary and middle schools. The researchers found that the teachers who consistently used the progress monitoring system had students who significantly outperformed their peers who were solely taught just using their traditional math curriculum. The benefits to this study have increased mathematical reasoning which will then lead to increased math test scores. Another gain is that students and teachers have effectively learned to use technology in the classroom to help differentiate and meet the needs of all learners..

Some teachers have not utilized the technology available in their classrooms as effectively as they could to help increase math achievement. After completing this research project, data will be shared with other teachers will help inform them of how they can effectively use this technology in their classrooms to help better meet the various needs of their students to help improve their overall math achievement scores.

Research Question

Ritzema, Deunk, and Bosker's (2016) research stated that more research is needed in the area of using technology and the effects of it on higher-order math skills. This research study addressed the following by answering the question, "How can technology effectively be utilized to differentiate for each student in a rural 4th grade classroom based upon their NWEA scores to help raise math achievement scores? By answering this question, knowledge gained will help teachers to learn how to better incorporate technology into the classroom by differentiating for each student. This utilization of technology focused each student onto what they needed to work on in order to increase their mathematical reasoning skills which then increased their test scores.

By answering this research question, findings shared with other teachers will help them to utilize technology to differentiate to meet the needs of all the learners in their classroom.

Core Concepts

Students have been increasingly being asked to use critical thinking skills to solve real world problems in math. With the increase of technology available to students in the classroom, it may be utilized to help differentiate to meet the needs of all learners in the classroom so that students can work on these real world math problems. Technology can be utilized to help lessen the burden on the teacher. Teachers could utilize this technology to assign intervention activities to each student based upon their own unique needs. This would enable the teacher to be freed up for more individualized instruction when needed. Doabler, Fien, Nelson-Walker, and Baker (2012) found that the math textbooks are an inadequate foundation for teaching effective core math instruction. The researchers found that textbooks were missing key pieces for teachers to

explicitly and systematically teach core academic material to students. Textbooks have offered limited support in linking assessment data to instructional decision making which could save teachers time. Doabler, Fien, Nelson-Walker, and Baker (2012) research supported the research of Kiger, Herro, and Prunty (2012) who found that students who received traditional instruction using a textbook and flashcards versus a traditional textbook and a group that used technology to enhance instruction where those students are outperforming their peers using traditional methods. One way to supplement the math textbook is to use technology. Technology has become much more available in classrooms to help differentiate and meet the needs and challenges of all learners.

However, once the devices have been given to the classrooms, the burden has fallen on the teacher to incorporate the technology into their classrooms. The research of Oliver and Corn (2008) claimed that to speed the rate of change from instructor- to student-centered classrooms, professional development is needed to ensure teachers have been appropriately trained and comfortable using technology. Hsu (2015) made similar connections in a mixed methods research study that stated that professional development activities about technology integration for teachers should focus on more subjects and practices for high-level learning for all students. Professional development is critical in the success of technology integration. It is important to differentiate professional development to meet the needs of all teachers and students.

General Approach of the Investigation

This quantitative research study utilized technology to increase mathematical reasoning skills to raise math achievement testing scores. Convenience sampling will be used for this

research. According to Creswell (2015), in convenience sampling, the researcher selected participants because they are willing and available to be studied. Where I teach both fourth grade math classes, it was convenient for me to use my current fourth grade classes to do my research project on. I wanted to do a study that would help increase our math scores. We have one-to-one computing in our school, so I wanted to incorporate technology into my research to help improve their math scores.

Before the research began, a request was submitted to the Institutional Review Board (IRB) at the University of Maine at Farmington to ensure that the students would be treated ethically throughout the research project. Once the IRB approved the research, the first phase of the research gathered the required consent and assent forms from the superintendent, building administrator, parents, and students. These forms needed to be obtained to let the participants know about the study and that all information would be kept confidential. Once permission was obtained, NWEA data was run off that was applicable to this study. Information from NWEA was used to create differentiated lessons for each of the students. Students completed these differentiated IXL assignments during the first half of data collection. During the second half of the data collection, student NWEA scores were inputted into Khan Academy which then individualized instruction for each of the students based upon these scores. While students worked on IXL and Khan Academy, they were observed for either being engaged and on-task or off-task. Students also took the Pearson Diagnostic Tests before and after their interventions as another source of data.

After the students took their Fall NWEA tests, NWEA published a student growth projection for each student. This growth projection was used to see if the students did not meet, met, or exceeded their expected growth when they took the Winter NWEA test.

Limitations to this Study

One weakness or limitation to this study was the amount of students that moved into and out of the district during the research study. Another weakness was the amount of students who were chronically absent during the study. Students who were absent made up their missed interventions at the end of the study. The biggest limitation to the study was the limited amount of interventions that were able to be completed during the study. The study needed a long data period to really know if the interventions were more successful than the findings indicated.

Methods of Inquiry

The method to which this research will be conducted will be a quantitative research study. This research project explored using technology to differentiate for the various abilities of each student using their Fall NWEA scores. The interventions included were IXL and Khan Academy; which will both be individualized for each student using their Chromebooks.

According to Creswell (2015), performance measures used to assess an individual's ability to perform on an achievement test (p. 150). Data collected from their Pearson Diagnostic Tests and NWEA aided in answering the research question put forth in this study. According to their websites, both the Pearson Diagnostic Tests and NWEA are valid and reliable tests.

Research Methods

Setting

Research was conducted at Mill Pond School which is located in Hodgdon, Maine. Hodgdon, Maine is a rural town found in the northern part of the state in Aroostook County. It is part of the MSAD #70 school district. MSAD #70 is made up of Mill Pond School and Hodgdon Middle/High School. It consists of seven local towns that attend MSAD #70. The student population consists 496 students between the two schools. The National Center for Education Statistics stated MSAD #70 is 93% Caucasian and 4.7% American Indian. The special education population is at 15.5%. The teacher to student ratio is 12.18 to 1. Our district is 72% free and reduced lunch at Mill Pond School.

I am a fourth grade teacher at Mill Pond School where I teach Language Arts and Math. The study was conducted in both my math classes that I teach to the regular education students. Permission has been obtained by both the superintendent and building administrator. Signed Parental Consent and Student Assent has been obtained by both the parents and students.

Sampling/Participants

Being a fourth grade math teacher at Mill Pond School, students in my regular education math classes were the participants in my research study. All thirty-one students were invited to participate. In the beginning, there were fifteen students in classroom 4A with nine males and six females. There were sixteen students in classroom 4B with nine males and seven females. A total of twenty-eight students ended up participating in the study due to many students moving in and

out during the study. A total of twelve females and sixteen males participated during the full length of the study. Parents and students were informed that the following data would be used:

- Scores from the regularly administered Fall and Winter NWEA math tests
- Student goal setting worksheet from NWEA
- Scores from the Pearson Pre and Post Tests
- Completion Data from IXL and Khan Academy
- Data on behavior during IXL and Khan Academy intervention time - Appendix A

Consent was obtained from their parents or guardians to use their child's scores to help differentiate their targeted intervention times using technology. Students had pre-established growth goals set for them from the NWEA website. Students were observed during their intervention time for on or off task behavior. Students were not pressured or rewarded for participating in the research study. All information obtained on the students were kept either on a password protected computer or in a locked filing cabinet. No identifiable names were used in the data analysis.

