4-20-2017

The effects of computer games on the mastery of multiplication facts for students with exceptional learning needs

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THE EFFECTS OF COMPUTER GAMES ON THE MASTERY OF MULTIPLICATION FACTS FOR STUDENTS WITH EXCEPTIONAL LEARNING NEEDS

By

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A Thesis

Submitted to the
Department of Interdisciplinary and Inclusive Education
College of Education
In partial fulfillment of the requirement
For the degree of
Master of Arts in Special Education
At
Rowan University
April 13th, 2016

Thesis Chair: S. Jay Kuder, Ed. D.

Acknowledgments

I would like to acknowledge Professor Kuder for his guidance and assistance throughout the whole thesis process. I would also like to thank my school principal, my students, and their parents for allowing me to do this research.

Abstract

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2015-2016
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The purpose of this study was to examine the effects of multiplication computer games on mastering multiplication facts for students with exceptional learning needs. Three students will be participating in this research study. There is one male student and two female students, in Grades 3 and 4. Each of the three students has an individualized education plan (IEP) and receives three hours of instruction outside the regular classroom in a resource room setting. Two of the students have been identified as having Specific Learning Disabilities and one as having multiple disabilities. The students were selected for the study due to a lack of mastery of multiplication facts. This study was utilized a pretest- posttest design and data was collected during the baseline, intervention, and post-intervention phases. The research study was designed to determine the increase of multiplication mastered by each student. The dependent variable was the student scores on the multiplication assessments. The independent variable was the multiplication computer games that the students were playing in this study. The computer games were used to improve mastery of multiplication facts. The data from this study suggests that multiplication computer games are an effective way to improve mastery of multiplication facts. This has led me to conclude that incorporating games, technology, and computer games is beneficial for skill development for students with and without disabilities. Technology is an effective mean to master multiplication facts. Games and technology

can increase motivation in math for all students. The results from this study parallel results from previous studies that technology and computer games are effective in improving math skills for students with disabilities. It should be incorporated into the math curriculums, not replace current curriculums. Technology and games can increase motivation in math. The findings suggest future investigations into the use of computer games in math.

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Chapter 1

Introduction

Students in the United States are lacking basic math skills, including conceptual understanding, procedural fluency, and automatic recall of math facts, according to the National Mathematics Advisory Panel (Poncy & Skinner, 2010). Basic multiplication facts involve solving single-digit multiplication. When recall of basic math facts is automatic, students are able to improve and apply abstract skills and concepts (Shapiro, 2004) due to the availability of more cognitive resources (LaBerge & Samuels, 1974; Wong, 1986). Abstract skills and concepts require knowledge of basic math facts (McCallum, Skinner, Turner, & Saecker, 2006). Students, who automatically recall math facts, have been found to participate in more math tasks, learn complex concepts, and have less math anxiety (Cates & Rhymer, 2003; Skinner, 2002; Skinner et al., 2005).

Students with disabilities often have difficulty with fact fluency, which prevents development of advanced math skills (Shapiro, 1996; Parmar et al., 1994). It is important for students with exceptional learning needs to develop mastery of multiplication facts. Without mastery of multiplication, students will have minimal mathematical growth during their school years and the rest of their lives (Caron, 2007). According to Kelley (2008), fact fluency is as important to math as decoding is to reading (Rave, 2014). The use of technology, specifically multiplication games, will be examined in this research project. This research will examine whether multiplication computer games have an effect on the mastery of multiplication facts for students with exceptional learning needs.

As a resource room mathematics teacher, I have found that students with exceptional learning needs struggle with mastery of multiplication facts. Students enjoy

using technology in math. When technology is incorporated into lessons, students are able to improve their math skills. With the use of multiplication fact games, I want to see if there is an improved mastery of multiplication facts. There is little research on the effectiveness of computer games for mastery of multiplication facts and more research is needed.

According to the National Council of Teachers of Mathematics (NCTM, 2000), effective math instruction incorporates technology. When students enjoy the math tasks, they are more likely to be engaged in the work (Billington & Ditommaso, 2003). Computer- assisted instruction has been found to improve basic multiplication fact recall of resource room students (Irish, 2002). Math apps have been shown to improve learning of multiplication for struggling learners (Parmar et al., 1994).

The purpose of this study is to evaluate the effect of multiplication fact computer games have on the learning of multiplication facts by third and fourth grade students with disabilities. This study will analyze the changes in multiplication knowledge of three students with exceptional learning needs from a baseline over the course of four weeks. Two computer games, *FactDash* and *The Wall*, that practice multiplication facts will be chosen for this study. The hypothesis that, when technology, specifically computer games, is incorporated into instruction, students with exceptional learning needs will improve recall of multiplication facts evidenced from a baseline pre-test. The results will provide information on the effectiveness and offer insight into the use of computer games on the mastery of multiplication facts. The results will also show to what extent the use of computer games result in changes of multiplication facts.

