The Impact of Intervention Software on Student Achievement in Mathematics

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Abstract

In a Multi-Tiered System of Support (MTSS), at-risk students struggling to meet standards receive instruction in addition to the core instruction received by all students. These struggling students are classified as receiving Tier 2 or Tier 3 interventions (Technical Assistance System Network, 2018). The purposes of this study were to determine the extent Tier 2 and Tier 3 high school students using the MATHia intervention program grow fall to winter and winter to spring, as measured by the change in the Northwest Evaluation Association (NWEA) Measures of Academic Progress (MAP) mathematics score; the extent there is a difference in these students' program growth between males and females, between students with a free/reduced lunch status and those without free/reduced lunch status, and between students with a learning disability and students without a learning disability; and the extent there is a difference in program growth, among students with high, moderate, and low utilization of the MATHia software. A quantitative descriptive study was used for this research. The dependent variables were growth scores, which were calculated from the NWEA MAP mathematics fall, winter, and spring assessment scores. The independent variables were student gender, socioeconomic status, learning disability, and the amount of time spent using the MATHia program.

The results of the analysis indicated that overall student academic growth in mathematics did increase as a result of the MATHia computer software program. Of the variables tested, there was not a significant difference in the effectiveness of the intervention program with the exception of usage. Students who utilized the program more often showed greater academic growth in mathematics.

The results from this study have implications for district personnel who are considering the purchase of the mathematics intervention software programs for all students. The impact of mathematics intervention software could improve overall academic achievement for students who are at-risk. Recommendations for future research include comparing another software program using the same methodology, conducting the same study to include additional variables or evaluate student growth and student movement between tiers. The current study could also be conducted as a mixed methods study.

Dedication

This final step in capturing my dream I dedicate to my loving family. My husband, who did not say much about my decision, showed support each day and night by keeping the home ship afloat. You were both mom and dad when I so badly wanted to be there. I would not have been able to do this without you. To my sweet babies, I thank you for your patience and love and look forward to you calling me "Dr. Mommy" as you all say you are going to. I pray that one day you will be encouraged to do hard things too. I will be there to hold your hand and help you! Each of you has so much to give to the world.

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Chapter 1

Introduction

Educators are seeking ways for high school students to improve their academic achievement in mathematics so that students may be successful in their future endeavors. Niederle and Vesterlund (2010) stated that mathematics test scores are an indicator of the future success of students. The researchers also reported that other studies have shown that the extent of scores specific to mathematics performance as an indicator of future success is consistent with their findings (Niederle & Vesterlund, 2010). Finding the right intervention system to assist in improving mathematics scores is important for school districts to determine when considering the financial costs, utilization of effort and time spent on research, planning, and professional development.

The increased use of technology in the educational setting is at the forefront of educational reforms. The presence of technology in education provides teachers and students with an unlimited amount of resources to provide differentiated instruction and more opportunities for learning (Boice, 2000). Technology can be utilized to indicate the specific needs of students and is becoming an essential part of mathematics instruction (Ozel, Yetkiner, & Capraro, 2008). The inclusion of technology and software-based intervention programs has been observed to improve student attitudes toward learning, which could result in positive effects on student achievement (Ozel et al., 2008).

Background

District D is a mid-sized district in the Kansas City Metro area. The Kansas Report Card from the Kansas State Department of Education (KSDE, 2018) included the following district demographic information: 52% of the district student population was male, 48% was female; 8% of the students in the school population received special education services; and 12.5% of the student population of the district was economically disadvantaged.

Included in Table 1 are the percentage of students who scored at level 1 or level 2 on the Kansas Math Assessment from the school years of 2014-2015 through 2016-2017. A level 1 score indicates that a student shows limited ability to be college and career ready. A level 2 score indicates a student is at a basic level of understanding of the mathematical skills necessary to be college and career ready. Levels 3 and 4 indicate that the student is approaching or has achieved the mathematical skills to be college and career ready.