Methodology

Research was conducted during this research study on using technology in the classroom to differentiate for each student's unique needs. Interventions were based upon the scores the students received from the computer adaptive test, Northwest Evaluation Association (NWEA), that our school currently uses. NWEA is a norm-referenced test and according to Creswell (2015), this type of assessment tests where the individual's grade is along with a measure of how well he or she did in comparison with a large group of test takers (p. 151). Fall NWEA testing

scores were used to differentiate for each student during their targeted intervention time. Technology was utilized to help meet the needs of each student. Online computer programs, IXL and Khan Academy, were used as interventions to help increase their math skills. Students completed twelve lessons for twenty minutes each of IXL and twelve lessons for twenty minutes each of Khan Academy. Students worked on these differentiated lessons approximately three days a week during their regular math class. Students were observed every five minutes of this intervention time on whether they were engaged and focused on the work or not engaged. They were tested again in January on NWEA to see if their scores improved especially in their weaker areas. NWEA's projected student growth goals were used for each student to see if these projected scores were met using these computer based interventions.

In addition to the NWEA data and intervention observations, students were also administered the Pearson's Grade 4 Diagnostic Test Form A for the pre-test before the targeted intervention period. After completing all twenty-four targeted interventions, the students took the Pearson's Grade 4 Diagnostic Test Form B to see if their scores improved after utilizing technology to differentiate for each student's unique needs.

Operational Measures

This research began and ended with the students taking the NWEA tests. The students also took the Pearson Diagnostic Test Form A before beginning the interventions. Pearson Diagnostic Test Form B was given after the interventions were completed. According to both the NWEA and Pearson websites, both have conducted research to prove that their tests are both valid and reliable. Observations completed during the interventions noted if the students were

on-task and engaged or off-task and unengaged. Students were marked on-task if they were actively looking at the screen and answering questions. The students were marked off-task if they were talking, out of their seats, or not looking at their computers. The quantitative data collected helped to answer the research question if technology can be utilized to differentiate for each student to increase their math reasoning skills to help raise their math NWEA scores.

Data Collection

The following data was collected and used in this research study: Scores from the regularly administered Fall and Winter NWEA math tests, student goal setting worksheet from NWEA, scores from the Pearson Pre and Post Diagnostic Tests, completion Data from IXL and Khan Academy, and data on on-task and off-task behavior during IXL and Khan Academy intervention time.

Data Analysis

After the collection of data, the Pearson Diagnostic Tests were scored to see if the students improved from the first test to the second one. IXL sheets were examined to see how many items were completed to a grade of 100 during the intervention phase. Khan Academy data was also analyzed for completion data to see if improvements were noted and how many assignments were completed. This quantitative information from this study was used to see if the interventions were successful in raising the students' math scores on the NWEA assessments. After the students have completed the Winter NWEA test, it was recorded whether they did not meet, met, or exceeded the projected growth that NWEA set forth for them to achieve. Data was

also analyzed to see how engaged and on-task the students were during their intervention times. Descriptive statistics were used to help analyze the data. According to Creswell (2015),

> descriptive statistics helps you to summarize the overall trends or tendencies in your data, provides an understanding of how varied your scores might be,and provides insight into where one score stands in comparison with others. These three ideas are the central tendency, variability, and relative standing (p. 181).

All data was inputted into Google Sheets where tables and charts were created to show the results of this study.

Expected Findings

Based upon the literature review, it was expected to find that using technology to differentiate for each students' needs will increase their math reasoning abilities which will then increase their math scores on the Winter NWEA test.

It is also expected to find that the students will gain confidence in their ability to work more independently on their math work as their math reasoning skills are improving. It will be of interest to see if this creates a better attitude in math for some who think that they cannot do the math and therefore do not work as hard as they potentially could.

Potential Issues and Weaknesses

One of the biggest potential issues with the research project was the students having difficulty to remain on task. The students were a chatty bunch who would much rather socialize

than be working on math. It will be interesting to see when the observations are collected during the interventions if the students were on task or not.

Another potential issue in the study was the students' apathetic attitudes towards doing well in their academic subjects. Compared to all my other years of teaching, these students settled for doing much less than they were capable of. It is hoped that they find their intrinsic motivation for wanting to do well academically. It is hoped that with parent teacher conferences coming up, that the students motivation would increase after talking with parents which would also affect their achievement on their tests.

Another weakness seen in this study was the inconsistency of the students coming to school on a regular basis. Many students were absent at least one day per week, if not more for some of them. Since the beginning of this research project, many students have moved in and out of the district, so the numbers were off from who's participating in the study from when it was first approved by the IRB.

The biggest issue to this study was the researcher also being their classroom teacher. It was difficult to not help the students to want to do better than they were. The teacher was also instructing during the research, so it would be difficult in such a short time, to know for sure if the gains were from the interventions or from their regular instruction.

Results

The purpose of this study was to investigate the student use of technology to help differentiate for each student to support higher math achievement. When looking at overall math scores at Mill Pond School during data meetings, the researcher noticed that the math scores on

standardized tests have declined these past few years. Since students have access to one-to-one computers in our district, the researcher decided to utilize this technology to be able to differentiate for each student based upon their fall NWEA scores in math. Students were able to receive not only intervention activities to help raise their scores but also allowed other students to be challenged who were working above grade level. This study aimed to answer the following research question: How can technology be utilized to differentiate for each student in a rural 4th grade classroom based upon their NWEA scores to help raise their overall math achievement scores?

NWEA Growth and Achievement Tests and Interventions

Students took the fall Northwest Evaluation Association (NWEA) test at the beginning of the school year. The NWEA test is a norm-referenced test that is used to compare student achievement against a group of students from the same age group that has taken the test from all over the country. The NWEA test is a computer adaptive test that was developed to show student growth over time. The test adapted to each student's answers as they were taking the test. If the students answered several questions in a row correctly, then the test increased the challenge for the students. If students incorrectly answered several questions in a row, then the test adapted to give the students easier questions that they should be able to answer. Therefore, after the students took the standardized test, the software calculated aRasch UnIT (RIT score) for each student. The RIT score was a measurement scale developed to help simplify the interpretation of the test scores. The NWEA software then took this RIT score and predicted a projected RIT score for each student to work towards for their winter NWEA test. The projected RIT score was based upon the students' past and present scores to best predict where they should be by the winter test.

This projected RIT score gave the students a target growth score to achieve to for their next NWEA test in the winter.

The researcher used these RIT scores to differentiate for each student during their IXL and Khan Academy interventions. IXL published a chart online that correlated to each of the subcategories of NWEA in math. The subcategories were Operations and Algebra, Numbers and Operations, Measurement and Data, and Geometry. The researcher ran off the correlated charts and constructed a document for each student that listed the IXL activities that they had to work on during their intervention times. Khan Academy had a specific site called mappers where once a class list was created by the teacher, a username and password was created for each student. The researcher then took the scores of each subcategory from NWEA and inputted these scores for each student into their own accounts. The Khan Academy website then automatically assigned each student interventions that corresponded to their NWEA subcategory scores. After all their interventions were completed in both IXL and Khan Academy, the students then took the winter NWEA to see if they met their projected growth goal or not. During this research study, the students also still received their regular classroom instruction (Figure 1).

	October	November	December	January	February
Assessment	Fall NWEA	Pearson Pretest		Winter NWEA	Pearson Posttest
Instruction	Place Value	Multiplication	Multiplication	Division	Fractions
Intervention			IXL	Khan Academy	
Intervention			12 x 20 minutes	12 x 20 minutes	

Figure 1. Timeline of research study.

The researcher calculated that the average student fall RIT score was 206.7 which fell at the 62% overall.In a norm-referenced test, the average score is 50%, so therefore a score above the 50% level means that the student scored above 50% of the students that took the test. The average student projected RIT score for the winter was 213.4. The students average Winter NWEA score was 211.8 which fell at the 58% overall. Students were expected to show an average growth of 6.7 points from Fall to Winter. They ended up showing an average growth of 5 points. Overall, 53.6% of the students individually met their projected growth goals from fall to winter (Figure 2).