Key Variables

Computer games: Games played on the computer that involve practicing multiplication facts

Mastery of multiplication facts: Students will able to recall eighty percent of multiplication facts.

Students with exceptional learning needs: Students in third and fourth grades that have an IEP and receive mathematics instruction in a resource room setting.

Baseline: Students will take a pre-test on multiplication facts (0-12) to determine a baseline.

Assumptions

- The teacher used in this study is competent to teach Mathematics and students with exceptional learning needs.
- The students are capable of mastering multiplication facts.
- The computer games selected for this study will involve the recall of multiplication facts.
- The pre-test and post-test will measure knowledge of multiplication facts.

Delimitations

This study will not address what computer games are the most effective. This study will not measure the effects of other multiplication strategies.

Limitations

This study involves a small sample size and students are in a small class setting. The students receive more intensive instruction on a daily basis. The pre-test and post-test may be affected by the students' attitude toward multiplication.

Chapter 2

Literature Review

The National Mathematics Advisory Panels reports that students in America lack key math skills compared to students in other countries (NMAP, 2008). The National Center for Education Statistics (2013) reports fifty-nine percent of fourth grades are below average in mathematics. NMAP indicates that curriculum, instruction, and assessment need to be addressed. The mastery of basic math facts is the major goal in elementary school (Fleischner et al., 1982). One of the first requirements for mathematical success is mastery of the basic math facts. Multiplication is a key concept according to the Common Core Standards for Mathematics (National Governors Association Center for Best Practices & Council of Chief State School Offices, 2010).

Fluency

The National Mathematics Advisory Panel stresses the need for "conceptual understanding, procedural fluency, and automatic (i.e., quick and effortless) recall of facts (NMAP, 2008). The National Council of Teachers of Mathematics also stresses the importance of math fact fluency, reporting that number and operations, number sense and fluency in math facts "form the core of mathematics education for the elementary grades" (NCTM, 200, p.32). Fluency is defined as the ability to perform skills and demonstrate knowledge both accurately and speedily without hesitation (Binder, 1990, 1996). Many students lack fluency in basic math facts. This leads to slow, time-consuming, and erroneous application (Sam & Spruill, 2005). Students that lack fluency tend to avoid math (Skinner, 2002). Typically, students are assessed on mastery of facts, such as 80% accuracy, not fluency (Nam & Spruill, 2005).

Automaticity

Knowledge of basic math facts has to not only be learned but be automatic. This allows for students to learn and develop advanced math skills (Shapiro, 2004). For example, estimation and mental computations require automaticity of math facts (Woodward, 2006). Automaticity reduces cognitive load (Caron, 2007; Woodward, 2006). Students, that have weak associations between a problem and a solution, will use several retrieval methods before they will produce an answer (Mabbott & Bisanz, 2008). To develop automaticity, students must practice, but do not need to be tested constantly (Caron, 2007).

Understanding of Multiplication

Students need to develop an understanding of the multiplication process. They also need to when and how to use the facts they learn. Students that just memorize the multiplication facts have little understanding of how to use the multiplication facts.

Importance

It is important that every student know the multiplication facts. By eighth grade, students will only have a minimal amount of success if they do not know the multiplication facts (Caron, 2007). Basic math skills are critical to success in math (Royer, Tronsky, Chan, Jackson, & Merchant, 1999), are necessary for higher- level math (Hartnedy et al., 2005), and required for independent living (Patton et al., 1997). According to Vaughn, Bos and Schumm (2007), students who do not know their basic math facts will not learn higher- level math.

Students with Learning Disabilities and Multiplication

Geary et al. (2000) utilized theoretical models, an experimental study to compare average math students and low achieving math students, and a longitudinal study. The students were assessed on basic numbers, counting, and arithmetic skills. They found that students with learning disabilities evidenced many deficits and delays. Students with learning disabilities tend have difficulties in learning mathematics, including basic math facts and calculations (Cawley & Miller, 1989, Geary et al., 2000). This may be due to cognitive impairments (Rao & Mallow, 2009). According to a study by Miller and Milam (1987), students with learning disabilities make most of their errors due to the lack of mastery of basic math facts. Research has shown that students with learning disabilities have difficulty with mastery of basic math facts and are less proficient than their peers (Fleishner, Garnett, & Shepherd, 1980). Students with learning disabilities and attention issues evidence erroneous and slow retrieval of multiplication facts (Zentall, 1990). Zentall (1990) tested students with ADHD, taking into consideration being off-task, speed, IQ, and reading comprehension. She found off-task behavior led to slow retrieval during multiplication.

Difficulties in math tend to start at an early age. Students with learning disabilities have been found to have a delay in the ability to learn automaticity of basic math facts (Goldman et al., 1988). Most students with learning disabilities will not master basic math facts before leaving elementary school (VanLuit & Naglieri, 1999).