Table 1

District D Percentage of Students Scoring at Levels 1 and 2 on the Kansas Math Assessment

	2014-2015	2015-2016	2016-2017
Female	28	29	30
Male	31	32	33
Low SES	74	74	75
Learning Disability	92	92	91

Note: Adapted from *Kansas State Assessment Data*, by KSDE, November 2018. Retrieved from https://ksreportcard.ksde.org/assessment_results.aspx?org_no=D0232&rptType=2

Through an evaluation of resources for mathematics, district leadership in the Teaching and Learning Department stated the need for a mathematics intervention resource at the high school level to support learning (director of curriculum and instruction, personal communication, July 10, 2017). An opportunity arose to utilize the

Carnegie MATHia program for a year in exchange for the return of surplus mathematics resources the district was not utilizing. Carnegie Learning's MATHia is an intervention software program that continually adjusts to the learning needs of each student. It offers formative assessments that evaluate learning and adjust as needed. The program was not reviewed or selected by teachers prior to their acceptance of the resource. General education math teachers, special education teachers, and at-risk support teachers were trained by a Carnegie Math instructor during a pre-service day in August 2017. Instruction included utilization of the software to differentiate teaching in the classroom and ways to use the software in tiered classes to strengthen mathematical skills and support the current curriculum.

In 2017 District D developed cut scores based on the results of the Northwest Education Association (NWEA) Measures of Academic Progress (MAP) scores (see Appendix A). The MAP is a computer adaptive test that measures student progress and growth over time. The district has utilized MAP to monitor student mathematical growth since 2009 (director of assessment and school improvement, personal communication, October 17, 2018). The NWEA MAP is administered three times per year to district students 3^{rd} through 11^{th} grade.

Statement of the Problem

Results of studies have shown that the gaps in mathematics achievement have become more prevalent in districts by gender, socioeconomic status, and disability (Flores, 2007). District D has also seen a similar trend over the years in data that has been collected on the state mathematics assessments. Some students were entering high school lacking mathematical skills (director of assessment and school improvement, personal communication, October 17, 2018). School districts are searching for ways to reverse this trend as well as remediate the current needs of students at the high school level. One way to evaluate student mathematical growth could be to introduce an intervention program that would both provide remediation and monitor student progress. District D leaders must determine whether to support the purchase of the intervention software program, MATHia. If student growth is evident when disaggregated by gender, socioeconomic status, learning disability, and the amount utilization of the MATHia intervention software at the high school level, then this data might help District D leaders determine whether to purchase the software and possibly influence a similar decision for other school districts.

Purpose of the Study

The first purpose of this study was to determine the extent to which high school students using the MATHia intervention program in Tier 2 and Tier 3 classes grew academically from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score. The second purpose of the study was to determine to what extent there was a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from fall to winter and winter to spring, as measured by the NWEA MAP Mathematics assessment, between males and females, between students with a free/reduced lunch status and those without a free/reduced lunch status, and between students with a learning disability and students without a learning disability. The final purpose of the study was to determine if differences existed in the extent to which high school students using the MATHia intervention program in Tier 2 and Tier 3 classes grew academically from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software.

Significance of the Study

The significance of this study is that it contributes to the literature linked to the understanding of the relationship between an online software intervention program utilized in high school and the improvement in student mathematics achievement on criterion-based tests. With the increase of computer software being implemented in schools, it has been difficult for districts to determine whether the use of the software affects student academic growth. This study is important to education and District D because it could provide insight into the effectiveness that the intervention software has on student achievement in tiered mathematics classrooms. School districts could also use the information from the results of the study to determine if the purchase would be worth the expenditure.

Evaluating the effectiveness of an intervention program focusing on the academic growth overall and whether gender, socioeconomic status, disability status, and the time students utilize the software affects students' mathematics growth could provide more definitive data to use in the decision-making process. It may help to direct district leaders in the decision about investing district time and monies to prevent loss of financial resources. The outcome of this study could direct the final process of selection of the mathematics intervention software and inform other districts' decision-making.

This study also contributes to the literature an understanding of how a technology-based mathematics intervention can influence mathematics standardized test score growth for at-risk high school students. Throughout the study of literature, various researchers suggest that student variables influence mathematics achievement and learning. Upon completion of this study, a further understanding of the variables in relation to the technology-based software could be available.

