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The effect of Imagine Math on high school students with learning disabilities

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THE EFFECT OF IMAGINE MATH ON HIGH SCHOOL STUDENTS WITH LEARNING DISABILITIES

by

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Dedications

I would like to dedicate my thesis to my son, Daniel, and my family. Your constant support made it possible for me to reach this point. Thank you for always believing in me and reminding me to keep moving forward. You helped me believe in myself. Daniel, your smile reminded me every day of why I was working this hard and why it was worth it. I hope I make you proud.

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Abstract

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The purpose of this study was to: (a) examine the effectiveness of Imagine Math in increasing the engagement of students in a high school resource Algebra 2 classroom, (b) examine the effectiveness of Imagine Math in increasing the academic achievement of students in a high school resource Algebra 2 classroom, and (c) determine if students in a high school resource Algebra 2 classroom are satisfied with the use of Imagine Math. The research was conducted using single-subject design methodology. The study followed an ABAB alternating baseline pattern. Academic achievement was monitored through daily assessments, while engagements was evaluated in three minute intervals for thirty minutes daily. The results suggest the the use of Imagine Math helps increase the engagement and academic achievement of students in a high school resource Algebra 2 classroom. Results also show that students were satisfied with the use of Imagine Math. Implications for instruction in this setting include recommendations to utilize additional strategies with technology such as Imagine Math in the classroom.

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Chapter 1

Introduction

One of the challenges teachers face today is engaging students with diverse abilities and learning preferences in the classroom (Subban, 2006). The Education of All Handicapped Children Act of 1975, now codified as the Individuals with Disabilities Education Act (IDEA), requires states to develop and implement policies that assure a free and appropriate public education to all children with disabilities (United States Department of Education, 2015). The No Child Left Behind (NCLB) Act of 2001, a reauthorization of The Elementary and Secondary Education Act of 1965, supports a standards-based education rooted in the premise that setting high standards and establishing measurable goals can improve individual student outcomes (United States Department of Education, 2015). These policies require that teachers use research-based instructional methods that ensure a better quality of education for all students so that they may achieve proficiency on state academic assessments. The integration of technology during instruction could help in the struggle to meet the educational needs of students with diverse abilities and learning preferences in the inclusive classroom.

Technology has been used in the classroom since the 20th century and has come a long way from overhead and film strip projectors. Technology in the 21st century is predominantly digital. Despite the preponderance of digital technology in education for over two decades, however, there is still much reluctance by some teachers to use technology in classrooms. According to O'Hara and Pritchard (2010) technology in the classroom provides multiple opportunities for students to gain knowledge. When students are engaged in learning, they can use computer technology as a tool to help enhance their learning (Moorse, 2004). Educators should be proactive in learning and teaching with technology to help students. As a result, it is the educator who controls whether technology is successfully integrated into instruction (Moorse, 2004).

The number of special education students who are being educated in inclusive classrooms has been increasing over the years. These students are expected to complete grade level assignments. Technology can be used at all levels to promote academic success, independence, self-worth, and productivity among students with disabilities (Simpson, 2009). One thing to remember when choosing which technology to use is how the individual's limitation is lessened. Technology applications assist teachers in creating universally designed learning environments for students with disabilities, and promote access, participation, and progress for students with disabilities (Etscheidt, 2016).

Within the last few years, there have been quite a few studies that suggest technology has helped improve academic achievement. Bouck, Flanagan, Joshi, Sheikh, and Schleppenbach (2011) conducted a study in which students were able to decrease the amount of time taken to complete assessments with a special calculator. Beal, Rosenblum, and Smith (2011) conducted a study in which the use of a self-voicing computer program supported students with visual impairments. The implementation of technology into the classroom has been shown to create rich learning and teaching environments for students with special needs. With the emphasis that has been placed on technology use in the classroom, it is important to look at how teachers can meet this demand.

Lengel (2013) reports that technology is important because it is in the classroom, students own it, it works, and it is required. Technology creates an environment where a student controls the work they do and it is important to know if that technology is helping or not. Leaving the student to be on their own with technology and software to help them with their learning allows the classroom to be more student centered. Barrow, Markman, and Rouse (2009) focused their research on computer aided instruction in pre-algebra and algebra classes to measure its impact on mathematics achievement. They discovered that those provided with computer based instruction achieved 26% of a grade level more than their peers in a traditional classroom at the end of a semester.

The Education for All Handicapped Children Act made it possible for students with severe disabilities to attend school for the first time. Pedagogy rapidly advanced to meet the needs of those students (Browder, Spooner, 2014). Bryant, Bryant, and Hammill (2000) completed a study of students with disabilities that showed over 50% of those showed weaknesses in mathematics, and that approximately 6-7% of students in the United States demonstrate poor achievement in mathematics. One of the standards of the National Council of Teachers of Mathematics is based on the fundamental notion that all students, regardless of personal characteristics, backgrounds, or physical challenges should have access to a curriculum that is challenging (Jitendra & Star, 2011). Many students need modifications of some sort to assist them in the mathematics classroom. These modifications help them succeed in an inclusive classroom.

Imagine Math is a software that can be used in mathematics classrooms of all levels. It is part the Imagine learning series. The entire program is adaptive and caters to the user's mathematical needs. The students complete an adaptive benchmark exam that places them on a pathway within their grade level that is comfortable for them. They then take two additional benchmarks to measure their growth in mathematics. Students complete work that can either be assigned to them or work that they choose for extra help. There is also a feature with live teacher feedback with U.S. certified math teachers (Think Through Learning, Inc. website, 2017).

Statement of the Problem

Students with learning disabilities have difficulties maintaining focus on their work. This then leads to them not being able to complete their classwork. Engagement in problem solving is critical for learning mathematics (Lambert & Sugita, 2016). Current educational standards want students to be proficient in 21st century skills such as technology. The more students participate, the more they learn in all content areas. Barrow, Markman, and Rouse (2009) showed in a study that students in a classroom with computer aided instruction scored higher than those in a regular classroom. The more students are engaged, the more work should be completed. This would then increase the classwork completion rate among the students.

Purpose of the Study

This study will seek to investigate the effect of Imagine Math on the academic performance and engagement of students with learning disabilities in mathematics. The study will focus on special education students in two high school resource classrooms and one high school mild/moderate classroom. Students will also be asked about their satisfaction with Imagine Math as an academic technology application.

Research Questions

1. Will the use of Imagine Math increase the academic achievement of students in a resource high school mathematics classroom?

2. Will the use of Imagine Math increase the engagement of students in a resource high school mathematics classroom?

3. Will students be satisfied with the use of Imagine Math?

Statement of Hypothesis

Students who receive instructional support from the Imagine Math online software will perform better academically and will be more engaged in the classroom.

Significance of the Study

The Think Through Learning website (https://www.thinkthroughmath.com/resources/case-studies/) provides case studies for the success of the Think Through Math Imagine Math program. A middle school in Alabama showed an 11% increase is state test scores in the first two years of using this program. Another district showed an average 10% increase in math proficiency rates across the schools. There is more research on the effectiveness of certain programs utilized in the classroom. However, there is limited empirical research on the effectiveness of a program like Imagine Math. This study aims to add to research by investigating the effects of the Imagine Math software on the academic performance and work completion of students in an inclusion high school mathematics classroom.

Key Terms

Technology

IDEIA:

According to the Individuals with Disabilities Education Improvement Act (IDEIA) of 2006, the definition of technology is the following:

Assistive technology device – any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of a child with a disability. The term does not include a medical device that is surgically implanted, or the replacement of such devices.