Specifically, mathematics learning disability (MLD) is a cognitive disorder that leads to below average scores on standardized assessments in mathematics (American Psychiatric Association, 1994). Students with MLD have poor working memory

compared to their peers (Geary, 1990). MLD is as common as reading disabilities and affects five to eight percent of students (Geary, 2004). However, there is less research on mathematics (Gersten, Jordan, & Flojo, 2005). In a study by Mabbott and Bisanz (2008), they found that students with MLD completed multiplication problems slower, less accurate, and relied on more procedures when compared to average achieving students.

Strategies Used by Students with Disabilities

Basic math fact strategies develop with age and practice for average achieving students (Fleischner et al., 1982). Students with disabilities tend to rely on counting strategies, which is not effective with multiplication (Stein et al., 1997). Goldman, Pellegrino, & Mertz (1988) found that students with learning disabilities do not rely on retrieval methods but rely on counting.

Teacher Strategies

Teachers use many different strategies to help students with learning disabilities learn basic math facts. Many teachers believe that drill and practice are the best ways to master basic math facts (Hasselbring, Goin, & Bransford, 1988). However, according to the Multiplication Practice Website, rote memory is not effective for memorizing and takes a lot of time and effort (Caron, 2007). According to research by Woodward (2006), explicit strategy instruction in most used by teachers. VanLuit and Naglieri (1999) studied students with poor math skills, forty-two with learning disabilities and forty-two with mild retardation. The students participated in the Mathematics Strategy Training for Educational Remediation (MASTER) program. This program was designed for the use of strategies in multiplication and division. They found that effective strategy instruction incorporates multiple strategies, practiced by applying them to authentic tasks, and occurs

in small groups (VanLuit & Naglieri, 1999). Special educators need to use effective strategies that lead to success in learning math facts and higher- level math understanding (Rao & Mallow, 2009).

Modifications are Necessary

Students with disabilities do not develop fact strategies naturally so modifications are important (Geary, 1993). Students with disabilities are often taught basic multiplication facts, the same way non-disabled students are taught, by repetition drills (Greene, 1992). Thornton and Toohey (1985) did a detailed case study to show a 5-step structured program, which modified basic subtraction instruction. They found that instructional sequence and instructional strategies need to be modified to promote mastery of basic facts (Thornton & Toohey, 1985). Interventions are necessary so that students with disabilities know their basic math facts automatically before they leave elementary school (Geary, 1993).

Research has found that students with disabilities need opportunities for correct academic responses (Skinner, 1998). It is important that students get frequent practice with multiplication facts (Cumming & Elkins, 1999). Students need to practice facts but do not need to be constantly tested on the facts (Caron, 2007). According to Gersten and Chard (1999), testing is always linked to practicing math facts. They reviewed research on early identification and early intervention related to mathematics difficulties. Once basic math facts are mastered, students with learning disabilities are able to retain the information, according to Fleischner et al., (1982).

Standardized Testing

There has been a trend toward computerized testing (Scheuermann & Bjornsson, 2006). Students with disabilities are required to take standardized tests and scores are used to rate the school's performance, according to No Child Left Behind and Individuals with Disabilities Education Act. According to No Child Left Behind (2001), students regardless of disability need to take and make progress on standardized tests. Knowing basic math facts is essential for success on standardized tests (Brookhart et al., 2004).

Students need to be taught basic math facts in the same way they are tested. If you want to improve math skills by paper and pencil, learning should occur with a paper and pencil (Skinner et al., 1997). Many teachers instruct students in one way and then want them to demonstrate learning in a different way (Nam & Spruill, 2005). Students should be given the opportunity to learn on the computer since they are being tested on the computer.

Math and Technology

"Technology is essential in teaching and learning mathematics," according to the National council of Teachers of Mathematics (2000). Back in 1969, the Committee on the Undergraduate Program in Mathematics suggested computers should be incorporated in the math curriculum (Rapp & Gittinger, 1993). Today, there is demand for technology to be incorporated into special education classrooms (Howell, Sidorenko, & Jurica, 1987). Gerber, Semmel, and Semmell (1994) developed and tested a program called DynaMath. The program was a computer-based assessment of multi-digit multiplication facts for secondary students with disabilities. They field tested the program over three years and found that technology appears to be a promise of improvement in the education

for students with disabilities (Gerber, Semmel, & Semmel, 1994). It has been found by Cheung and Slavin (2013), that technology has improved student achievement in math. Cheung and Slavin (2013) reviewed seventy-four qualified studies on the effects of educational technology on mathematics achievement. Technology can have a positive impact on achievement, self-concept, and attitudes. It also leads to independence, increased participation, and prepares students for later life transitions (Burgstahler, 2003). It should be used to compliment a math curriculum, not replace it (Kraus, 1998). Technology has been shown to improve the academic achievement of students with disabilities (Marino, 2010). Research shows that most teachers use some sort of technology that will increase skills (Ganesh & Middleton, 2006). Teachers need to make sure activities using technology are meaningful and promote learning (King-Sears & Evmenova, 2007). Varying math instruction for students with disabilities will increase engagement, motivation, and confidence (O'Malley et al., 2013). O'Malley et al. (2013) completed a four week study using a single case reversal design with ten students with disabilities enrolled in a special education school.