Delimitations

The delimitations utilized by the researcher in this study were needed to focus on the effectiveness of the intervention software. This study was limited in the application of results for those who may be seeking similar information regarding comparable intervention programs.

1. The setting of this study was one medium-sized suburban school district in Northeast Kansas.
2. The participants included high school general education students who were at risk in mathematics and were receiving Tier 2 or 3 interventions in mathematics and special education students with learning disabilities in mathematics. These students used the MATHia program during the 2017-2018 school year.
3. Mathematics growth on the NWEA MAP from fall to winter and winter to spring during one school year was utilized as the measure of mathematics achievement for each participant.
4. Three student demographic characteristics were used in data collection: gender, socioeconomic status, and learning disability.

Assumptions

According to Lunenburg and Irby (2008), assumptions are "postulates, premises, and propositions that are accepted as operational for the purposes of the research" (p. 135). This study operated under the following assumptions:

1. All teachers instructing tiered classes received professional development on the MATHia intervention program.
2. The teachers delivered the MATHia program with fidelity.
3. The students were all fully engaged in the MATHia program.
4. The students applied full effort on the assessments.
5. The NWEA MAP Mathematics assessment is a valid and reliable measurement of student mathematics achievement.

Research Questions

The primary query guiding this study was to determine the effect of the intervention program, MATHia on Tier 2 and Tier 3 high school students' academic growth. The following research questions were written to address the purposes of the study:

RQ1. To what extent do Tier 2 and Tier 3 high school students using the MATHia intervention program grow fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score?

RQ2. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between males and females?

RQ3. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with free/reduced lunch and students without free/reduced lunch?

RQ4. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with a learning disability and students without a learning disability?

RQ5. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software?

Definition of Terms

Lunenburg and Irby (2008) recommended that terms that are important to the understanding of the study should be provided to present a common understanding. The following key terms are defined for this study:

At-risk students. The term, at-risk students,

> is often used to describe students or groups of students who are considered to have a higher probability of failing academically or dropping out of school. The term may be applied to students who face circumstances that could jeopardize their ability to complete school, such as learning disabilities, low test scores, disciplinary problems, grade retentions, or other learning-related factors that

could adversely affect the educational performance and attainment of some students. (“At-Risk,” n.d.)

Individualized Education Plan (IEP). Pretti-Frontczak and Bricker (2000) defined an IEP as a document that is developed for children who need special education services. The plan specifies the individualized objectives of a child who has been determined to have a disability or requires specialized accommodations as defined by the federal government.

Learning disability (LD). KSDE (2019) defined LD as “A disorder in one or more of the basic psychological processes involved in understanding or using language, spoken or written, that may manifest itself in an imperfect ability to listen, think, speak, read, write, spell, or do mathematical calculations” (p. 49).

Low socioeconomic status (SES). A student whose combined family income is below a state-determined cut off is indicated to be of low socioeconomic status (Dietrichson, Bog, Filges, & Klint Jorgensen, 2017).

Measures of Academic Progress (MAP). NWEA (2016a) states that the MAP is a computer-adaptive assessment that measures student progress and growth over time. The assessment measures growth in reading, language usage, and mathematics.

Multi-Tiered Systems of Support (MTSS). The Technical Assistance System Network (2018) defined MTSS as a systemic, continuous improvement framework in which data-based problem solving and decision making is “practiced across all levels of the educational system for supporting students” (Technical Assistance System Network, 2018, p. 37).

Rasch UniIT (RIT) score. The score is a stable equal-interval vertical scale established by the NWEA to help educators understand every student's current achievement level (NWEA, 2016b). A score that indicates the level of question difficulty a given student can answer correctly about 50% of the time is defined as a RIT.

Tiered support class. Shapiro (2018) defined tiered support class as a model in which "the instruction delivered to students varies on several dimensions that are related to the nature and severity of the student's difficulties" (p. 2). Tier 1 instruction is evidence-based and embedded in the core instruction (Technical Assistance System Network, 2018). Tier 2 is delivered through targeted small group interventions, and frequent progress monitoring is utilized to guide intervention design. Tier 3 provides intensive, individualized, and customized skill interventions for students. Frequent progress monitoring guides intervention design.