(A) In general.--The term `assistive technology device' means any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve functional capabilities of a child with a disability.

(B) Exception.--The term does not include a medical device that is surgically implanted, or the replacement of such device.

NJ Admin Code:

The New Jersey definition of Assistive Technology originates from the Administrative Code Title 6A Chapter 14:Appendix G

Assistive technology service. The term "assistive technology service" means any service that directly assists a child with a disability in the selection, acquisition, or use of an assistive technology device. Such term includes—

(A) The evaluation of the needs of such child, including a functional evaluation of the child in the child's customary environment;

(B) Purchasing, leasing, or otherwise providing for the acquisition of assistive technology devices by such child;

(C) Selecting, designing, fitting, customizing, adapting, applying, maintaining, repairing, or replacing assistive technology devices;

(D) Coordinating and using other therapies, interventions, or services with assistive technology devices, such as those associated with existing education and rehabilitation plans and programs;

(E) Training or technical assistance for such child, or, where appropriate, the family of such child; and

(F) training or technical assistance for professionals (including individuals providing education and rehabilitation services), employers, or other individuals who provide services to, employ, or are otherwise substantially involved in the major life functions of such child.

Chapter 2

Review of the Literature

The introduction of technology into education has one major goal, to impact academic achievement (Amaury & Snyder, 2009). Educational technology made its debut in the 1920's with the invention of audio and video recordings and playback devices along with photographs. In the 1940's and 1950's technology shifted to audiovisual instruction instead of still media. In the 1960's and 1970's technology becomes more complex. Today educational technology encompasses three primary areas: hardware-based (planning, installation and support), software-based (learning programs to enhance teaching and learning), and instructional design (Alenezi, 2017). The use of computer technology is becoming increasingly commonplace in every facet of society. Although technology is being used more frequently, it is not as easily accessible across all social groups in society (Morse, 2004).

Teachers have experienced technology being incorporated into the classroom at a rapid rate and have reported using it frequently (Morse, 2004). Even the best teachers need tools and resources for their classrooms that will help meet the needs of students today. This literature review will discuss the use of technology in instruction, students with disabilities in mathematics, use of technology to increase student achievement and engagement, and Imagine Math in the classroom.

Use of Technology in Instruction

Barrow, Markman, and Rouse (2009) report that computer-aided instruction has boosted the math scores of students in the classroom. Moreover, Barrow et al. (2009) report that in response to the lack of proficiency in mathematics many teachers have begun to turn to advances in computer technology as effective and creative approaches to improve student math skills. Nearly all schools have had access to the internet since 2003. Morgan (2017) states technology is a strength for students in this digital era so integrating that into the classroom is beneficial for them. According to Alenezi (2017), technology has the ability to help students add to what they know and enhance their skills because it has the ability to be personalized. The success of the integration of technology in the classroom is reliant on how it's used. Research suggests that technology has a positive effect on student's academic achievement (Barrow, Markman, & Rouse, 2009; Bouck, Flanagan, Schleppenbach, & Sheikh 2011; Beal, Rosenblum, & Smith, 2011; Fernandez-Lopez, Martinez-Segura, Rodriguez-Almedros, & Rodriguez-Fortis, 2012; Ash, 2005; Pilli, 2008). Students have been raised in a digital environment that has shaped how they learn, think, and act. Students are more knowledgeable of technology than teachers (Gu, Guo, & Zhu, 2012). Students are often referred to as the "net generation," "new millennium learners," and "digital natives" (Gu, Guo, & Zhu, 2012, p.392). Teachers are often referred to as "digital immigrants" (Gu, Guo, & Zhu, 2012, p.392).

Students with Learning Disabilities in Mathematics

Browder and Spooner (2014) state that more studies are needed for students with significant disabilities. For students with disabilities, much is known about the lack of literacy skills with an overemphasis on sight words, however only some strands of mathematics have been addressed. According to Lambert and Sugita (2016), simply including students with disabilities in standard-based instruction is not enough; they require access to high quality mathematics instruction that prepares them to meet math state Common Core standards. Jitendra and Star (2011) state that although mathematics achievement has improved over the years, the achievement rates for students with learning disabilities is still considerably lower than that of other students. According to Jitendra and Star (2011), the beneficial effect of math programs for students with disabilities is not well documented.

Bryant, Bryant, and Hammill (2000) conducted a review of the literature to target mathematical weaknesses in students with learning disabilities. They compared whether the weaknesses noted in research studies are consistent with weaknesses noted by professionals that work with students with disabilities. A rating scale was created and sent to professionals with students with learning disabilities for them to rate their students' math behaviors. A list of 15,000 randomly selected professionals who worked directly with students with learning disabilities was purchased from a commercial mailing list company. Three hundred ninety one professionals from 42 states and the District of Columbia agreed to participate. Ratings completed on 1724 students showed that 870 students had math weaknesses. The data was analyzed and showed that behaviors cited in literature and research are indeed evident in students with math weaknesses. These behaviors were identified as indicators of students with potential learning disabilities in mathematics. They are as follows:

- Has difficulty with word problems
- Has difficulty with multi-step problems
- Has difficulty with the language of mathematics
- Fails to verify answers and settles for the first answer
- Cannot recall number facts automatically

- Takes a long time to complete calculations
- Makes “borrowing” errors
- Counts on fingers
- Reaches unreasonable answers
- Misspells number words (writes 13 as threeteen)
- Calculates poorly when the order of digit is presentation is altered
- Orders and spaces numbers inaccurately in multiplication and division
- Misaligns vertical numbers in columns
- Disregards decimals
- Fails to carry numbers when appropriate
- Fails to read accurately the correct value of multi-digit numbers because of their order and spacing
- Jumps impulsively into arithmetic operations
- Misplaces digits in multi-digit numbers
- Skips rows or columns when calculating
- Misplaces digits horizontal numbers in large numbers
- Makes errors when reading numbers aloud
- Experiences difficulties in the spatial arrangement of numbers
- Does not follow spatial commands or directions
- Misreads computational signs
- Reverses numbers in problems
- Has difficulty learning to tell time
- Does not remember number words or digits

- Writes numbers illegibly
- Starts the calculation in the wrong place
- Cannot copy number accurately
- Experience left-right disorientation in numbers
- Omits digits on left or right of a number
- Does not recognize operator signs

Calhoon, Emerson, Flores, and Houchins (2007) completed a competency profile of 224 high schools students with mathematical disabilities. The students were from four urban high schools in Tennessee. The students were administered the Mathematics Operations Test-Revised that consisted of 50 problems requiring basic mathematical operations. The questions encompassed mathematics from grade levels 1 through 6. Students were administered the test in 10 minutes and then the data was analyzed. Data was compared across grade and skill levels. It was reported that retention of fourth grade computational skills appear to be where the difficulty is for students with mathematical disabilities in regards to computational fluency. The results show that these students have difficulty with (a) upper level division of whole numbers; (b) basic operations involving fractions, decimals, and percentages; (c) multiplication of whole numbers; (d) multistep problems; and (e) regrouping and renaming.

Cirino, Fuchs, Fuchs, Powell, & Seethaler (2008) conducted a study on intervention for third grade students with severe mathematics deficit. They described different remedial intervention for number combinations as well as word problems and used the interventions to discuss how to design tutoring protocols for students with mathematical disabilities. Six principles are outlined: students with mathematical disabilities need explicitness in their instruction, instructional design to minimize the learning challenge, conceptual foundation, drill and practice, cumulative review, and motivators to regulate attention and behavior.