According to a study by Trifiletti, Frith, & Armstrong (1984), computer- based instruction improved math skill fluency more than using worksheets. They completed an experimental study using a control group and experimental group of twenty-eight learning disabled students comparing a computerized math program and a resource math instruction program. Nordness, Haverkost, & Volberding (2011) found that interventions that incorporate technology effectively improve math skills for students with disabilities by examining the effects of a flashcard app on a hand held device on three students with learning and behavioral disabilities. Technology allows students to work at their own

pace and provides immediate feedback (Baker, Gersten, & Lee, 2002). Both of these benefits are an advantage to students with disabilities. According to Brosvic and his colleagues (2006), immediate feedback benefits students with learning disabilities.

According to Kraus (1998), the Internet can promote an interactive experience for general education students and students with disabilities. He did a three- year project that included on-line lessons and activities in math and aeronautics for students with physical disabilities. The advantages of the Internet include: it is motivating, lessons are available anywhere, information and resources are abundant, and it is self-paced (Kraus, 1998).

iPads have also been found to be an effective tool for students with disabilities (O'Malley et al., 2013). In a study by O'Malley et al., (2013), they found that the iPad increased math fact fluency for students with disabilities. The iPad also makes learning portable and mobile (O'Malley, Lewis, & Donehower, 2013). There are so many educational apps available that can be correlated to the math curriculum. Math apps keep students engaged (Zhang, Trussell, Gallegos, & Asam, 2015). Zhang, Trussell, Gallegos, and Asam (2015) did an exploratory study in an inclusion fourth grade class, half of the students performed poorly in math. The students used three math apps to utilize decimal and multiplication skills. Pre- and post-tests showed improvement of math learning. Kagahara et al., (2013) found from reviewing 15 studies that the use of the iPad improved academic, communication, and transitioning skills for students with developmental disabilities.

Math and Games

All students can relate to game playing. Playing games in math can help with intellectual, psychological, and social development in students with disabilities (Rieber,

1996). Games allow students to practice and reinforce skills, according to Andy Issacs, director of the third edition of Everyday Mathematics (Cavanaugh, 2008). Math concepts can be presented in a "colorful and simple way", according to Isaacs. Through the use of games in math, students are able to practice skills in different contexts (Van Luit & Naglieri, 1999). Games can be used for practice, warm-up activities, and rewards (Bragg, 2012). Problem-solving skills are developed through the use of games (Ernest, 1986). Games require students to be actively engaged which will increase motivation (Ernest, 1986). To be effective, however, games need to be incorporated with instruction not be used in isolation (Bragg, 2012). Bragg (2012) did a quasi-experimental design with a pre-test, post-test, and delayed post-test with 10-12 year olds in eight different classrooms using different teaching approaches for teaching multiplication and division of decimals. Results indicated that teachers need to choose games carefully to ensure effectiveness.

Math and Computer Games

Using computer games in math is now widespread (Ke & Grabowski, 2007). Computer games "deliver, support, and enhance teaching, learning, assessment, and evaluation", according to Connolly and Stansfield (2007). When a task is less complex, learning may be greater (Harris, Graham, Reid, McElroy, & Hamby, 1994). Harris et al. (1994) did a study using self-monitoring as a strategy to increase attention. Computer games can also improve students' attitude toward mathematics (Rosas et al., 2003). Using an experimental group, internal control group, and external control group, Rosas et al. (2003) studied the effects of 1,274 students from economically disadvantaged schools using computer games in math. Results indicate an increase in student motivation and improvement in skills. Student's task concentration increases, collaboration with peers

improves, and tasks get completed through the use of computer games (Rosas et al., 2003). Computer games can be a great potential for students with disabilities (Gerber, Semmel, & Semmell, 1994). They are effective if they have a skill- building component, and fluency can be improved for students with disabilities through computer games (Chiang, 1986). Fluency development is just as important as knowing multiplication facts (Baroody, 2006). Computer games can be motivating and motivation is important in learning multiplication facts (VanHouten, Morrison, Jarves, & McDonald, 1974). Computer games allow students to construct knowledge through play (Chen & Wang, 2009).

Effectiveness of Computer Games

Research has been contradictory on the effectiveness of computer games. In a meta-analysis, Randel, Morris, Wetzel, and Whitehall (1996) found that 36 of 68 studies showed no improvement from the use of computer games and 22 of 68 studies showed improvement. In their pretest- posttest design, Ke and Grabowski (2007) found that math game playing did improve math achievement. Dempsey et al. (1996) also found that computer games improved math concepts. Keller (1987) found that it is through fantasy that computer games will increase student motivation. Students with disabilities have been found to benefit from math computer games (Burns, Kanive, & DeGrande, 2012).