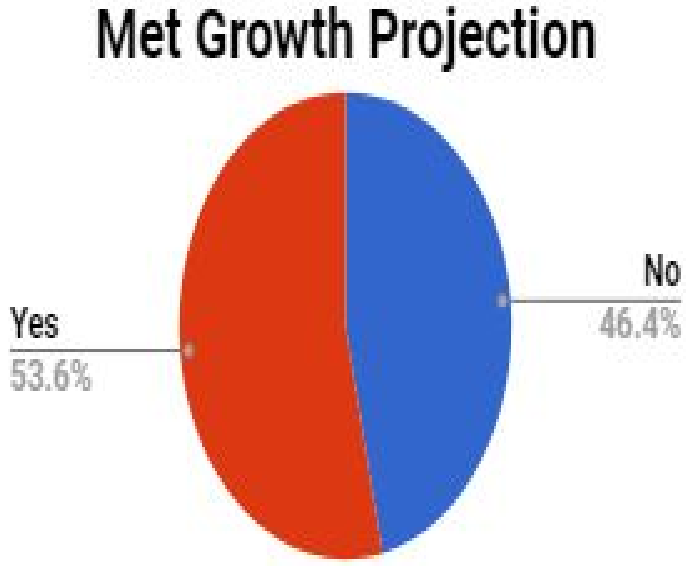

Figure 2. Growth projection graph.

The researcher differentiated the interventions for each student for each of the four subcategories of NWEA. The four subcategories were Operations and Algebra, Numbers and Operations, Measurement and Data, and Geometry. The students completed an intervention each day rotating through Operations and Algebra, Numbers and Operations, Measurement and Data,

and Geometry. The students were scored based upon whether they completed their intervention activities to one hundred percent.

The second intervention that the students completed was Khan Academy. Again, the students rotated each day through the four subcategories of NWEA. After completing their lessons for twenty minutes in each of the four subcategories, student data was analyzed. Students were given credit for each intervention completed to 100% (Figure 3).

In both interventions, students worked to 100% for each of the activities before they moved onto the next activity assigned. It took students longer to reach 100% in IXL than Khan Academy. If a student incorrectly answered a question in IXL, the program dropped the student back several points making them work back up towards 100% again. This did not happen in Khan Academy which may have attributed to students completing more Khan Academy interventions than IXL interventions.

	Operations and Algebra	Numbers and Operations	Measurement and Data	Geometry
IXL	3 x 20 minutes	3 x 20 minutes	3 x 20 minutes	3 x 20 minutes
Khan Academy	3 x 20 minutes	3 x 20 minutes	3 x 20 minutes	3 x 20 minutes

Figure 3. Interventions for each subcategory

Operations and Algebra

After completing the interventions, the researcher analyzed the data for each of the four subcategories in math on the NWEA. The students completed an average of 15% of their interventions assigned in IXL for the subcategory of Operations and Algebra. Students completed an average of 67% of their assigned interventions in Khan Academy for Operations

and Algebra (Figure 4).

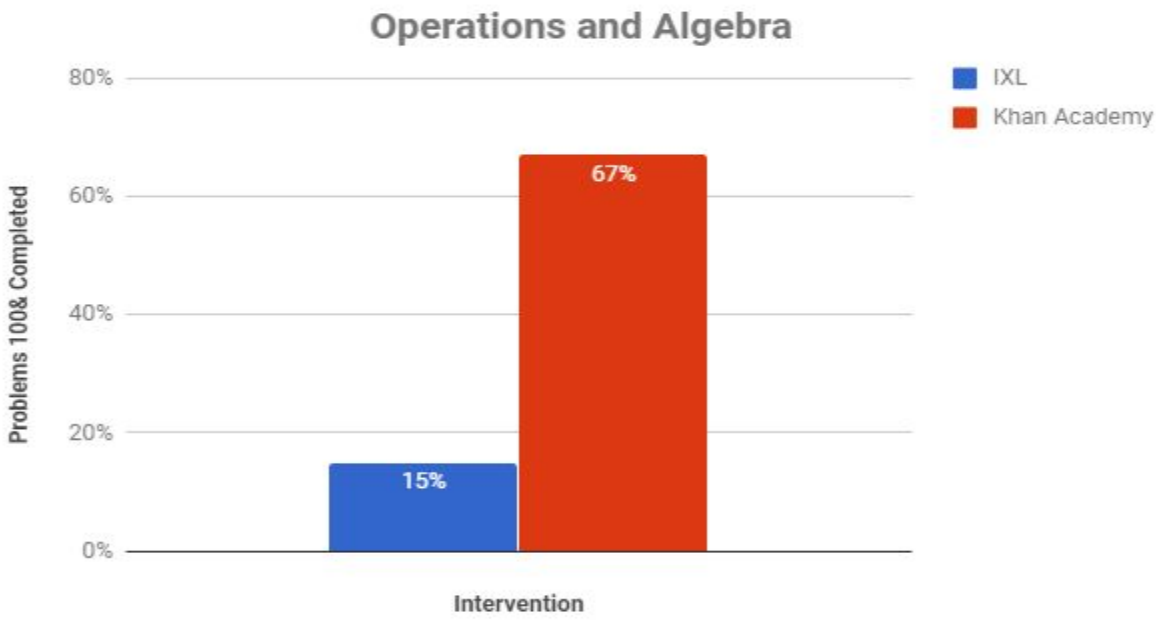

Figure 4. Percent of problems completed during Operations and Algebra interventions.

The students average Operations and Algebra score on the fall NWEA test was 205. The winter NWEA average was 214 which showed a growth of nine points (Figure 5). There were fifteen students out of the twenty-eight students who participated in the research study that grew nine or more points. The Operations and Algebra subcategory showed the most growth during the intervention phase of data collection. This subcategory also had the highest completion rate for Khan Academy which may have attributed to this subcategory showing the most growth. Students also continued to receive their regular classroom instruction during this research which may have helped student growth. Students worked on multiplication and division topics during the research study topic which all together could have accounted for this subcategory showing the most growth

One student grew a total of twenty-two points from the fall test to the winter test which was outstanding. At the beginning of the research study, this student scored at the 74% with a 211 RIT score. The student had a RIT score of 217 which was at the 72% on the winter NWEA test. The student completed 18% of their IXL interventions and 84% of their Khan Academy interventions. A conclusion may be drawn that Khan Academy helped increase this student's RIT score on the NWEA test. The researcher also anecdotally found that this particular student's grades and confidence have continued to increase in math since the research study began.

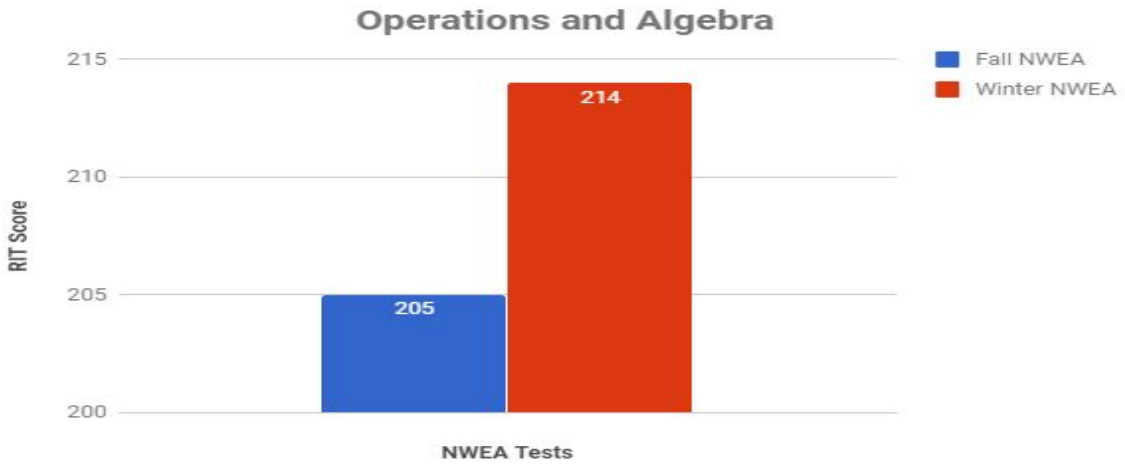

Figure 5. NWEA test comparison between fall and winter scores.