Organization of the Study

This study is presented in five chapters. Chapter 1 included the background statement of the problem, the purpose of the study, the significance of the study, the delimitations, assumptions, research questions, the definition of terms, and the organization of the study. Chapter 2 reviews the historical overview of mathematics interventions, the history of software usage, reviews of Carnegie MATHia, the effects of demographic variables on intervention software, and the usage of the intervention programs. Chapter 3 includes the research design, selection of participants, measurement, data collection procedures, data analysis and hypothesis testing, and the limitations of the study. The results of the data analysis are presented in Chapter 4. The last chapter includes a study summary, findings related to the literature, and the conclusions.

Chapter 2

Review of the Literature

Improving mathematics achievement and other educational outcomes could depend on how schools utilize technology and the interventions associated with it in order to increase academic growth for all students. It is imperative an intervention software is effective, but especially so in assisting students who struggle academically in mathematics to minimize the learning gaps and provide for future academic gains. This chapter includes a review of the historical overview of mathematics interventions, the history of software usage, reviews of Carnegie MATHia, the effects of demographic variables on intervention software, and the usage of the intervention programs.

Historical Overview of Mathematics Interventions

Monaghan, Trouche, and Borwein (2016) stated that an educational intervention is a set of steps or program that will assist in helping a child improve in an area of academic need. As a part of the intervention process, the steps are prescriptive to the needs of each student. These interventions that are scheduled to be a set number of weeks or months are revisited and adjusted at periodic points throughout the intervention process.

Mathematics education became a national focus in the 1950s and 1960s during what Kilpatrick (1992) would refer to as the golden age in the field of mathematics. Colleges and universities were concerned with the lack of knowledge and understanding that was shown by incoming students. Their lack of knowledge in computational conceptual understanding and the ability to apply the knowledge was alarming (Jones & Coxford, 1970). The "new math" movement in the 1960s included a framework for helping students understand math by utilizing interventions that had not formally been used before this time. Strategies known as interventions were introduced to educators to improve learning of educational concepts. Riedesel (1967) introduced the idea of teachers guiding the learning that would take place, much like the way teachers utilize scaffolding literacy. The process involved the presentation of the problem and then working with students struggling with the concepts on a one-to-one basis during class time. Students were asked to create diagrams or explanations to process through the problems. Discovery Learning involved small-group and whole-class discussions. The emphasis for the teacher was not the mathematical content, but the ability to ask the right questions of the students so that they were able to work through the problem (Riedesel, 1967). Use of a precise vocabulary and discovery learning were the first recorded mathematical interventions utilized (Lagemann, 2000).

In the 1960s, students were tested and evaluated by clinicians to determine cognitive delays and learning disorders in children. Students who were deemed to have learning deficits were then provided remediation. This remediation could range from visual-motor perceptual training to task analysis (Haring & Batemen, 1977). Glennon and Wilson (1973) shared some intervention techniques during this time period. Their approach to intervention included the “use of manipulatives, pictorial representations, and the student’s cultural or ethnic background” (Glennon & Wilson, 1973, p. 285). Most of the techniques were more effective with students who were more severely cognitively delayed than with students who had mild learning disabilities.

The 1960s new math failed as a result of abstract teaching methods for K-12 teachers. The movement involved the creation of new instructional materials and curriculum reform. Teachers were unable or unwilling to learn and properly provide the interventions that were to be implemented (Moon, 1986). The failed movement was the primary circumstance that led to the establishment of the National Institute of Education in 1972 (Good, Grouws, & Ebmeier, 1983). The organization focused on the relationship between classroom teaching and student achievement outcomes during the 1970s and 1980s. Educators focused on an understanding of basic mathematical skills that were taught to students. The Institute then developed standardized tests to begin evaluating teaching behaviors and interventions that directly improved performance on the tests. A model of effectiveness for mathematics teaching was specific and directed yet allowed for teaching a number of students with different academic abilities in the classroom, thus the beginning of differentiation in the classroom (Good et al., 1983).