Fact Dash

FactDash is a math fact game by Macmillan McGraw-hill developed in 2008. Students can choose between addition, subtraction, multiplication, division, or a mixed review. The students can choose different sets of facts to work on. For example, with multiplication, students can choose from facts 0-5, 6-9, and 10-12. Students are able to

set their own pace to complete problems, from not timed up to ten minutes. They can also choose how the facts are presented, vertically or horizontally. The students are to complete thirty problems. At the end, the results are displayed and students can print this page.

The Wall Multiplication Game

The Wall was developed, by Not Just Sums in 2014. In the game, the students have to click on the brick with the correct answer to a problem before the time runs out. Each correct brick is removed from the wall. To get to the next level students must destroy the wall. Students have 15 seconds to complete 16 problems. After the student's time runs out, their final score is displayed.

Conclusion

This research review's purpose is to gain a better understanding of the effectiveness of technology, specifically computer games, in teaching multiplication facts to students with learning disabilities. It is not clear from the research to what extent computer games are beneficial to students with learning disabilities in regards to multiplication. However, it is clear from the research that students with learning disabilities struggle with learning multiplication facts and computer games improve the motivation of students with learning disabilities. Further research is required to define the most effective way to incorporate computer games into math instruction for students with learning disabilities.

Chapter 3

Methodology

Participants and Setting

Three students will be participating in this research study. There is one male student and two female students, in Grades 3 and 4. Each of the three students has an individualized education plan (IEP) and receives three hours of instruction outside the regular classroom in a resource room setting. Two of the students have been identified as having Specific Learning Disabilities and one as having multiple disabilities. The students were selected for the study due to a lack of mastery of multiplication facts. Each student scored less than 60% on the pre-test. All students involved in the study have basic computer skills.

Student A is a nine-year-old Caucasian/ Mexican female in third grade. She is diagnosed with Specific Learning Disability, oral expression and mathematics calculations. Student A scored below average in math on the Weichsler Achievement Test-III (WIAT-III). On the Measurement of Academic Progress test (MAP), she scored in the 27th percentile in math, which equates to a beginning/ mid year second grade level. On the multiplication pre-test, she scored a 30 out of 100.

Student B is a 10 –year-old Caucasian female, who is in the fourth grade. Her diagnosis is Specific Reading Disability, reading and listening comprehension. On the Weichsler Achievement Test-III (WIAT-III), student B scored borderline to below average in math. She scored in the 7th percentile in math on the Measurement of Academic Progress (MAP) test, which equates to beginning/ mid second grade level. She scored a 35 out of 100 on the multiplication pre-test.

Student C is a 10-year old Caucasian male in fourth grade. He is diagnosed with Autism; Attention Deficit Hyperactivity Disorder, combined presentation; and Disruptive Mood Dysregulation Disorder. Student C scored below average in math on the Weichsler Achievement Test-III (WIAT-III). On the Measurement of Academic Progress test (MAP), he scored in the 1st percentile in math, which equates to a beginning/ mid year Kindergarten level. Student C performs at a mid third grade level in math. He scored a 58 out of 100 on the multiplication pre-test.

The research study took place in a public elementary school that has students from preschool disabled to 6th grade in a small suburban town in New Jersey. There are 210 students enrolled at the school. Ten students receive instruction in a Resource Room setting, eight of these students receive Resource Room Math instruction. Students in the Math Resource Room are currently using the PMI Math curriculum and supplemental materials from various sources, including:

Fact Dash - A math fact computer game by Macmillan McGraw-Hill developed in 2008.

The Wall – A math fact computer game developed, by Not Just Sums in 2014.

Multiplication/ Division Fact Pre-Test, Checkpoint 1, Checkpoint 2, Checkpoint 3, Checkpoint 4, Checkpoint 5, Checkpoint 6, and Post-test. These tests are used by the school and kept in their student files. Only the multiplication tests will be used for the purpose of this study.

Instruments

For Students A, B, and C, a 50- multiplication fact pre-test, Checkpoints 1, 3, and 5 that was administered at the beginning of each week for the three weeks, Checkpoints

4,5, and 6 that was administered following a 30- minute session playing Fact Dash and The Wall, and a Post- test that was administered at the end of week 4. All five tests consist of the same facts in a different order.

Dependent Variable

The research study was designed to determine the increase of multiplication mastered by each student. The dependent variable was the student scores on the multiplication assessments.

Independent Variable

The independent variable is the multiplication computer games that the students are playing in this study. The computer games were used to improve mastery of multiplication facts.

Procedure

All three of the students, completed a 50- multiplication fact pre-test and the amount of time it took to take the test was recorded. To score the test, the teacher subtracted two points from 100 for every fact that was answered incorrectly.