Numbers and Operations

After completion of the Operations and Algebra interventions, the students completed interventions for the NWEA subcategory Numbers and Operations. The students completed an average of 12% of their interventions assigned in IXL. Students completed an average of 43% of their assigned interventions in Khan Academy (Figure 6).

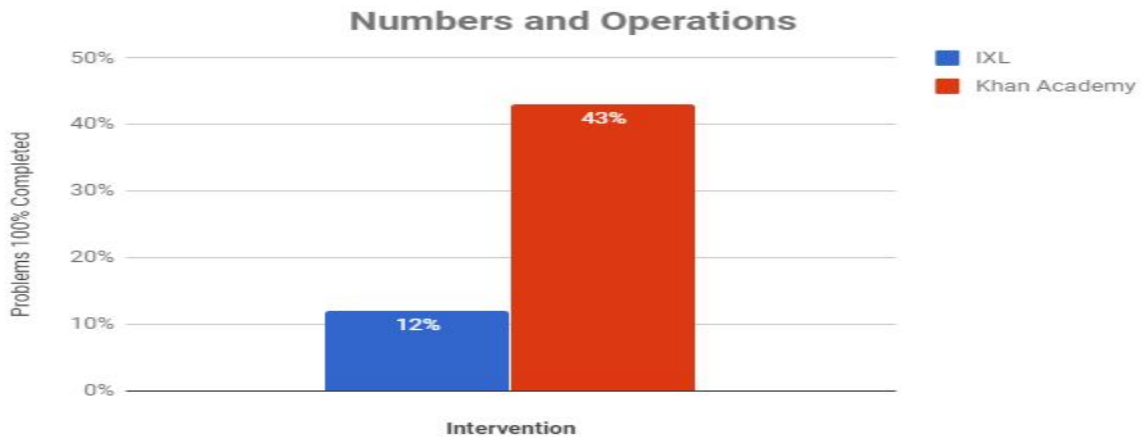

Figure 6. Percent of problems completed during Numbers and Operations interventions.

The students average Numbers and Operations score on the Fall NWEA test was 204. The winter NWEA average was 212 which showed a growth of eight points (Figure 7). There were nine students who grew eight or more points from the fall to winter test. Another student significantly gained growth in this area with an increase in their RIT score of twenty-four points, which is outstanding. This student completed 14% of their IXL interventions and 50% of their Khan Academy interventions. They scored a 205 on the fall NWEA math test. This score fell at the 59%. This student later scored a 214 on the winter NWEA test which was at the 64%. Both scores are above average for fourth grade. This student along with the student who gained a tremendous amount of growth in Operations and Algebra also has gained confidence and math scores have increased in class since the beginning of this research study.

Numbers and Operations showed the second greatest growth during the research study. Along with Operations and Algebra, one reason that this may have showed greater growth than the other two subcategories could have been that similar topics such as multiplication and division were being taught in the classroom during this data collection phase.

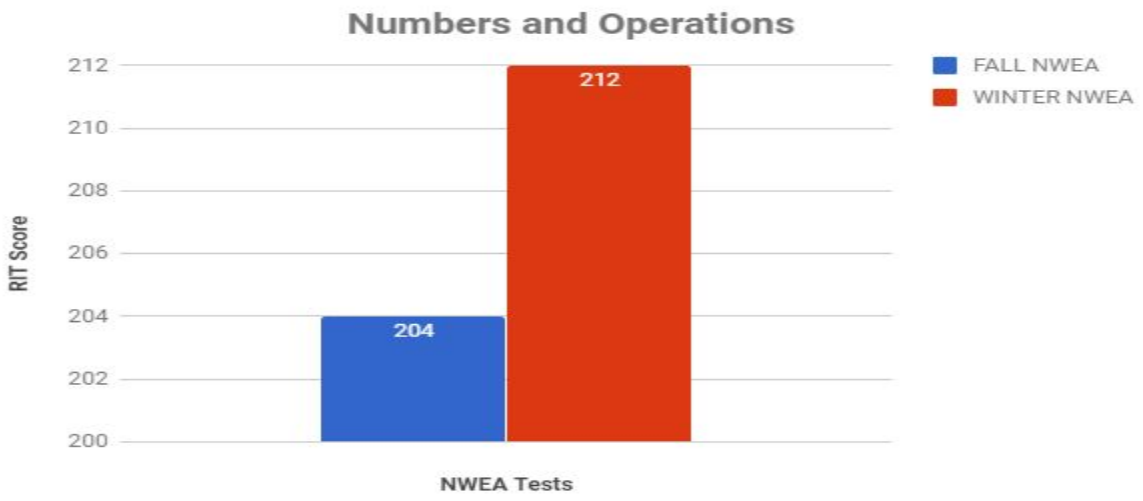

Figure 7. NWEA test comparison between fall and winter scores.

Measurement and Data

The third intervention that the students completed for the NWEA subcategories was for Measurement and Data. The students completed an average of 4% of their interventions assigned in Measurement and Data. Students completed an average of 35% of their assigned interventions in Khan Academy (Figure 8).

Figure 8. Percent of problems completed during Measurement and Data interventions.

The students average Measurement and Data score on the fall NWEA test was 209. The winter NWEA average was 210 which showed a growth of one point (Figure 9). Half of the students, which was fourteen students, gained fourteen or more points on this subcategory of NWEA. The most that one student increased was by sixteen points. This particular student had a RIT score of 201 on the fall NWEA test which was at the 47%. This is slightly below average when compared to all students across the country taking the test. This student later scored a 211 on the winter NWEA test which was at the 56%. This increase brought the student to slightly above average in math. This student completed 8% of their IXL intervention activities and 36% of their Khan Academy interventions. Khan Academy could be the reason the student raised their math score by sixteen points on the winter test.

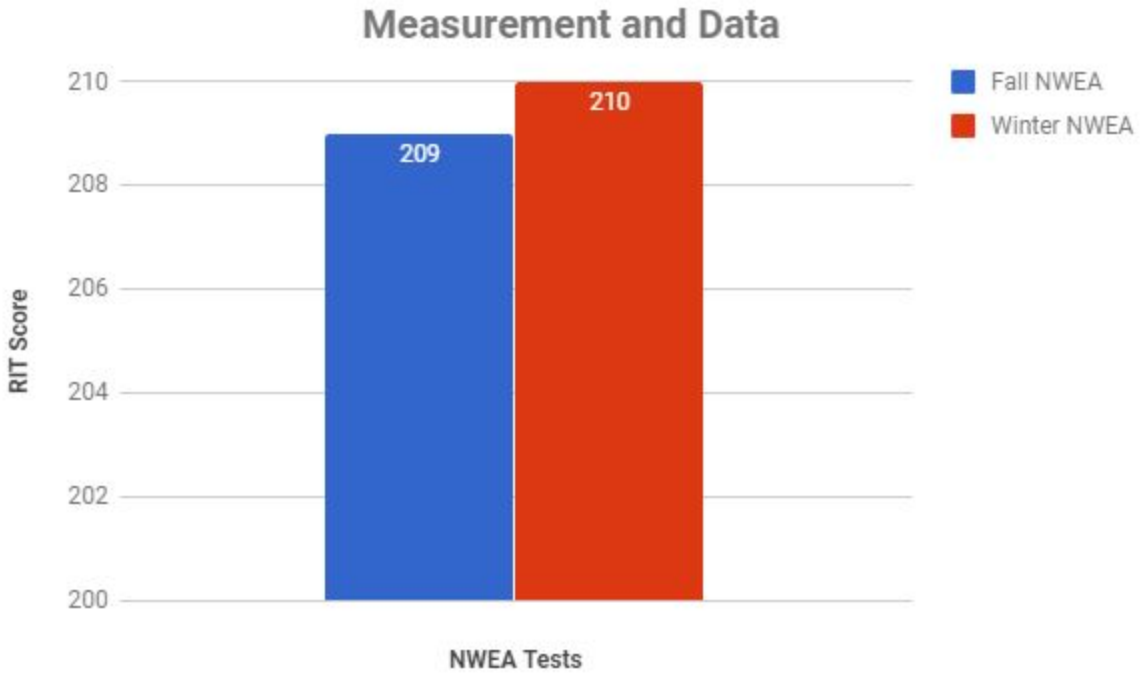

Figure 9. NWEA test comparison between fall and winter scores.