Use of Technology to Increase Student Achievement and Engagement

Barrow, Markman, and Rouse (2009) studied whether mathematics instruction was more effective when delivered via the computer or using traditional methods. They considered two forms of bias: (1) that teachers would only pick students who they believed would benefit from computer instruction and (2) that some teachers are less inclined to use computers and prefer traditional instructional methods. Barrow et al. (2009) focused on the effectiveness of a program called I Can Learn distributed by JRL Enterprises. The program allows students to study math concepts at their own pace. The study was conducted in three large urban districts, all of which are predominantly minority. It was concluded that the implementation of computer aided instruction in the classroom does increase student achievement in pre-algebra and algebra.

Bouck, Flanagan, Schleppenbach, and Sheikh (2011) completed a study that tested a computer based voice input, speech output calculator with three high school visually impaired students. The three students were chosen based on the following criteria: (a) attended and resided at the school for the visually impaired for that state, (b) were of similar age, (c) had similar mathematical skill level and completed all previous math courses, and (d) were willing to participate in the study. Results showed that at first students took more time to complete the assessments while using the VISO calculator as compared to their typical method of calculation. However, the more time the students spent using the calculator, the time taken to complete the assessments and the number of problems attempted decreased. The students noted increased independence with using the new calculator.

Beal, Rosenblum, and Smith (2011) conducted a study where fourteen students field tested a computer program called AnimalWatch-IV-Beta. The idea of this program was to find a way to increase the ability to solve word problems for middle school students. Students completed a tutorial on the program and then, through a self-voicing audio feature, the program delivered 12 Pre-algebra math problems and hints. Then students provided feedback on how the program can be improved. Data on students' responses were tracked on the computer and made available to the teachers. The results showed that students with weaker math skills used more hints. This suggests that students were highly engaged in the program while they were working through the problems.

Fernandez-Lopez, Martinez-Segura, Rodriguez-Almedros, and Rodriguez-Fortis (2012) created a program called Picaa for students with special needs and tested it on students. Picaa is a program that allows educators to create and manage activities to use in their classroom through use of a mobile device (e.g., iPad, tablet, etc). The study consisted of 39 students with special education needs from Spain. Students' performance was tracked before and after use of the program in the classroom. The results showed an average 5.56% increase in math skills. However, the study was pre-experimental with no control group. Fernandez-Lopez et al. (2012) suggest that the use of technology increases the interest of students helping them learn while entertained.

Ash (2005) conducted a study on 328 students from Tennessee to investigate the impact of the Orchard program on student mathematical achievement. These students were given a pre-test and one hour a week on a computer program. The Orchard program is adaptive to the students' needs. As the students answer questions, the program will either make the problems more or less difficult depending on whether the previous answer was correct or incorrect. At the end of the study, the students were given a post test to gauge their progress in mathematical achievement. Results showed that the experimental group, which was exposed to computer assisted instruction, did have higher academic gains than those in the control group with no technology.

Pilli (2008) completed a study focusing on the effect of computer based instruction on the mathematical achievement of fourth graders. There were 55 students split into two groups. The control group had no computer assisted instruction and utilized traditional instructional methods. The other group, the experimental group, used a drill and practice software called Frizbi Mathematics 4. After the semester was over, students were administered a post test. Results indicated those who were exposed to the computer assisted instruction outperformed those who were exposed to traditional instruction.

Imagine Math in the Classroom

According to Think Through Math (retrieved 2017), Imagine Math is a critical piece of response to intervention (RTI), science, technology, engineering, and mathematics (STEM), and offers 1:1 strategies for school systems. This program can be used as complementary instruction, a secondary math course, or as part of a before/after school program. Imagine Math is an adaptive program that provide a personalized pathway to meet each students specific needs. Since it is an online program, students can access it from wherever they have internet, including at home (https://www.thinkthroughmath.com/math-intervention-program-online/). Lott Middle School in Alabama began using Imagine Math midway through the 2014-2015 school year. Teachers were given in depth training and began incorporating it into their classrooms. They repurposed computers that were not in regular use around the school to make the program accessible to students throughout the day. The school had an 11% improvement on the ACT Aspire test from the 14-15 school year to 15-16.

Roswell Independent School District in New Mexico replaced their previous state assessment with the Partnership for the Assessment of Readiness of College and Careers (PARCC) assessment. With that came new standards and new challenges. They implemented Imagine Math as a third grade pilot program during summer of 2015. That fall they continued with implementing it in 4th and 5th grade as well. Both teachers and principals underwent training for the program. The performance levels were tracked while the students worked. In the short period of time from taking the placement test to when the students completed their most recent benchmark, the amount of students reaching the proficient level rose from 200 to 566.

Murrieta Valley Unified School District in Murrieta, CA utilized Imagine Math as well. They rolled out the program in one of their middle schools and eventually implemented it in all of the middle schools in the district. Students were given a social validity survey, and results suggest they approved of the use of the program. Middle School #1 saw a 10.1% increase in the percent of students that met proficient on the performance levels Middle Schools number two saw a 10% increase, middle school #3 saw a 10.4% increase and middle schools #4 saw a 9.9% increase.

Cherokee County School District in Canton, Georgia has a special education population of 12%. In the 2012-2013 school year, 10 schools in the district implemented the Think Through Math software. 76% of teachers agreed that TTM was easy to implement and 84% agreed it helped their students learn important math concepts. The students take an assessment called the Criterion-Referenced Competency Test. Scores were pulled to see the effect that Imagine Math had on the test scores in the middle school. 38% of the schools saw an increase in the number of students scoring proficient on the CRCT and 63% exceeding the standard.

While the effect of Imagine math on student performance in mathematics appears promising per studies reported on by Thinking Through Math, it is important that independent empirical studies are conducted to build on the validity of this research. Sharp and Hamil (2017) conducted a study to measure the effects of Think Through Math on the mathematical achievement of special education students. The study consisted of 259 middle school students. Throughout the school year students used this program in the classroom. Students' scores from the STAAR assessment were taken from the previous year and compared to the scores received after working with the Think Through Math Software. Results showed that the software had a significant positive impact on the scores of middle school students on the STAAR assessment in the state of Texas.

Conclusion

This review of literature details current technology in the classroom, the needs of students with learning disabilities in the math classroom, using technology to increase student achievement and engagement in mathematics, and the online software Imagine Math. Common results of studies reviewed are that the use of technology has been found to improve mathematical achievement and student engagement. As previously stated, however, the beneficial effect of technology-based math programs for students with disabilities is not well documented. This study aims to add to the research centered on the use of technology in the special education mathematics classroom by investigating the use of Imagine Math with students in high school Algebra 2 classes. Benchmark assessment scores will be tracked along with classwork. The purpose of this study is to: (a) examine the effectiveness of Imagine Math on the academic achievement of special education students in a high school Algebra 2 class, (b) examine the effectiveness of Imagine Math on the classwork completion rate of special education students in high school Algebra 2 classes, and (c) determine if special education students in high school Algebra 2 classes are satisfied with the use of Imagine Math.

Chapter 3

Methodology

Setting

School. The study was conducted in a public high school located in an urban New Jersey city. The school district consists of three preschools, eleven elementary schools, one gifted and talented school, one middle school, and one high school. During the 2016-2017 school year, there were approximately 14,130 students enrolled in the district. The high school served 3,115 students in grades nine through twelve and is considered to be a Title 1 School wide Focus School. Out of the 3,115 students enrolled, 471 students are classified as special education receiving services. The academic school day is approximately 7 hours and 7 minutes. Single periods are 42 minutes long, while double periods are 89 minutes long. Students have 5 minutes to pass in between each period.