The students played each game, Fact Dash and The Wall, for 15 minutes a day Monday- Friday at the end of Math class on their laptops at their assigned desks. The students were given a 50- multiplication fact Checkpoint test on Monday prior to playing the games and Fridays following the 30 minute game session to measure the increase in mastery of multiplication facts. At the end of Week 4, the students were given a 50- multiplication fact Post-test. All Checkpoint tests and Post- tests were scored the same way as the Pre- test. During these four weeks, students continued to receive regular math instruction using the PMI curriculum.

Assessments

Students were assessed on the percentage of facts answered correctly as well as the time it took to complete the Pre-test, Checkpoints 1-3, and Post- test. All five tests have the same facts in a different order. Fact Dash also tracks how many facts the students get wrong. The students in the intervention group will print out their results following each game session on Fridays.

Data Analysis

All of the students' number of facts mastered on the Pre-test, Checkpoints, and Post- test will be presented on a graph. The score range will be calculated and changes from the baseline to intervention will be calculated.

Chapter 4

Results

In this single subject study, the effects of computer multiplication games on mastery of multiplication facts was examined with three students with exceptional learning needs in Grades 3 and 4. Will multiplication computer games improve mastery of multiplication facts for students with exceptional learning needs?

The students took a 50- multiplication fact pre-test. This test was used to establish the baseline of each student in this study. Then, they played two different multiplication computer games, The Wall and FactDash, for fifteen minutes per day, Monday through Friday over the course of four weeks. A post-test was given at the beginning of the fifth week.

Table 1 shows the scores on the pre-test, checkpoints, and post-test for each student. This table also includes the difference between the baseline and post intervention scores.

Table 1.

Results for Pre-Test, Post-Test and Difference

Participant	Pre-test	CP. 1	CP. 2	CP. 3	CP. 4	CP. 5	CP. 6	Post-test	Difference
Student A	30	62	50	48	56	44	54	54	24
Student B	26	34	34	60	50	42	38	34	12
Student C	58	62	62	62	68	74	74	70	12
Mean	38	51	49	57	58	53	57	53	16

The pre-test was administered to establish a baseline for all three students. The students took a Checkpoint (CP.) test on Mondays at the beginning of class before receiving any interventions. They took another Checkpoint test following a 15- minute game session on Fridays. Students participated in 15- minute game sessions Monday and Friday over a three- week period. The students took a post- test at the beginning of Week 4.

The mean of each assessment for all the students was calculated. The difference between the pre- and post-test was calculated for each student to determine improvement.

Student A

Figure 1 shows the scores of the pre-test, checkpoints, and post-test for student A. Student A scored a 30 out of 100 points on the baseline test. The score increased 28 points to a 58 out of 100 after the first checkpoint test. After two weeks of the intervention phase, Student A's score increased to a 56 out of 100 and increased to a 58 out of 100 during the third week of the intervention. Student A had a mean score of 52 out of 100 during the intervention. Student A scored a 54 out of 100 on the post-test. The difference between the pre- and post-test scores was an increase of 24 points.