This subcategory showed the least growth on the NWEA tests. Students seemed to like this subcategory the least. When analyzing the school textbooks, it was found that measurement and Data was often found in the back of every grades' math textbooks. This may indicate that the students have received the least instruction on this topic. This topic was also not being taught during the intervention phase of the data collection. Many students required more assistance from the teacher or educational technician for this intervention topic in the classroom than during any of the other interventions.

Geometry

The last subcategory from the NWEA tests for interventions was Geometry that the students completed. The students completed an average of 20% of their interventions assigned in IXL for Geometry. Students completed an average of 41% of their assigned interventions in Khan Academy (Figure 10).

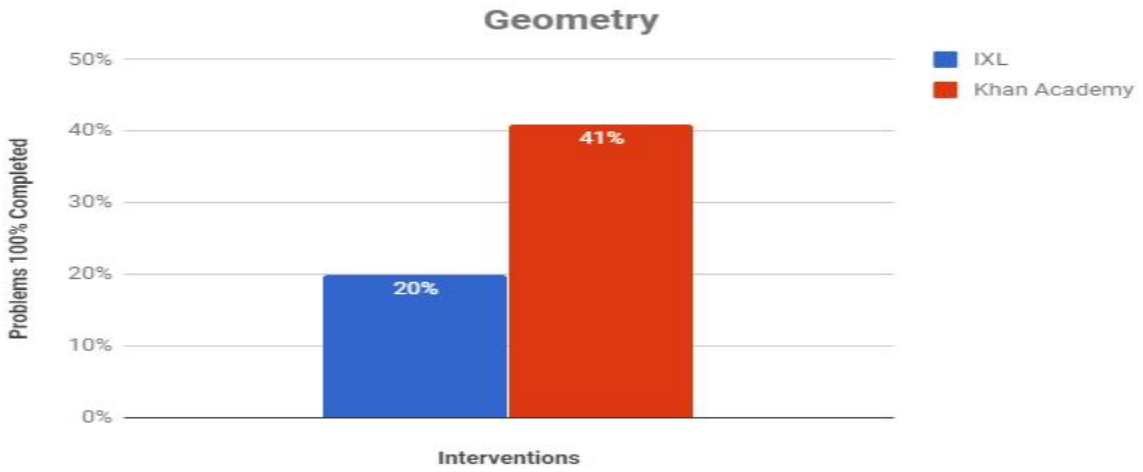

Figure 10. Percent of problems completed during Geometry interventions.

The students average on the fall NWEA test in Geometry was 208. The winter NWEA average was 211 which showed a growth of three points (Figure 11). Fourteen of the students showed a growth of three or more points in this subcategory from the fall to winter NWEA test. Two students tied for showing the most growth with fourteen points. One student scored a 217 on their Fall test which was at the 86%. This student later scored a 223 on the winter test which fell at the 84%. This student was already working above grade level before the research study began. They completed only 4% of their IXL interventions due to them being slightly more challenging than what others were given. Khan Academy interventions were completed at the 24%. The other student to show growth started with a 201 on the fall NWEA test. This score fell at the 47% which is slightly below average. After completing 10% of their IXL interventions and 86% of their Khan Academy interventions, this student then scored a 213 on their Winter NWEA test. This score fell at the 62% which is a significant increase from their fall score which brought them to working above average. With a high completion rate of 86% for Khan Academy, it can be concluded that this intervention was highly successful for this student.

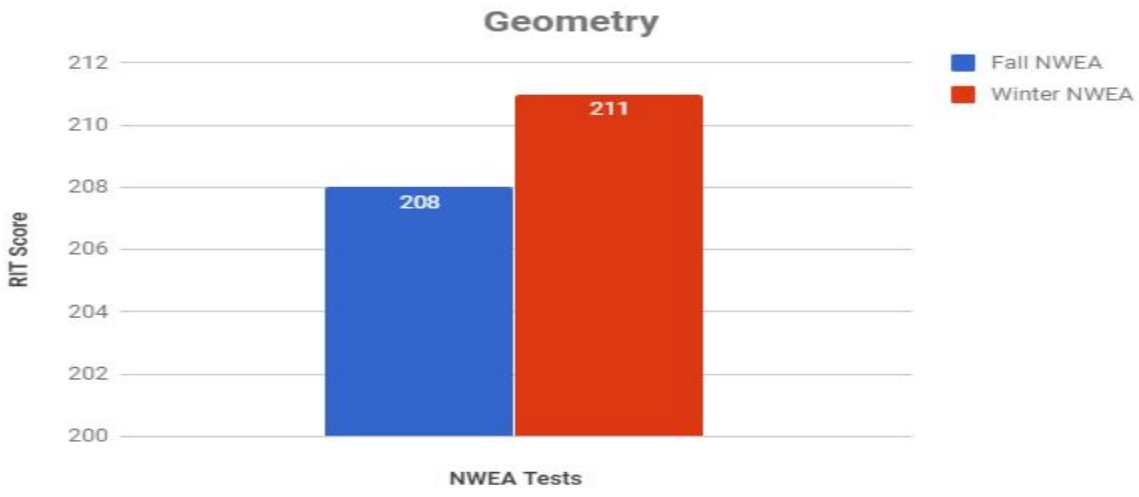

Figure 11. NWEA test comparison between fall and winter scores.

This subcategory was the second to show the least growth. Again, these topics are often found in the back of the textbooks and often completed later in the year. Geometry was not being taught during the data collection phase of this research which may indicate lower growth than the other subcategories.

After the student data was analyzed for completion rates in IXL and Khan Academy, the researcher then analyzed student growth on the NWEA tests. Once this was completed, the researcher then analyzed the data for on and off-task behaviors during the interventions.

Engagement during Interventions

Students were observed during their intervention times for their engagement of the interventions for either being on-task or off-task during the interventions. They were observed every five minutes during their twenty minute intervention time. They were checked as to whether they were on-task or off-task (Appendix D). On task behavior would include looking at and interacting with questions on the computer, remaining in seat, and/or not talking with others. Off task behavior would include talking to others, going to the bathroom, getting a drink, being out of seat, and/or not looking at or interacting with the computer. Students were highly engaged during both of the interventions. They were 96% engaged during their IXL interventions and 97% engaged during their Khan Academy interventions (Figure 12). The students responded quite well to getting right on task once the timer started and continued working until the timer went off twenty minutes later. Students were able to ask the teacher and educational technician in the room for help when needed. This would be considered on task behavior when they were receiving help. Appendix A has a copy of the form used to collect and analyze on and off task

behavior during the interventions.