Classroom. The study was conducted in an Algebra 2 special education classroom within the high school. The classroom consists of 4 student tables for groups, and two teacher desks. The room is shared with a special education English. The room has a SMART board with a projector. There is a Chromebook cart located in the back corner of the classroom. The cart houses and charges a class set of 12 Chromebooks for the students to utilize. Each student is assigned their own computer. The participants in the study were in attendance during the block for periods 1/2 (7:30-9:07 am). The class routine remained unaltered except for the addition of the intervention.

Participants

Students. A total of 5 Algebra 2 students, 2 females and 3 males, participated in this study. All of the students were previously identified by the district as needing special education services. Evaluation of previous academic skills and performance in the classroom along with their classification determines whether students are placed in resource, mild/moderate, or severe classrooms. Table 1 shows general participant information.

Table 1
General Participant Information

Student	Age	Gender	Grade	Classification
1	15	F	10	Resource
2	16	M	11	Resource
3	18	M	11	Resource
4	17	F	10	Resource
5	16	M	10	Resource

Student 1 is a 15-year-old Hispanic female. She is classified as having a communication impairment. Her strengths include perseverance and asking for help when needed. Her weaknesses are her lack of participation with the group in class. She has difficulty learning new content but does know the basics for the course. She benefits from one to one instruction.

Student 2 is a 16-year-old Hispanic male. He was classified as having ADHD. He has a behavior plan built into his IEP. This student receives a break midway through the block to release some of the energy he has. His strengths are how quickly he grasps the content and how fast he completes his work. His weaknesses include how susceptible he is to distractions and his inability to complete homework. He responds well to redirection and one on one assistance.

Student 3 is an 18-year-old Hispanic male. He is cognitively impaired and he also suffers from seizures. He is academically capable and functions at the highest level in the class. His strength is how quickly he is able to understand content. His weakness is his inability to focus at times. He responds well to one-to-one assistance.

Student 4 is a 17-year-old African American female. She is classified as having an intellectual disability at a mild level. Her strength is her persistence. She will continuously ask for extra work to do on each topic until she fully understands the content. Her weakness is her inability to remove herself from situations that present distractions. She does need frequent redirection when working independently.

Student 5 is a 16-year-old Hispanic male. This student is classified as cognitively impaired. His strength is how quickly he grasps content. He spent two months on home instruction and when he returned he caught up quickly. His weakness is how quickly his mood changes. Because of this, his work tends to be incomplete as he has moments where he refuses to work.

Teacher. A certified high school math teacher instructed the class, period ½, for the duration of the study. The teacher is in her 6th year of teaching high school math overall and her 4th year teaching high school math in the district. The teacher is responsible for creating lessons and lesson plans that follow the district's curriculum and also incorporate the New Jersey Core Curriculum Content Standards for Algebra 2.

Materials

The materials used in this study include the online textbook Algebra 2 Common Core Volume 1, published by Pearson, worksheets for independent practice for each topic, and individual student Chromebooks assigned to the classroom by the district. A timer was used to keep track of three minute intervals while completing the classwork completion checklist to see how many problems were completed during that interval. The software Imagine Math was used via Chromebook for the intervention.

Measurement Materials

Classwork completion checklist. A checklist, shown in Figure 1, was created to monitor classwork completion during the thirty minutes of independent practice. The teacher checked how many problems were completed every three minutes for the duration of the independent practice. There were ten problems on each independent practice sheet. The teacher placed a number to indicate how many problems out of 10 were completed at the end of each interval.

Week of: ____________________ Week #: ___________ Day #: ___________________

Student #	3 Minutes	6 Minutes	9 Minutes	12 Minutes	15 Minutes	18 Minutes	21 Minutes	24 Minutes	27 Minutes	30 Minutes
1										
2										
3										
4										
5										

Figure 1. Classwork Completion Checklist

Daily assessments. The students were given a three question assessment, worth 9 points, at the end of each class. The questions were directly related to the content taught that day during the lesson. All assessments were created by the teacher and administered through Plickers, an assessment program.

Student academic progress table. An academic progress table was developed to record scores from daily assessments (see Figure 2).

Week of: ____________________________ **Week #: ____________**

Student #	**Assessment 1**	**Assessment 2**	**Assessment 3**	**Assessment 4**	**Assessment 5**
1					
2					
3					
4					
5					

Figure 2. Student Academic Progress

Student Likert survey. At the end of all intervention, the participants completed a survey using a Likert Scale regarding their satisfaction with using the Imagine Math software. The survey consisted of ten statements in which students selected their level of agreement as strongly agree, agree, undecided, disagree, and strongly disagree. Questions inquired about the ease and helpfulness of Imagine Math, whether or not participants felt Imagine Math helped increase their academic scores, and whether or not they preferred Imagine Math over normal instruction. All surveys were completed anonymously (see Figure 3).

Imagine Math Survey

Directions: Read each sentence below and place an **X** in the column you feel most accurately indicates your feelings.

Statements	Strongly Agree 5	Agree 4	Undecided 3	Disagree 2	Strongly Disagree 1
1. I found Imagine Math easy to navigate.					
2. I enjoyed completing the problems on the computer					
3. I would prefer to solve on paper					
4. I would prefer to read from the textbook					
5. From using Imagine Math, I felt as though I learned more about the topics we were discussing about in class.					
6. I felt as though the questions were too hard to answer.					
7. I enjoyed using the program in class.					
8. I felt as though the program was too easy for me.					
9. I hope we use this program more in the future and other classes.					
10. I think I will do better on tests, that are conducted on line, in the future because of my experience with Imagine Math					

Figure 3. Likert Scale Student Satisfaction Survey

Research Design

The research was conducted using single subject design methodology, following an ABAB alternating baseline pattern. During Phase A, baseline data was collected for a week for the class. Baseline data was collected using a classwork completion checklist and daily assessment grades. During Phase B, the intervention phase, the students used Imagine Math for one week daily prior to beginning their independent practice. Imagine Math served as the independent variable, while student academic scores and classwork completion served as the dependent variables. Data was collected daily using the classwork completion checklist and student academic progress chart. Imagine Math was then removed for one week during the second Phase A, and then reintroduced during the second Phase B. The class received the baseline instruction and intervention on alternating weeks. This alternating pattern continued until study conclusion. Student academic progress was measured through the implementation of daily assessments related to the mathematical content of that day. Classwork completion was measured through daily teacher observation of how many problems were completed every three minutes for thirty minutes. At the end of the study, participants were given a Likert scale satisfaction survey to provide feedback on the use of Imagine Math.

Procedures

The research was implemented over a five-week period. Prior to the intervention, students were taught how to use Imagine Math. They were taught how to access the software from the Passaic Schools website. They were also given an opportunity to navigate through the program and try some examples.

Instructional design. Instruction was provided by the teacher for the class. The class received the intervention on alternating weeks once the initial baseline phase was completed. During the baseline/Phase A, participants moved from guided notes directly to independent practice. The researcher completed the checklist for classwork completion for the duration of independent practice and participants were administered daily assessments at the conclusion of their independent practice.

During the intervention/Phase B, students completed guided notes, then moved directly to Imagine Math, and then moved to independent practice. Participants would utilize the Imagine Learning link on the school website each day to access Imagine Math. They worked independently on their own problems, as they are adaptive to the student. Students transitioned into independent practice immediately following Imagine Math use. The researcher then completed the classwork completion checklist for the duration of independent practice and students were administered the daily assessment at the conclusion of independent practice.