Following the new mathematics teaching movement, direct instruction was a successful intervention that was utilized that supported the curricular component (Anderson, 1990). Small groups of students were taught using specific instructional materials that prescribed exactly what teachers or paraprofessionals were to say were utilized with struggling students (Good et al., 1983). The "instruction focused on a careful progression of basic skills in a step-by-step manner based on behavioral theory" (Becker, Engelmann, & Thomas, 1975, p. 16). There were extensive data "that the model provided for a superior method for teaching subjects like arithmetic to students who were at-risk" (Becker, 1977, p. 519).

During the 1980s, Silver (1987) influenced mathematics instruction and interventions in education. Problem solving became a new strategy in information processing that was effective for raising student academic achievement. Students were attempting concepts of organizing “information in long-term memory, the role of visual images in enhancing understanding, and the importance of metacognition in the problem solving process” (Silver, 1987, p. 37). This concept of problem solving was continued into the mid to late 1980s.

During the late 1980s and early 1990s, the constructivist theory of learning was the focus of researchers. Anderson (1990) stated that new knowledge is built in the mind by the learner. Again, this change in intervention approaches from the scripted resources to the problem and solution style model for students improved student academic achievement. Emphasis was primarily placed on “strategy instruction, direct instruction, or curriculum-based measurement as an intervention for students who were struggling with mathematics” (Anderson, 1990, p. 41).

Goldman (1989) introduced a review of effective problem-solving intervention strategies for students with learning disabilities. The intervention strategy review focused on general and task-specific strategies. Goldman shared that the most effective problem-solving interventions were self-instruction strategies, mediated performance, and strategy instruction in word problem-solving.

Lave (1988), a constructivist researcher, shared that facts, procedures, and concepts were simply not remembered out of context. Cultural context impacts a student’s ability to learn and understand. Culture and society continue to influence mathematical learning and instruction. The researcher’s studies of teaching were based on contextual learning which included “teacher thinking, pedagogical content knowledge, and student attitudes and beliefs” (Lave, 1988, p. 17). In 2000, researchers Kelly and Lesh agreed with Lave’s conclusions based on their own research on contextual learning.

The researchers also determined that successful interventions are related to much more than the interventions alone.

Gersten and Baker (1998) tried to create a systematic method of teaching mathematics that shared values of both behaviorism and social constructivism. The researchers shared that highly algorithmic methods for performing basic operations on fractions could be presented for an extended period of time, which is a behaviorist approach. Once students master the algorithms, the teacher could then shift to constructivist methods for problem solving. The method has been successful for students who are at risk or have a learning disability. Intervention strategies returned to the structured step-by-step methods and highly directed instruction. The researchers desired clear communication in the delivery of the strategies.

In 2004, the Response to Intervention (RTI) (Fuchs, Fuchs, & Zumeta, 2008) process was introduced. The process was presented as a method to identify students with learning disabilities. RTI strategies were then utilized with the identified students. These interventions focus on the skill that is not being learned and can be delivered in the regular education classroom, which is considered a Tier 1 class setting. Depending on the skills needed to be successful, a student could receive interventions in a Tier 2 or Tier 3 classroom setting, away from their peers. A Tier 2 setting is where interventions for students can become more intensive because students are at greater risk of failure. Typically, 15% of students receive interventions at Tier 2. A Tier 3 setting is where interventions can also be delivered to general or special education students. Only 5% of students receive interventions at Tier 3. Through regular evaluation and communication with a team, teachers can determine if more or less intense interventions are necessary or if there is the possibility of a specific learning disability (Special Education Guide, 2018). In 2018, RTI is currently the standard practice for interventions in most school districts.

History of Software Usage

Technology and technology software has been a formal part of educational instruction and learning since the 1970s. David Cohen (1988) stated that technology was beginning to shape students' lives and the way they think. Technology supports encourage meaningful student involvement that is authentic and challenging to the student (McCoog, 2007). As the world has evolved and technology has improved, teachers continue to review the advancements that inspire and lead to student learning. The majority of the research reported in this section provides the background and history of mathematics software programs.