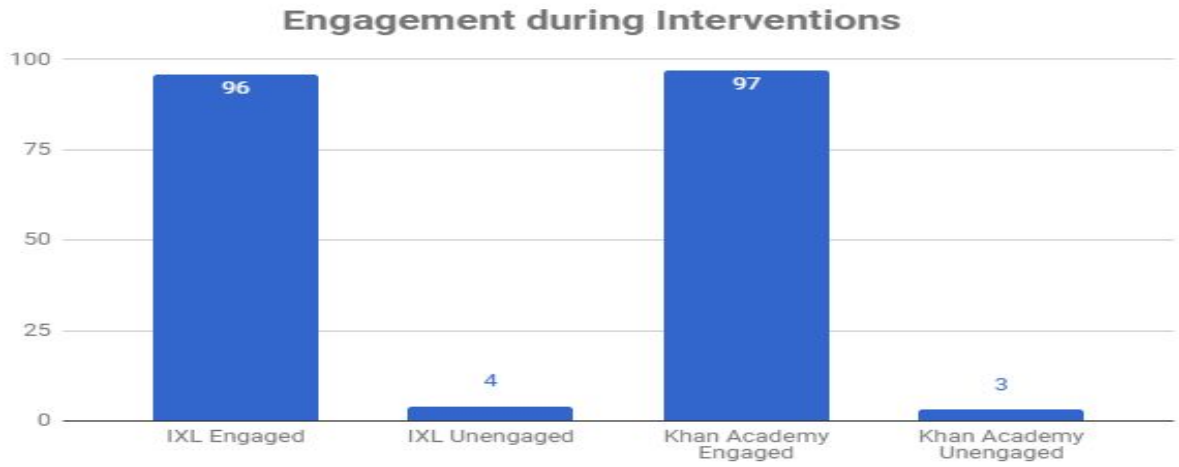

Figure 12. Engagement during interventions.

Pearson Tests

The students were given the Pearson Diagnostic Test Form A from the school's math curriculum. The students scored an average of 49 on the pretest given before the interventions. After the interventions, students were given the Pearson Diagnostic Test Form B. The students received an average of 59 on that test (Figure 13). This showed an average growth of ten points. The test scores seemed low at first, but when analyzed, they had done quite well considering the students were only about a third of the way through the curriculum at the time of the tests. Student growth could also be attributed to having spent more time in the classroom receiving instruction from pretest to posttest.

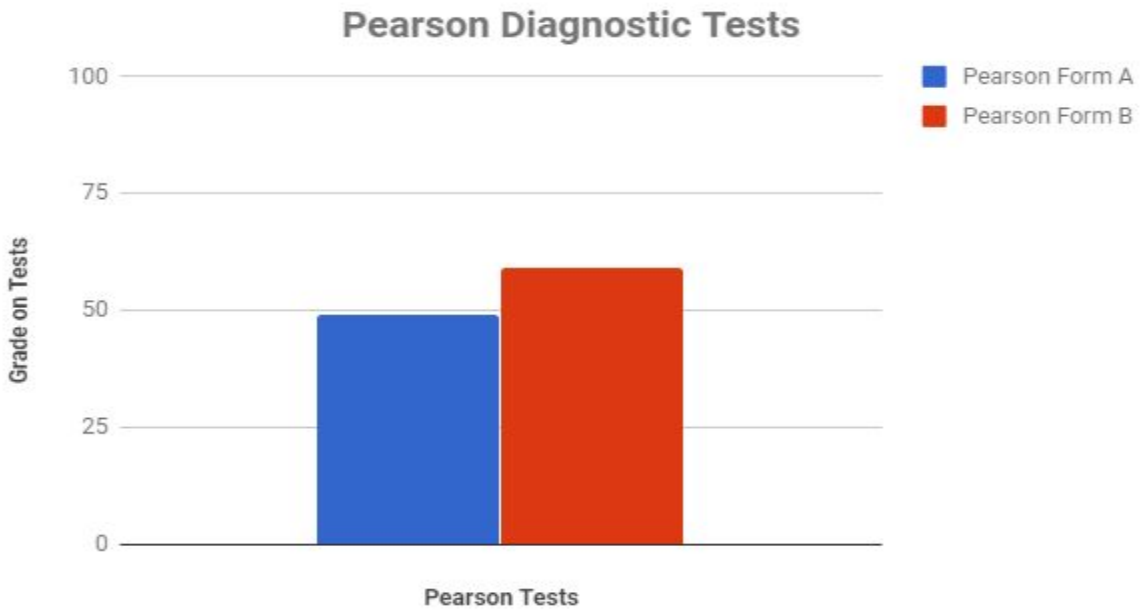

Figure 13. Pearson Diagnostic Test Scores.

The subcategories of the Pearson Diagnostic Tests do not line up exactly to the same subcategories of the NWEA subcategories. However, they are very similar and helpful when analyzing student growth. The first subcategory of the Pearson test is Numeration. On the pretest, the students had an average score of seven. The students showed a one point growth in this category on the posttest with a score of eight. This growth does not align with the growth on the NWEA tests for Numbers and Operations which had an eight point growth. The second category is Operations. The students scored an average of twelve in this category on the pretest. On the posttest, the students received an average of fifteen. The Operations category on the Pearson test showed the greatest growth from the pretest to the posttest which was similar the greatest growth on the NWEA subcategory of Operations and Algebra. The third category of the Pearson pretest was Fractions. The average pretest score was ten. The average posttest score was twelve which showed a two point growth. The next subcategory on the Pearson test was

Measurement. The pretest score was eleven with the posttest score being thirteen. This showed a two point growth which was one point greater growth than the NWEA subcategory measurement and data growth of one point. The next category to go along with Measurement was Data. The pretest score was two with a posttest score of three with a one point growth. This also was one point higher than the Measurement and Data growth on the NWEA tests. The last category of the Pearson test was Problem Solving. Both the prestests and the posttests were the same score of three showing no growth during the intervention phase (Figure 14).

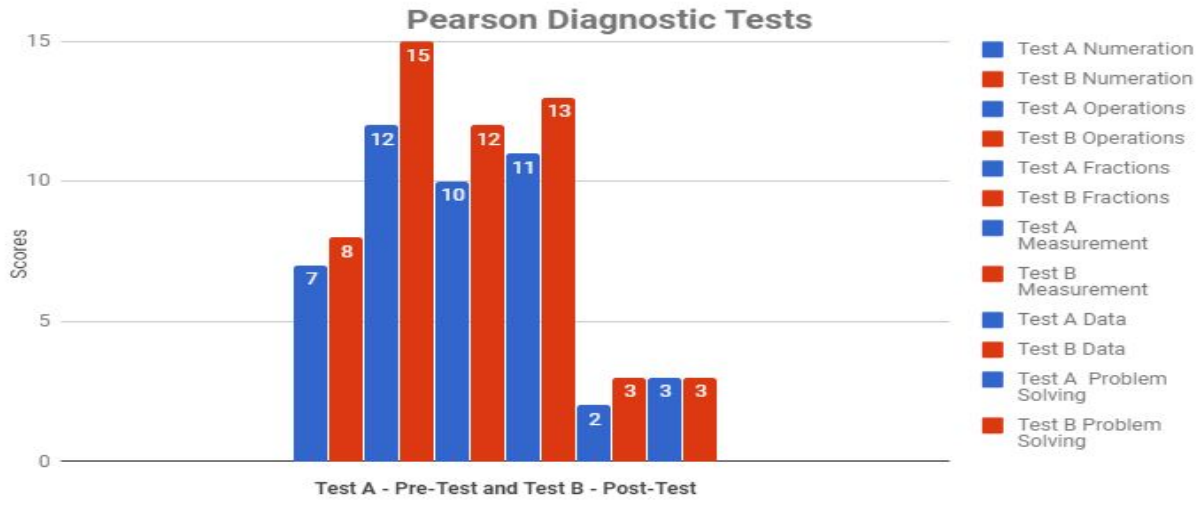

Figure 14. Pearson diagnostic test category scores.

The researcher found that the Pearson diagnostic tests helped to supplement the NWEA data during the research study. The Pearson tests saw similar growth in some of the categories similar to the NWEA test.