Measurement Procedures

Observations. Immediately after guided practice, the researcher observed the participants as they began working on the independent practice. The researcher used a timer to check classwork completion every three minutes for thirty minutes. The researcher observed by walking around from student to student. During each interval, a number was used to note how many problems were completed during that interval.

Academic grades. Immediately after completing independent practice, students completed a daily three question assessment. The questions were directly related to that day's mathematical content. Participants worked quietly and independently to complete the assessment. They were permitted to ask clarification questions only. Once completed, the assessments were turned in directly to the teacher.

Survey. At the conclusion of the study, all participants completed a satisfaction survey. All responses were anonymous. After reading the statements out loud, the teacher stepped into the hallway to allow students to complete and turn in their surveys.

Data Analysis

Graphs were created to illustrate and compare each phase of data collection. Data points for this study occurred 5 days a week. Student academic scores from the academic assessments were collected daily. Classwork completion checks were also collected daily over 10 three minute intervals. All data was recorded into a spreadsheet. Academic scores are out of 9 points and classwork completion scores are out of 10 points.

Chapter 4

Results

Academic Achievement

Research question one asked, will the use of Imagine Math increase the academic achievement of students in a resource high school mathematics classroom? Student academic achievement was evaluated daily using a 3 question assessment, worth a total of 9 points, administered at the end of each class period. The assessment questions reflected the content taught in that day's lesson. Means and Standard Deviation (SD) of each student's academic achievement were calculated are are presented in Table 2.

Table 2

Mean and SD of Academic Scores

	Baseline 1		Intervention 1		Baseline 2		Intervention 2	
Student	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
1	1.4	0.8	6.0	1.10	3.4	0.49	7.0	0.63
2	1.4	1.2	5.8	1.17	2.6	0.8	6.4	0.49
3	1.8	1.17	5.0	0.63	2.4	1.36	7.0	0.89
4	3.2	0.75	6.4	0.8	2.6	0.8	6.8	0.75
5	2.2	1.17	6.8	1.17	2.8	1.17	6.6	0.49

Note. Mean and SD out of 9 total possible points

For student academic achievement, the group mean for baseline 1 was 2 with a standard deviation of 1.23, and the group mean at intervention 1 was 6 with a standard deviation of 1.17. The group mean at baseline 2 was 2.76 with a standard deviation of 1.03, and the group mean at intervention 2 was 6.76 with a standard deviation of 0.71. Both intervention phases show a higher mean than the baseline phases. Intervention phase means for all students were above the means for their respective baseline phases. Student 7 had a lower mean in baseline 2 than in baseline 1. Student 10 had a lower mean in intervention 2 than in intervention 1.

Engagement

Research question two asked, will the use of Imagine Math increase the engagement of students in a resource high school mathematics classroom? Student engagement was monitored immediately after the use of Imagine Math. The lesson itself was taught before the use of Imagine Math. A checklist was used to record engagement in three minute intervals for a total of thirty minutes. At each interval, a number was placed to indicate how many problems were completed from the assigned worksheet. The assignment contained 10 problems. The engagement score at the end of each day was the total amount of problems completed. Means and Standard Deviation (SD) of each student's engagement were calculated and are presented in Table 3.

Table 3

Mean and SD of Student Engagement

	Baseline 1		Intervention 1		Baseline 2		Intervention 2	
Student	Mean	SD	Mean	SD	Mean	SD	Mean	SD
1	4.2	0.98	8.8	0.4	4.0	0.0	8.4	0.49
2	3.6	0.49	8.4	0.49	2.8	0.4	9.8	0.4
3	3.0	0.63	7.8	0.75	3.0	0.0	9.0	0.63
4	3.2	0.40	8.6	0.49	3.0	0.89	9.6	0.49
5	3.0	0.63	7.6	0.49	4.0	0.0	8.8	0.75

Note. Mean and SD out of 10 total possible points

For student engagement, the group mean at baseline 1 was 3.4 with a standard deviation of 0.8, and the group mean at intervention 1 was 8.24 with a standard deviation of 0.71. The group mean at baseline 2 was 3.36 with a standard deviation of 0.68, and the group mean for intervention 2 was 9.12 with a standard deviation of 0.77. Both intervention phases show a higher mean than the baseline phases. Intervention phase means for all students were above the means for their respective baseline phases. Students 1, 2, and 4 had a lower mean in baseline 2 than in baseline 1. Student 1 had a lower mean in intervention 2 than in intervention 1. The group mean was lower for baseline 2 than for baseline 1.

Individual Results

Student 1 is a 15-year-old Hispanic female. She is classified as having a communication impairment. Figure 4 shows both the academic and engagement scores in points for Student 1. During baseline 1, Student 1's mean academic score was 1.4. During intervention 1 when Imagine Math was implemented, the mean score increased to 6.0. Student 1's mean academic score during baseline 2 decreased to 3.4 and increased once again to 7.0 during intervention 2. The academic scores also ranged from as low as 3 points to as high as 9 points.

Student 1's mean engagement score during baseline 1 was 4.2. The mean engagement score increased to 8.8 during intervention 1 and then decreased to a 4.0 during baseline 2 when Imagine Math was removed. During intervention 2, the mean engagement score then increased to 8.4. Student 1's engagement scores ranged from 0 to 8 points.

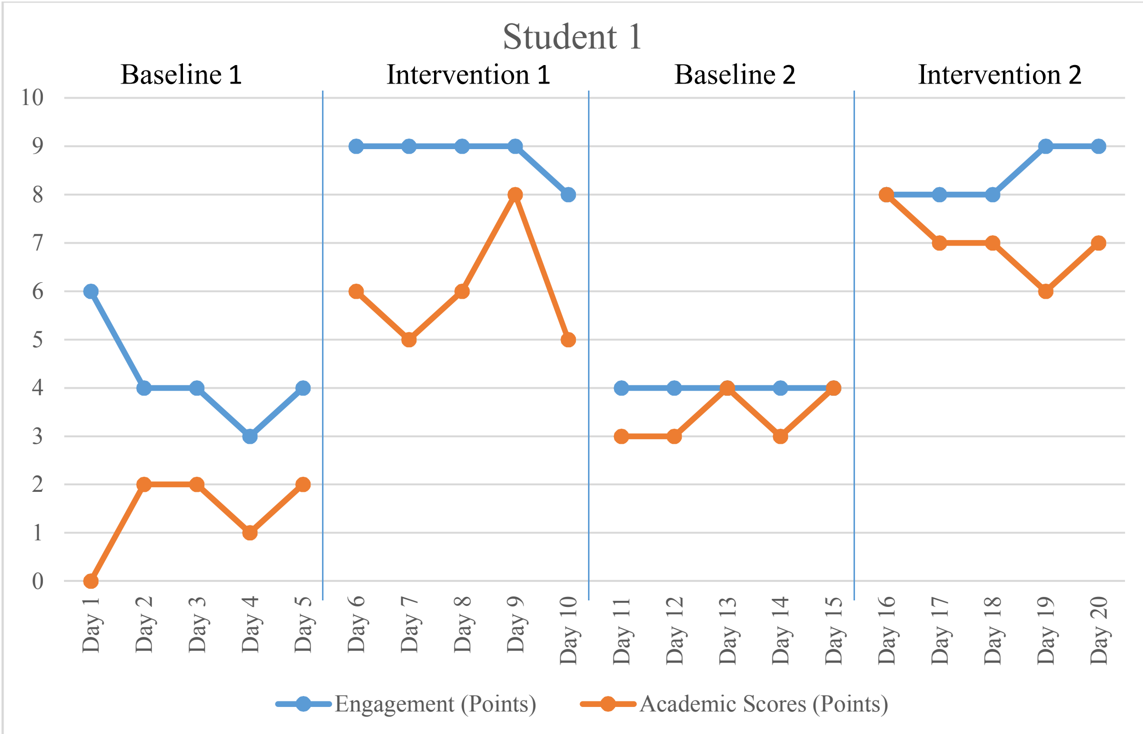

Figure 4. Student 1 Academic Scores and Engagement

Student 2 is a 16-year-old Hispanic male. He was classified as having ADHD. Figure 5 shows both the academic and engagement scores in points for Student 2. During baseline 1 before implementing Imagine Math, the student's mean academic score was 1.4. Student 1's mean academic score increased to 5.8 during intervention 1. During baseline 2 when Imagine math was removed, the mean academic score decreased to 2.6 and then increased again to 6.4 during intervention 2. The academic scores for Student 2 range from as low as 0 to as high as 7.