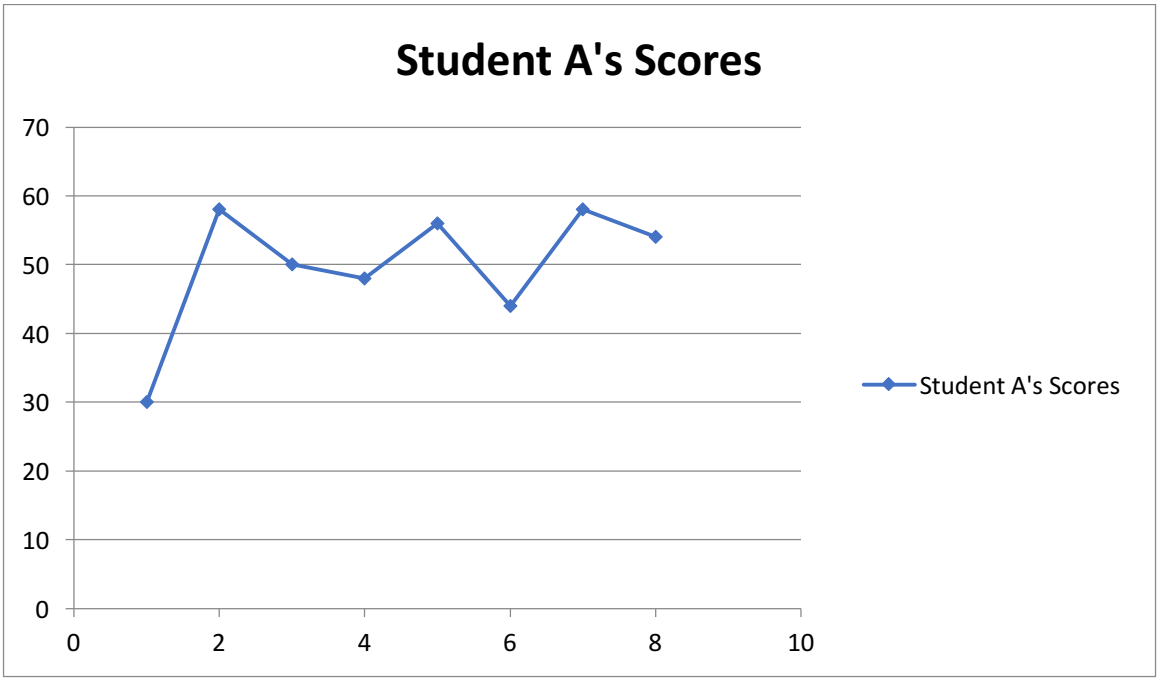

Figure 1. Scores for Student A

Student B

Figure 2 displays the results of student B's scores on the pre-test, checkpoint tests, and post-test. On the pre-test, student B scored a 26 out of 100 on the pre-test. During the first week of the intervention phase, student B's score increased 8 points to a 34 out of 100. Student B achieved her highest scores during week 2 with scores of 60 out of 100 and 50 out of 100. In the third week, student B had scores of 38 and 34 out of 100. The mean score during the intervention phase was a 43 out of 100. On the post-test, student B had a score of 34 out of 100. Student B's score increased 12 points from the pre-test to the post-test.

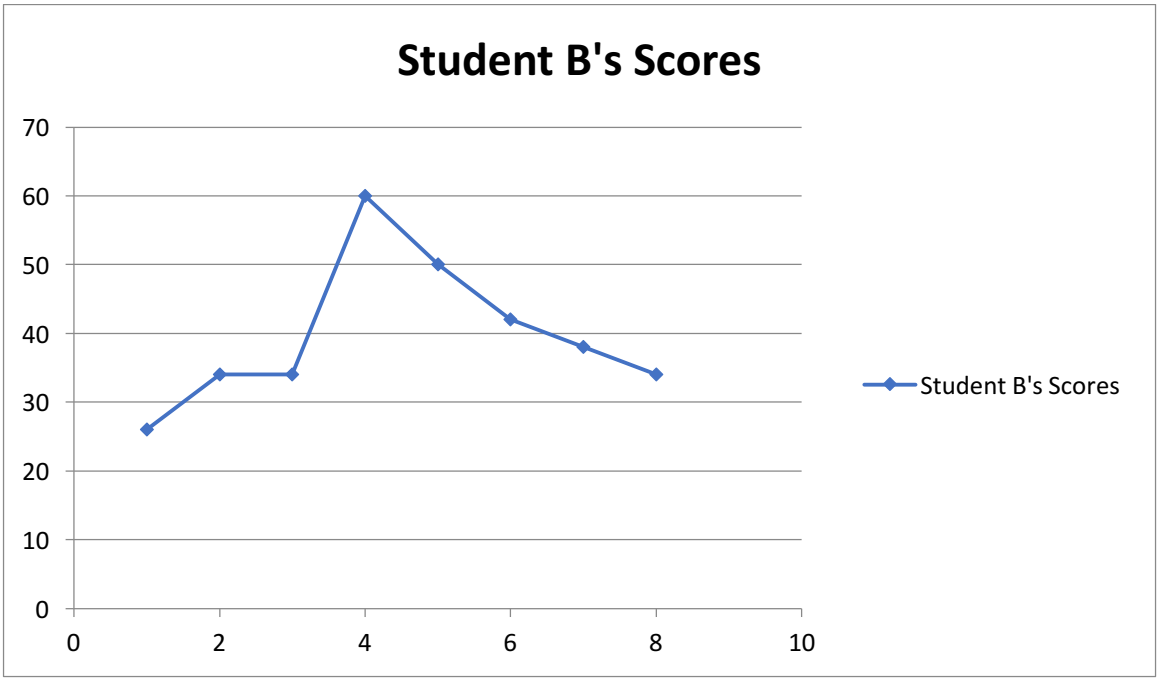

Figure 2. Scores for Student B

Student C

Figure 3 shows the scores of the pre-test, checkpoints, and post-test for student C. Student C scored a 58 out of 100 points on the baseline test. The score increased 4 points to a 62 out of 100 during the first week of the intervention phase. After one and a half weeks of the intervention phase, Student C's score increased to a 68 out of 100 and increased to a 74 out of 100 during the third week of the intervention. Student C had a mean score of 67 out of 100 during the intervention. Student C scored a 70 out of 100 on the post-test. The difference between the pre0 and post-test scores was an increase of 12 points.