Discussion

When looking at test scores and data in our district, the researcher noticed that our math scores have been declining these past several years. The Maine Department of Education has

published school scores for that last several years, and this showed to be similar of many districts throughout the state where math scores have been declining. There is a significant difference in reading scores than math scores in the data. Reading scores have surpassed math scores for many years according to the Maine Department of Education's website. One reason could be the lack of supplementary materials for math needed to raise math achievement. Students are increasingly being asked to think critically in math than ever before. When the researcher first started teaching math fifteen years ago, the state tests were more geared towards lower level questions such as simple answers to math facts. Students are now being asked to perform multi-step problems on math tests requiring more than just simple arithmetic.

One way to support higher math achievement in the classroom is through the use of technology. Doabler, Fien, and Nelson-Walker (2012) noted in their research study that just utilizing textbooks in the traditional classroom found that students had weaker scores in math than others who supplemented their curriculum. Being provided one-to-one computers in our school, the researcher decided to use this technology to differentiate for each student based upon their NWEA scores to help raise their math achievement scores. Hsu (2016) noted in his research study that teachers supported using technology to support higher level learning. Teachers wanted to use the technology available but are not always sure what is available for them to use. He noted that teachers needed professional development to help support teachers utilizing technology in the classroom.

The students utilized their Chromebooks for their interventions during this research study. They completed individualized interventions on both IXL and Khan Academy based upon their Fall NWEA math scores. After the interventions were completed, the students took their

Winter NWEA test. It was found that 53.6% of students reached their targeted RIT growth goal after utilizing technology to differentiate for each of the students' interventions. Kiger, Herro, and Prunty (2012) further supported this study by finding that students who used technology outperformed their peers by more than 8%. Kaur, Koval, and Chaney (2017) conducted a research study on fourth graders who were not meeting the proficiency of the NWEA Map Test. The researchers used iPads that corresponded to areas where the students were weaker. The students that used these iPads were more engaged and focused on their work. Being able to use the iPads allowed for more differentiation for each student. The outcome of the study was that the students conceptual understanding of numbers and skills improved more than the students who just used the traditional textbook. This further supported my research study that the use of technology supporter higher math achievement as evidenced in the students' growth in each of the four subcategories of NWEA.

Ysseldyke and Bolt (2007) further researched the use of technology and differentiation for each student using the Accelerated Math program. The students who utilized the technology all outperformed their peers who solely used the traditional math curriculum which consisted of using the textbook and corresponding worksheets to each lesson.

There has been a huge shift these past few years to students receiving interventions to help raise their scores. However, there are many advanced students who need to be challenged, too. Ritzema, Deunk, and Bosker (2016) supported this by researching traditional classroom settings. They found that traditional teaching methods do not support challenging advanced learners. While doing this research study, it was evident when analyzing scores that not all students needed intervention activities but that some needed to be challenged. By using the

NWEA scores, some students who scored above the 50% worked above grade level on activities during the intervention times. This was a great way to reach the higher achieving students while the other students received interventions in their weaker areas.

Recommendations

Based upon the results of the research study, the first recommendation would be for teachers to receive professional development on how to best utilize the technology available to them in their classrooms. Specifically in MSAD 70, the superintendent has looked into the teachers receiving an updated training on using the NWEA data available to them to further inform their instruction and differentiation for each student. It is recommended that teachers try using Khan Academy in their classrooms next year in addition to IXL to further enhance their students critical thinking skills in math.

The second recommendation would be for teachers to have professional learning time to further look at data available. While looking at data for this research project, it became clearer to me which areas students were weaker in and possibly why this was so. Students were weaker in measurement and data. One reason may be because this topic is almost always found at the back of the textbook. Teachers may not get to this as in depth as they should if left for the end of the year. Teachers spend enormous amounts of time planning and assessing students. Time is much needed to interpret all this data that teachers collect to figure out how to best increase math achievement scores.

Another recommendation would be for teachers to embrace change. Students do not need to be taught solely from the textbook. There are other ways to supplement the curriculum and

technology would best fit this need. By utilizing technology, teachers can meet the needs of all the learners in their classrooms.

The last recommendation would be when further researching math interventions, it would be best recommended to use a whole year to collect data on the different math interventions being utilized in the classroom. It would have been better to split this study into two separate sessions. The first session would have been between the fall and winter NWEA. One classroom could have only completed IXL interventions while the other classroom only completed Khan Academy interventions. The students could then take their winter NWEA test. After this test, the classrooms would then have switched interventions until the spring NWEA. This would have made it easier to compare which intervention truly worked better. The researcher could also use Appendix A to note student's on and off task behavior during interventions throughout the year long study. The researcher could also use this chart to compare on and off task behavior during regular in class instruction. They could then compare the on and off task behaviors of the students between interventions and instruction.

Implications

The first implication for this study was that all students would need interventions. After the students took their fall NWEA, some students scored above the recommended grade level RIT score in each of the four subcategories in math. This enabled these students to be challenged during the intervention time rather than work on intervention skills that were at or below grade level. This was an added bonus to the students who needed to be challenged rather than them having to work at or below grade level that can often happen during class instruction.

Another implications for this study was the limited amount of interventions done for each of IXL and Khan Academy before taking the Winter NWEA test. The students only ended up completing three each of both the IXL and Khan Academy interventions for each of the four subcategories of NWEA. It was first believed that the students would be able to complete twelve lessons in each of the four subcategories.

Another implication was that the students would be in school ready to work on their interventions each day. However, during the study, many students ended up being chronically absent due to having the flu or taking vacations with the families. Their intervention times were made up at the end of each part of the research.

Conclusion

Throughout this research project, the students remained highly engaged during their intervention times. There was very little off-task behavior. The students responded well to trying to challenge themselves to answering as many questions as they could during the twenty minute intervention time. Only few students struggled and needed help daily from the teacher or educational technician in the room. The students have used IXL in their classrooms since kindergarten. They have never used Khan Academy before. Once they started the Khan Academy interventions, there were many comments on how they liked this much better than IXL. IXL was easier for the students to do but required them to answer more questions to reach 100% completion. Khan Academy was more difficult and required the students to think more critically than IXL. Many of the Khan Academy problems were multi-step problems which required more time to complete. There were less problems to complete on Khan Academy to

earn the 100% completion rate. At the end of the research, the students were informally asked which intervention they liked best. It was unanimous that they liked Khan Academy the best. With over half of the students reaching their targeted RIT score, it was found that students had more success with their Khan Academy interventions. It may be concluded that this resource may be beneficial to others looking to use technology to differentiate interventions.

References

Doabler, C. T., Fien, H., Nelson-Walker, N. J., & Baker, S. K. (2012). Evaluating three elementary mathematics programs for presence of eight research-based instructional design principles. *Learning Disability Quarterly*, *35*(4), 200-211. http://dx.doi.org.ursus-proxy-6.ursus.maine.edu/10.1177/0731948712438557

Higgins, K. N., Crawford, L., Huscroft-D'Angelo, J., & Horney, M. (2016). Investigating student use of electronic support tools and mathematical reasoning. *Contemporary Educational Technology*, *7*(1), 1-24.

Hsu, P. (2016). Examining current beliefs, practices and barriers about technology integration: A case study. Techtrends: Linking Research And Practice To Improve Learning, 60(1), 30-40. DOI 10.1007/s11528-015-0014-3

Huang, S. (2015). Mixed-Method research on learning vocabulary through technology reveals vocabulary growth in second-grade students. *Reading Psychology*, *36*(1), 1-30. DOI: 10.1080/02702711.2013.808723

Kaur, D., Koval, A., & Chaney, H. (2017). Potential of using iPad as a supplement to teach math to students with learning disabilities. *International Journal Of Research In Education And Science*, *3*(1), 114-121

Kiger, D., Herro, D., & Prunty, D. (2012). Examining the influence of a mobile learning intervention on third grade math achievement. *Journal Of Research On Technology In Education*, *45*(1), 61-82.