During baseline 1, the student's mean engagement score was 3.6. Student 2's mean engagement score increased to 8.4 during intervention 1 after Imagine Math was implemented and then decreased to 2.8 during baseline 2. During intervention 2, Student

2's score increased significantly to 9.8. The engagement scores range from as low as 2 points to as high as 10 points.

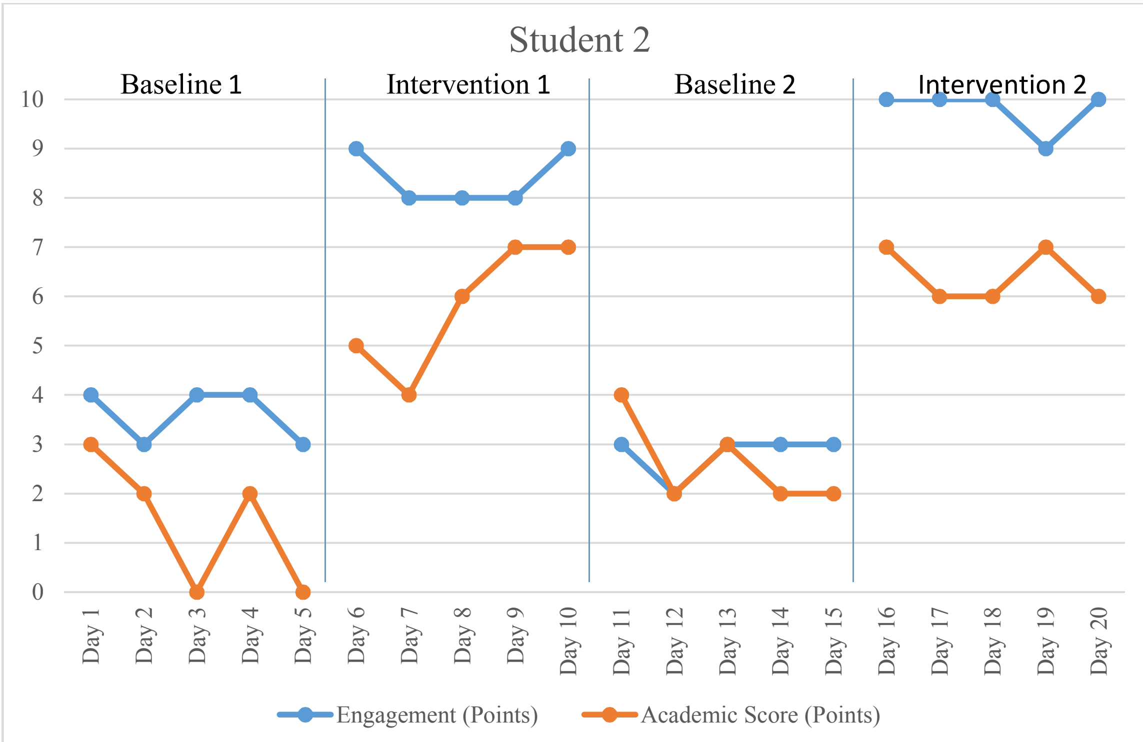

Figure 5. Student 2 Academic Scores and Engagement

Student 3 is an 18-year-old Hispanic male. He is cognitively impaired and he also experiences seizures. Figure 6 shows both the academic and engagement scores in points for Student 5. During baseline 1, the academic score mean was 1.8. During intervention 1 after Imagine Math was implemented, the mean increased to 5.0. The mean then decreased to 2.4 during baseline 2 and increased after to 7.0 during intervention 2. The range of the academic scores was from as low as 0 to as high as 8.

During baseline 1, the engagement score mean was 3.0 and increased to 7.8 during intervention 1. Student 3's mean engagement score decreased back to 3.0 during baseline 2 and then increased to 9.0 during intervention 2. The range of the engagement scores went from as low as 2 to as high as 10.

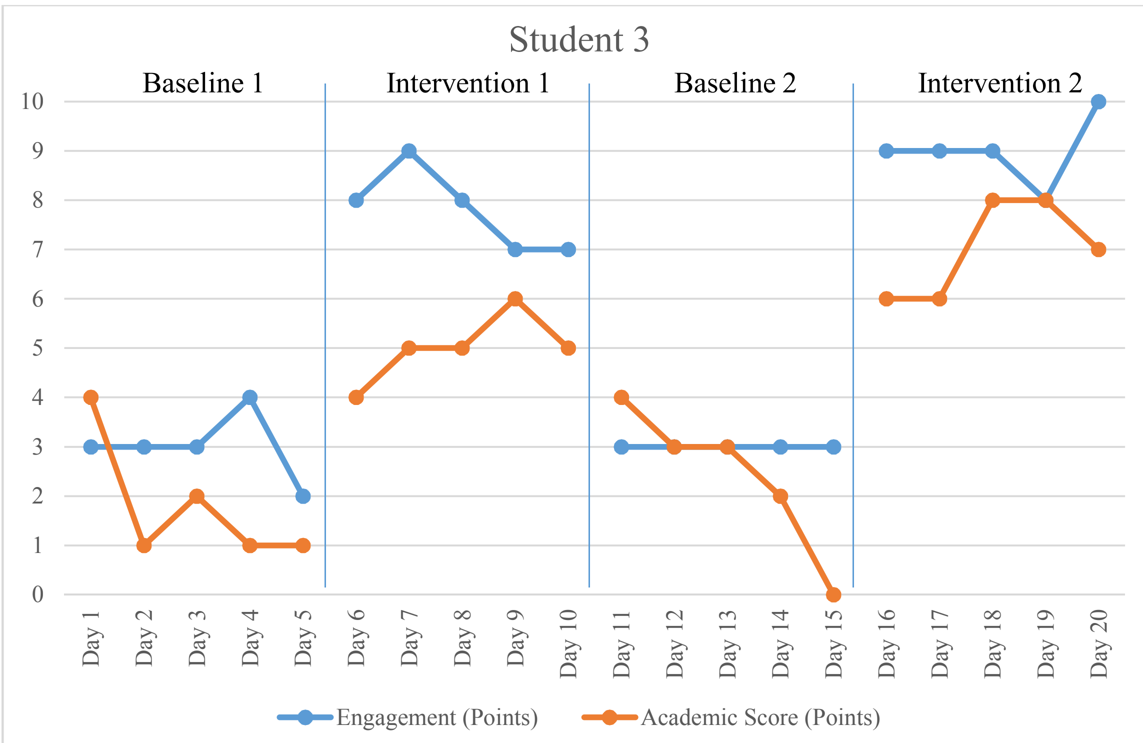

Figure 6. Student 3 Academic Scores and Engagement

Student 4 is a 17-year-old African American female. She is classified as having an intellectual disability at a mild level. Figure 7 shows both the academic and engagement scores in points for Student 4. During baseline 1, the academic score mean was 3.2 and then it increased to 6.4 for intervention 1. Student 4's academic score mean for baseline

2 was 2.6 and then increased to 6.8 during intervention 2. The academic scores ranged from as low as 0 to as high as 8.