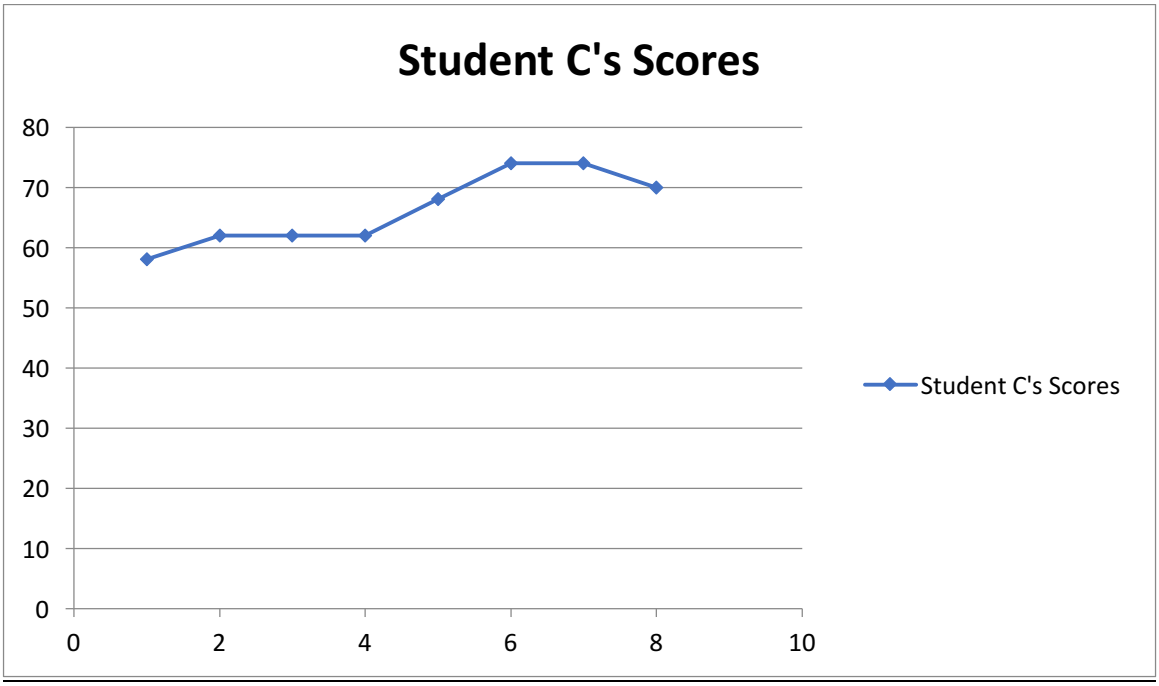

Figure 3. Scores for Student C

Chapter 5

Discussion

The study examined the effects of the use of multiplication computer games on the mastery multiplication facts of three students with exceptional learning needs in Grades 3 and 4.

In this study, multiplication computer games had a positive effect on multiplication facts learned by the students. All three students scores improved from the multiplication pre-test and post – test. Two students had an increase of 12 points, and one student improved by 24 points.

Previous studies have found that the use of technology, games, and computer games are effective in improving math achievement. In a study by Cheung & Slavin (2013), involving reviewing 74 previous studies, it has been found that technology is beneficial to achievement in math. Nordness, Haverkost, & Volberding (2011) did a study with three students with learning and behavioral disabilities and found that technology improved math skills. In a study by Zhang, Trussell, Gallegos, & Asam (2015), it was found that math apps improved math learning. Rosas et al. (2003), did a study with 1,274 students and found computer games increased motivation and math skills.

This study had similar results. The use of computer games can improve math skills and multiplication fluency. Ke & Grabowksi (2007) and Keller (1987) found that games in math improved math skills and motivation in their study. The use of computer math games is effective for students with disabilities, according to a study by Burns, Kanive, & DeGrande (2012).

Limitations

The sample size for this study was relatively small using only 3 students with disabilities. The study also took place in a small class setting. As a result, it is difficult to know whether the results would generalize to a larger subject sample.

There was also no control group to compare the results to. All three of the students showed improvement of multiplication facts although it is not known if this is a direct result of the games.

The students played two games so it is not known which game was more effective in improving multiplication facts.

Future Studies

Future studies should study which computer games are most effective in improving mastery of multiplication facts. It would also be useful to study how much of an impact computer multiplication games have on mastery by using a control group of students who do not play the games. It would also be useful to use a larger sample size to determine the effectiveness of computer games. Future research may also want to compare the effects of computer games on mastery of multiplication facts by comparing students with disabilities and students without disabilities. Doing this study in a larger classroom would also be useful in future studies.

Implications

The data from this study suggests that multiplication computer games are an effective way to improve mastery of multiplication facts. This has led me to conclude that incorporating games, technology, and computer games is beneficial for skill development for students with and without disabilities. Technology is an effective mean

to master multiplication facts. Games and technology can increase motivation in math for all students.

Conclusion

The results from this study parallel results from previous studies that technology and computer games are effective in improving math skills for students with disabilities. It should be incorporated into the math curriculums, not replace current curriculums. Technology and games can increase motivation in math. The findings suggest future investigations into the use of computer games in math.

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