In the 1970s and 1980s, during the age of the information processing theory of education, it was discovered that "computers were instrumental tools for modeling human thought processes. Cognitive scientists used computer simulations, in-depth qualitative studies, and small-scale experimental studies to investigate the processes behind mathematical understanding" (Brown & Burton, 1978, p. 159). This experimentation led to the discovery of using artificial intelligence computer programs for determining student concept weaknesses (Riley, Greeno, & Heller, 1983). These were the first attempts in the cognitive mathematics era.

Videodisc technology was a frontrunner in intervention software during the 1980s. It had large storage abilities that could provide a systematic and consistent approach to classroom instruction. The teacher was able to share entire lessons to the whole class from a television and videodisc player. Software intervention developers were able to provide direct instruction using technology-based media (Good et al., 1983).

Hasselbring, Goin, and Bransford (1988) introduced a software program for teaching math facts with an automated approach. The experimental program was called Fast Math. The computer software program "pretested students on known facts, built on their existing knowledge of facts, taught facts in small instructional sets, used controlled response times to reinforce automaticity" (Hasselbring et al., 1988, p. 2). The program also combined past practices within the new skills that were being taught. The results of the posttest revealed the program successfully developed the recall of basic math facts.

Kulik and Kulik (1991) examined the effectiveness of computer-based instruction. The review was a meta-analysis of findings from 254 controlled evaluations of computer-based instruction. Learners from kindergartners to adults were appraised. At the end of each assessment that was performed, the researchers filled out a course evaluation form. The researchers reported that the classes of students had been divided into experimental and control groups. One group of students utilized computer-based instruction and the other was the control group, receiving conventional methods only. The researchers determined from the data collected that computer-based instruction raised student examination scores by 0.03 standard deviations (Kulik & Kulik, 1991).

Sandholtz, Ringstaff, and Dwyer (1997) released the results of a 10-year longitudinal study by five Apple Classrooms of Tomorrow. They investigated how the use of technology could benefit teaching and learning when utilized by both students and teachers. Sandholtz et al. (1997) found that there were positive effects when teachers utilized technology with other teaching strategies. Technology itself became an intervention for students as they exhibited more initiative, independence, and desire to perform to expectations. The authors concluded that the use of technology with other teaching strategies was successful because it suggested alternative ways of learning.

Schwartz and Beichner (1999) created a learning series curriculum for teachers that focused on the uses of technology in the classroom setting. Included as a part of the software were materials for every major curriculum area and ideas to utilize technology as a resource for intervention. In 1999, the belief that computers could be used as tools that could alter the way subjects were taught was shared in the education world. The curriculum provided sample lessons, studies, and integration strategies for education. Professional development was included with the series curriculum. Follow-up on the programming determined it was a successful step in integrating computer-assisted instruction into classroom settings.

Continued reviews of technology usage in the classroom in the 2000s described promise for increased depth of knowledge and effectiveness of addressing individual needs of students. Software systems continued to advance to raise mathematics competency (Simkins, 2006). Software programs began to be produced, evaluated, and pursued by educational institutions to increase mathematics success for students.

Hannafin, Burruss, and Little (2001) examined traditional teacher-led geometry instruction in conjunction with another computer-based program, Introduction to Geometry. This program provided the student and teacher with feedback, instruction, and examples to cover the learning targets. Students who actively engaged in the computer-based program as an intervention in addition to traditional teaching strategies reported further understanding of geometry and felt more successful.

Another angle that has been researched in connection to computer-based software interventions in mathematics is the concept that students who were given the opportunity are able to monitor their speed and accuracy. Xin (1999) researched this idea by integrating computer-assisted cooperative learning in diverse classroom settings. Three suburban and urban area schools and 118 students with learning disabilities and 25 students without learning disabilities were included in the study. Either cooperative learning or whole group instruction strategies were employed. Three commercial computer software packages were utilized in which each included a focus on concepts, computation, application, and problem-solving skills. Xin (1999) determined there were gains for students regardless of gender, socioeconomic status, or learning disability in the technology-assisted instructional classroom.