During baseline 1, the engagement score mean was 3.2. The mean increased to 8.6 during intervention 1 only to decrease to 3.0 during baseline 2. Student 4's engagement score mean then increased again to 9.6 during intervention 2. The scores range from as low as 3 to as high as 10.

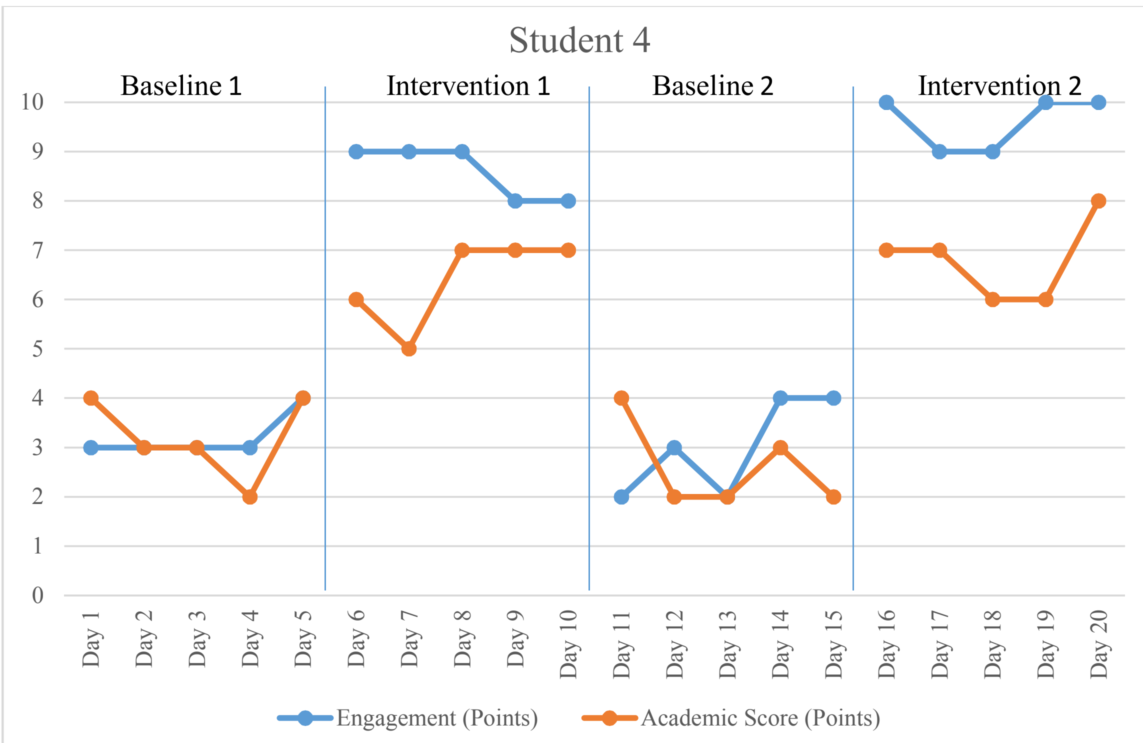

Figure 7. Student 4 Academic Scores and Engagement

Student 5 is a 16-year-old Hispanic male. This student is classified as cognitively impaired. Figure 8 shows both the academic and engagement scores in points for Student 10. Student 5's mean academic score during baseline 1 was 2.2. With the use of Imagine

Math during intervention 1, the score increased to 6.8. Baseline 2 showed a decreased mean score of 2.8, followed by an increased mean score of 6.6 for intervention 2. The range of the scores went from as low as 0 to as high as 8.

Student 5's mean engagement score during baseline 1 was 3.0. The score then increased to 7.6 during intervention 1 with a decrease to 4.0 during baseline 2. During intervention 2, the score increased again to 8.8. The range of scores went from as low as 3 to as high as 10.

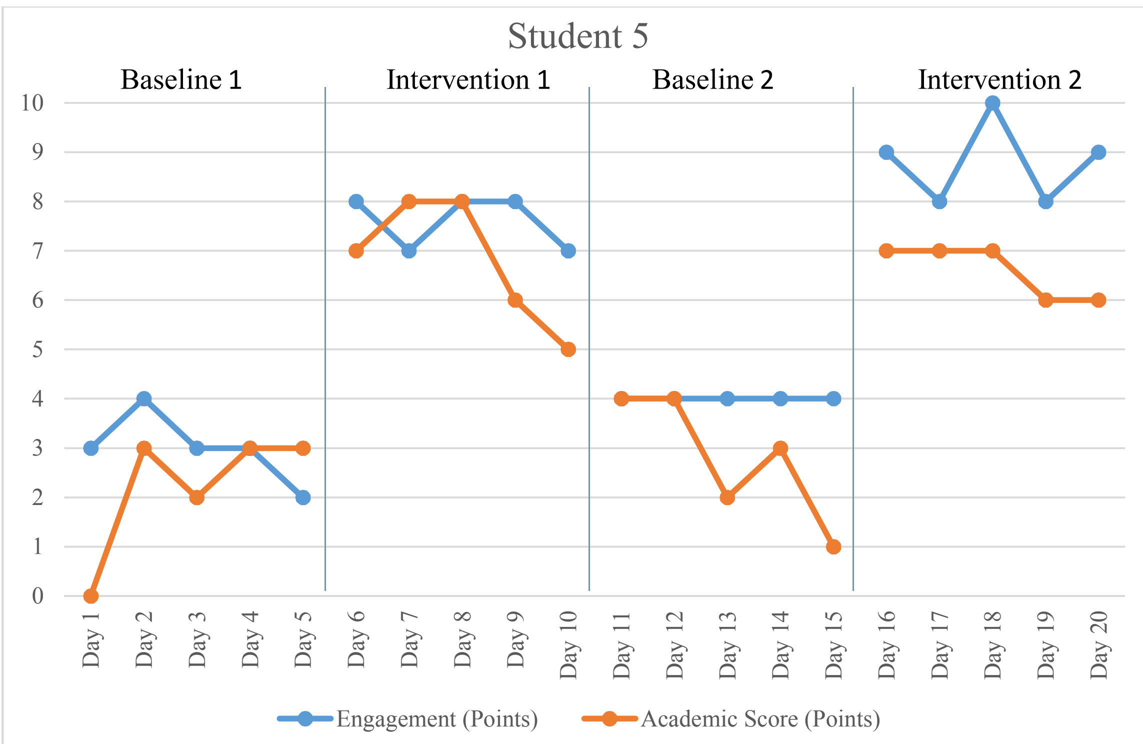

Figure 8. Student 5 Academic Scores and Engagement

Student Satisfaction

Research question three asked, will students be satisfied with the use of Imagine Math. Student satisfaction with the program was measured at the end of the study using a Likert scale survey. Students completed the survey anonymously. It consisted of ten statements in which students selected their level of agreement as strongly agree, agree, undecided, disagree, or strongly disagree. Results were tallied, and percentages of student responses are presented in Table 4.