Musti-Rao, S., & Plati, E. (2015). Comparing two classwide interventions: Implications of using technology for increasing multiplication fact fluency. *Journal Of Behavioral Education*, *24*(4), 418-437. doi: 10.1007/s10864-015-9228-x

Oliver, K. M., & Corn, J. O. (2008). Student-Reported differences in technology use and skills after the implementation of one-to-one computing. *Educational Media International*, *45*(3), 215-229.

Ritzema, E. S., Deunk, M. I., & Bosker, R. J. (2016). Differentiation practices in grade 2 and 3: Variations in teacher behavior in mathematics and reading comprehension lessons. *Journal Of Classroom Interaction*, *51*(2), 50-72.

Rosen, Y., & Beck-Hill, D. (2012). Intertwining digital content and a one-to-one laptop environment in teaching and learning: Lessons from the time to know program. *Journal Of Research On Technology In Education*, *44*(3), 225-241.

Ulu, M. (2017). Examining the mathematical modeling processes of primary school 4th-Grade students: Shopping problem. *Universal Journal Of Educational Research*, *5*(4), 561-580. DOI: 10.13189/ujer.2017.050406

Ysseldyke, J., & Bolt, D. M. (2007). Effect of technology-enhanced continuous progress monitoring on math achievement. *School Psychology Review*, *36*(3), 453-467.

APPENDIX A: SCHOOL ADMINISTRATOR CONSENT FORM

Dear Mr. Richardson and Mrs. Wiley

My name is Aimee Goff, and I am a student at the University of Maine Farmington. I am interested in conducting a research study in my class from October 2017 through June 2018. I am interested in exploring using technology to differentiate for students in math using their Fall NWEA scores. I would like to input their Fall NWEA scores into Khan Academy and IXL to have them do focused interventions for twenty minutes each at least three times a week in their weaker math areas. They will do a total of 24 targeted interventions. They will also take the grade 4 Pearson Diagnostic Tests to further show if the interventions were successful in raising scores. The students will be observed every five minutes during their interventions to see if they are engaged or not. The students will fill out a brief survey at the end of the research asking them about their experience.

Student math scores have been stagnant for the last several years, and I am looking for ways to use technology to help differentiate for each student based upon their own unique needs to help raise their math scores. I will compare their Fall to January NWEA scores for a comparison to see if the interventions have been effective at raising scores. I will also use the Diagnostic Test scores as a supplement to see if there has been improvement.

I will not share any identifiable data about specific students, parents, or others involved in the study. All information will be kept on a password protected computer or in a locked file cabinet.

If you have any questions about this study, please contact me, Aimee Goff, at aimeegoff@msad70.org or at 207 694-0971. You may also reach my faculty advisor, Johanna Prince, at johanna.prince@maine.edu on this study. You may also contact the Chair of the IRB, Dr. Karol Maybury, karol.maybury@maine.edu.

Thank you for considering my request to conduct research,

Aimee Goff

I have reviewed Aimee Goff's research plan for "Using technology to differentiate for each student based upon their NWEA scores to help raise their math scores". I give my consent to conduct this research in MSAD #70 at Mill Pond School. I am aware that I may also ask to view the report at the end of the study.

_____	_____	_____
Date	Name	Position in District/Site

APPENDIX B: PARENTAL INFORMED CONSENT FORM

Dear Parents,

Hello! I am Mrs. Goff, your child's fourth grade math teacher. I am also a student at the University of Maine at Farmington where I am working to get my masters in Educational Leadership. I am currently researching how to use technology in the classroom to help meet each student's needs in math to help raise their math scores. I am looking to use their Fall NWEA scores to assign them specific tasks to do on the computer during math class. They will then be assessed on the NWEA's again in January to see if the interventions were successful in raising their math scores.

What Will Your Child Be Asked to Do?
All activities and tests involved in my study are typically occurring in math class. These are not added tasks to their day and will not need to be completed at home. Therefore I am seeking your permission to use the following data to help inform my teaching.

If you consent for your child to participate, I will use the following data:

- Fall and Winter NWEA math test scores.
- NWEA Student Goal Setting Worksheet
- Pearson Grade 4 Diagnostic Tests
- Data from IXL and Khan academy completion during math class
- On/Off Task data during interventions

Risks
No risks to your child will be associated to them during this research project.

Benefits: Your child may be able to increase their math scores even more than they typically would have by using IXL or Khan Academy specifically targeted to meet their needs. Additionally this study may help future students at our school and in other classrooms, as I hope to learn more about targeting interventions to each student's unique needs using technology.

Confidentiality: All information regarding your child will be kept confidential. Any information obtained will be kept on a password protected computer or in a locked filing cabinet. Your child's name will not appear on any notes or documentation that is made public.

Voluntary: Participation is voluntary. If you choose to have your child take part in this study, s/he may stop at any time. Whether or not your child participates will not impact your child's relationship with the school, his classroom teacher, or any other teachers. Your child may withdraw from the study at any time.

Contact Information: If you have any questions about this study, please do not hesitate to contact me, Aimee Goff, at aimeegoff@msad70.org or 532-9228. You may also reach my faculty advisor, Johanna Prince, at johanna.prince@maine.edu concerning this study. You may also contact the Chair of the IRB, Dr. Karol Maybury, at karol.maybury@maine.edu.

Your signature below indicates that you have read and understand the above information. You will receive a copy of this form.

_____ _____

Signature Date

APPENDIX C: WRITTEN ASSENT CONSENT SCRIPT
Children 8-17

Hello,

My name is Mrs. Goff, and I am a student at the University of Maine at Farmington. This letter is to explain to you about my project. I am doing a research project to learn more about using technology to differentiate for each of your unique needs in math.

If you agree to be in my study, we are going to be using your fall NWEA scores to work to your specific level to help increase your math scores. For example, I will ask you to use the computer for twenty minutes at least three times a week to work on either IXL or Khan Academy. I will be observing you during this time to see if you are engaged or not engaged with the interventions.

We will be using the NWEA Student Goal Setting Worksheet to give you a target score to work towards on the Winter NWEA tests. You will also take the Pearson Diagnostic Tests before and after the study so you can see your progress in math.

You can ask me questions about this study at any time. If you decide at any time not to finish, you can ask me to stop. When we report results you will not be identified by name.

If you sign this paper, it means that you have read this and that you want to be in the study. If you don't want to be in the study, don't sign this paper. Being in the study is up to you, and no one will be upset with you if you don't sign this paper or if you want to change your mind later.

Contact Information: If you have any questions about this study, please contact me, Aimee Goff at aimeegoff@msad70.org or 532-9228. You may also reach my faculty advisor, Johanna Prince, on this study at johanna.prince@maine.edu. You may also contact the Chair of the IRB, Dr. Karol Maybury, at karol.maybury@maine.edu.

Your signature: _____ Date _____
Your printed name: _____ Date _____
Signature of person obtaining consent: _____ Date _____
Printed name of person obtaining consent: _____ Date _____

APPENDIX D: OBSERVATION PROTOCOL

Math Observation Checklist

Date:_____

Student Names	0-5 min. On Task	0-5 min. Off Task	6-10 min. On Task	6-10 min. Off Task	11-15 min. On Task	11-15 min. Off Task	16-20 min. On Task	16-20 min. Off Task

Every five minutes during the twenty minute intervention period, a box will be checked whether the student is on task or off task. On task behavior would include looking at and interacting with questions on the computer, remaining in seat, and/or not talking with others. Off task behavior

would include talking to others, going to the bathroom, getting a drink, being out of seat, and/or not looking at or interacting with computer.