In 2002, The Geometric Supposer software, which was published in 1993, was introduced to a group of students. The software exposes students to visual and numerical data that the student can apply to shapes and make a basic construction. The student can then utilize the shape to construct points, segments, circles, parallels, perpendiculars, angle bisectors, and extensions of line segments. Funkhouser (2002) executed a study that allowed students to construct commonly taught geometric concepts. The study involved a sample of 49 participants in tenth- or eleventh-grade who were enrolled in a geometry course. A pretest was administered and then compared to a test that was given after the students had utilized the software. Students who were instructed through a combination of the constructivist approach to teaching and use of computer-augmented activities were more successful in the knowledge of geometry concepts when compared to those who experienced a more traditional approach to geometry instruction as determined by a posttest.

Ysseldyke, Thill, Pohl, and Bolt (2005) analyzed the usage of Math Facts in a Flash by Renaissance Learning (2003) to determine if the software did increase computation fluency. All students in third- through twelfth-grade from 13 schools across the country participated in the study. From October to May, Math Facts in a Flash was utilized by 2,169 students. From January to May, 2,055 students used the intervention software. The teachers followed a prescribed utilization schedule of 5-15 minutes a day for each student. Students answered questions at the end of each session and teachers monitored the progress. The computer software kept track of the time spent using the software, the number of questions asked, the results of sessions, levels the student mastered, and the level range for each student. Ysseldyke et al. (2005) determined that students who used Math Facts in a Flash for a year had significantly more academic growth than those who used the software for only half the year.

Moyer and Reimer (2005) performed a study based on the concept of using virtual manipulatives created through computer applets. Students who were involved in the study were not only at-risk but were also students with an IEP for a deficit in mathematics. For a pretest, students utilized physical manipulatives. The posttest students utilized the virtual manipulatives available through the applets. Data from the pretest and posttest showed that 10 of the 19 students improved their scores. The results indicated that the manipulatives helped more than half of the students to increase their assessment scores and understanding of manipulatives. Moyer and Reimer (2005) determined that students demonstrated academic growth while using the software.

In 2007, research on SimCalc Math Worlds, one of the pioneering examples of mathematics software, showed the most effective evidence of gains in student learning at that time. SimClac Math Worlds encourages students to utilize exploration techniques to learn mathematical functions through an online platform. The teacher is able to communicate with the student to share immediate feedback. Students can use concrete visual representations and graphs that they can manipulate to determine answers to the proposed problems. Students were more motivated and enjoyed the individual learning they experienced as a result of being connected directly to the teacher through the program (Trotter, 2007). Students who were not confident in their abilities felt more comfortable to ask anonymously for assistance, making this an intervention that provided safety for those students who struggled.

A study comparison between paper and pencil and a computer-based practice was conducted in 2007 by Wong and Evans. The study setting was Sydney, Australia. The participants were a group of 67 students of which 37 students completed instruction using paper and pencil, and the other 27 students received computer-based instruction. Students worked independently and then completed tests to evaluate progress in the mathematical recall of multiplication facts. Wong and Evans (2007) determined in this case that the paper and pencil student group showed more academic growth than did the students who received the computer-based instruction because they were able to retain the increase for at least four weeks after the termination of the program.

Dresel and Haugwitz (2008) conducted a study that was based on a computer-based mathematics program, MatheWarp. The creators claimed it would help provide students with motivation and knowledge acquisition. A total of 151 sixth-grade students in Germany volunteered. They were randomly assigned one of three variables: placebo, attributional feedback, or attributional feedback enriched with metacognitive control questions. Dresel and Haugwitz (2008) concluded that the use of a computer-based mathematics program, along with feedback, effectively motivated and increased knowledge acquisition in students in comparison to exclusive attributional feedback.

Biesinger and Crippen (2008) evaluated a computer-based program for mathematics. It was introduced in Nevada to increase student's proficiency on the Nevada State High School Proficiency Examination in Mathematics (NHSPEM). Access to the intervention software was given to all students who failed the NHSPEM for use in and out of the classroom. Students were also supported by the teacher in addition to normal classroom instruction. Ten schools in Nevada participated in the pilot study through a grant the state education system financed. The findings from the study indicated that those who used the software were more successful on the NHSPEM than those who did not use the software.