Table 4

Student Satisfaction Survey Results in Percentages

Statements	**Strongly Agree (%)**	**Agree (%)**	**Undecided (%)**	**Disagree (%)**	**Strongly Disagree (%)**
1. I found Imagine Math easy to navigate.	20	80	0	0	0
2. I enjoyed completing the problems on the computer	100	0	0	0	0
3. I would prefer to solve on paper	0	40	0	0	60
4. I would prefer to read from the textbook	0	0	0	0	100
5. From using Imagine Math, I felt as though I learned more about the topics we were discussing about in class.	20	60	20	0	0
6. I felt as though the questions were too hard to answer.	0	20	20	60	0
7. I enjoyed using the program in class.	100	0	0	0	0
8. I felt as though the program was too easy for me.	0	0	20	60	20
9. I hope we use this program more in the future and other classes.	100	0	0	0	0
10. I think I will do better on tests, that are conducted on line, in the future because of my experience with Imagine Math	20	60	20	0	0

According to the results of the student survey, 100% of the students enjoyed using Imagine Math. All students either agreed or strongly agreed that Imagine Math was easy to navigate for them. In regards to completing problems on the computer, 100% strongly agreed that they enjoyed doing so. Over half of the students, 60%, strongly disagreed that they would prefer to solve problems on paper and 100% strongly disagreed that they would refer to read from a textbook. All of the students either strongly agreed, agreed, or were undecided as to whether they learned more about the topics from class by using Imagine Math. Over half of the students, 60%, disagreed with the questions being too hard. However, one student, 20%, felt that they were too hard. In terms of ease, all students either strongly disagreed, disagreed, or were undecided about the program being too easy. In regards to future use, 100% hoped that the program is used in the future, and all students either strongly agreed, agreed, or were undecided as to whether future use would help them do better on tests conducted online.

Chapter 5

Discussion

The purpose of this study was to examine the effectiveness of Imagine Math in increasing the academic engagement and achievement of students in a resource high school algebra classroom. At the conclusion of the study, students completed a survey to determine if they were satisfied with the use of Imagine Math.

Findings

The results of this study show that academic scores increased during the intervention phases for all students. When Imagine Math was implemented in the classroom, academic scores increased for all students across both phases from intervention to baseline. Academic scores for Students 1, 2, 3, and 5 increased from Baseline 1 to Baseline 2. The remaining student, Student 4, decreased from Baseline 1 (M=3.2) to Baseline 2 (M=2.6). Students 1, 2, 3, and 4 had academic scores that increased between the two intervention phases; whereas Student 5 decreased from Intervention 1 (M=6.8) to Intervention 2 (M=6.6). The finding that the use of Imagine Math increased academic scores corroborates the findings of Ash (2005) and Barrow, et. al. (2009) suggesting that the use of computer programs is effective in increasing student academic scores.

The results of this study also show that the engagement scores increased overall for all students. However, Student 5 was the only student whose mean score for Baseline 2 (M=4.0) was higher than the mean score for Baseline 1 (M=3.0). Students 1, 2, and 4 had mean Baseline 2 scores that were lower than that for Baseline 1 and Student 3 remained the same for both Baseline 1 (M=3.0) and Baseline 2 (M=3.0). All students increased from Baseline 1 to Intervention 1 and from Baseline 2 to Intervention 2. The findings that the use of Imagine Math increased student engagement corroborates with the findings of Bouck, et. al. (2011) and Fernandez-Lopez et.al. (2012) suggesting that the use of technology can aid in engagement.

Bouck et. al. (2011) found that students were more engaged in their work while using technology. They actually were so engaged that the amount of time needed to complete problems decreased. Upon review of the individual data, when the engagement was high, the student academic scores were also high. Although they did not follow the same trends, the scores did increase between baselines and interventions. Within each individual phase, the academic scores did not always follow the same trend as engagement scores. Intervention scores overall were higher than baseline scores for both engagement and academic; however, within each phase, the engagement scores seemed to be higher than the academic scores. For example, Student 1's mean academic score was a 1.4 and the mean engagement score was a 4.2. During Intervention 1 both increased to a mean academic score of 6.0 and a mean engagement score of 8.8. While both score increased between phases, the academic score still remained lower than the engagement score. This pattern is noticeable for all students. This may be due to the fact that academic scores initially were below the engagements scores. It also may be that even though the students were engaged during the lessons, the still had difficulty demonstrating mastery on the daily assessment.

All student participants completed a satisfaction survey at the conclusion of the study. The results illustrate that all of the students were satisfied with the use of Imagine Math and strongly agreed to enjoy using it. The present study also found that all students enjoyed completing their problems on the computer and also strongly agreed that they would like to use the program in the future. Out of the 5 students, 4 either strongly agreed or agreed that they felt they would do better on tests conducted online due to use of this program. The last student remained neutral.

Limitations

This study had several possible limitations. One limitation was the time frame. The study was implemented over a four-week period. Due to drills and PARCC preparations, periods were shortened on certain days. Data was still collected in the planned manner, however, instruction time was shortened. The data from the study may have been stronger if it was able to be collected for longer than a four-week time period.

A second limitation may have been the small number of participants in the study. Only 5 students participated in this study due to lack of parental consent. Therefore, the results of the study cannot be generalized to the entire population of students in a high school resource Algebra 2 class.

A third limitation may have been the subject area itself. Because this study took place in a mathematics classroom, the students were taught a new lesson every day. It is possible that student academic scores on the daily assessments were affected by their ability to truly master one specific concept. For example, if there were 5 separate lessons in a week, it is possible that students scores may continue to be lower than engagement scores due to still not understanding the lesson from the day prior. Finally, concepts may have a direct impact on academic scores as one concept may be more difficult than another for any given student.

Implications and Recommendations

Though this study has its limitations, the data does suggest that the use of Imagine Math may help to increase the engagement and academic achievement of students in a high school resource Algebra 2 classroom. Imagine Math was found to increase the weekly mean engagement score and the weekly mean academic score for all students. This corroborates prior studies that have suggested the use of technology serves as an effective strategy for increasing student academic performance and student engagement (Barrow, Markman, & Rouse, 2009; Bouck, Flanagan, Schleppenbach, & Sheikh 2011; Beal, Rosenblum, & Smith, 2011; Fernandez-Lopez, Martinez-Segura, Rodriguez-Almedros, & Rodriguez-Fortis, 2012; Ash, 2005; Pilli, 2008). As a result of all students increasing their mean academic scores, the findings for academic achievement may be considered consistent. All students had intervention mean academic scores that were greater than their baseline scores. In addition, all students had mean engagement scores that were greater than their baseline scores.

Broader implications emerging from this study include the recommendation to implement additional education strategies such as Imagine Math in the classroom. Imagine math could serve as an effective online program in the classroom that allows for increased student engagement and instant feedback. Given the results from the survey, it is likely that students will enjoy utilizing programs like Imagine Math in other mathematics classrooms and other contents. Following the recommendations of prior researchers, additional studies should be conducted to identify other programs that are helping to improve student learning (Jitendra & Star, 2011; Browder & Spooner, 2014).

Conclusions

This study was successful because it increased academic performance and engagement among students in a high school resource Algebra 2 classroom. It also showed that students were satisfied with the use of Imagine Math. While this study did show the effectiveness of Imagine Math in increasing academic and engagement scores, the number of participants was small and further studies are needed to validate findings. Future research should conduct the study with a larger number of participants across a longer period of time.

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