Reynolds (2010) conducted a study to determine if the use of a flashcard computer software would be effective for students. The researcher utilized an experimental design to determine the treatment effects of remediating math fact difficulties. Student participants were assigned one of two groups, the control group or to be a participant in the flashcard intervention. Data was collected and compared on math fact acquisition, fluency, and retention at multiple points. The results of the study over the flashcard software supported the concept that

> computerized math fact intervention's effectiveness in increasing math fact fluency on average for all students was successful. The intervention was effective

> at increasing accuracy and retention of math facts in low achieving students. Students in the computerized flashcard intervention group reported enjoying the intervention more than students in the control intervention, as well as had significantly higher perception of their math abilities. (Reynolds, 2010, p. 43)

Once again, the use of software to increase math fact fluency yielded higher levels of learning than traditional models.

Li and Ma (2010) conducted a systematic review of the literature in which they studied the effects of computer technology on school students' mathematics learning by utilizing a constructivist approach. From their study of 36,793 learners, which was a collection of 46 primary studies, Li and Ma determined that there was a positive statistically significant effect of computer technology on mathematics achievement. Additional results of the study showed that computer technology was more effective for elementary students than middle or high school students, and it was more effective for students with special needs when compared to general education students. When computer technology is coupled with a constructivist approach to teaching, the data collected showed student growth. Using technology, mathematics achievement was evident as a result of the intervention (Li & Ma, 2010).

Harris (2011) conducted a study to determine the impact of an integrated learning system on students who were considered at-risk of academic failure on the Texas Assessment of Knowledge and Skills (TAKS) mathematics assessment. The study sample included 1,676 ninth-grade students in Algebra 1 from a large north Texas suburban school district. Students who were considered at-risk were also enrolled in a remediation math lab class in addition to the Algebra 1 class. The learning system

VMath Voyager was used with the students in the math lab class. Data from the TAKS was utilized to determine if there were any differences in student achievement among the groups. Harris (2011) found that “the remedial math lab class students had statistically significant growth on the 2010 mathematics portion of the TAKS test as determined by the Texas Growth Index (TGI)” (p. v). However, it did not show enough academic growth in one school year to pass the mathematics portion of the TAKS test. Students in the Algebra 1 course who were not enrolled in the math lab course showed typical growth.

Townsend (2012) utilized data from the Education Longitudinal Study of 2002 to investigate the relationships among teachers’ participation in professional development in technology, the use of computer technology in mathematics classes, and differences in student mathematics achievement and use of computers between males and females. The purpose was to examine computer technology as it relates to achievement and to explain the extent to which computer technology use in classrooms or at home correlates similarly with achievement for male and female students. The researcher found that

> students whose teachers participated in professional development were more likely to use computers in the classroom. Secondly, the researcher found that the use of computers in the classroom was negatively related to student achievement. Finally, there were interaction effects between student gender and the use of computers to instruct one-on-one and between student gender and the use of computers at home. (Townsend, 2012, p. 3)

The final synopsis by the researcher suggested that the relationship between professional development and technology use in the classroom relates to the use of technology in educational settings. There has been a varied connection between computer use and the effectiveness on student achievement based on how computers are used. Townsend (2012) also stated that there are some gender differences in the relationship between computer use and achievement.

In 2013, Cheung and Slavin completed a meta-analysis of 74 studies related to the "educational technology applications for enhancing mathematics achievement in K-12 classrooms" (p. 89). The researchers discovered that educational technology produced a positive effect on learning for students. Computer-management learning, comprehensive programs, and computer-assisted instruction were the types of educational technology reviewed in the study. Of the three types, computer-assisted instruction had the largest effect on student learning. The results of the investigation showed no proof that there is a relationship between educational technology application and features associated with the program.

Ramsay (2014) investigated the effectiveness of technology-integrated instruction effect on high school students' mathematics achievement scores. The study population was a ninth-grade Algebra class in a public school district. Students utilized Study Island, a "commercialized web-based program, customized to specific state standards and applied as a supplemental instructional tool" (p. 3). The purpose of the study was to determine the effectiveness of Study Island with general education students to conclude if it was useful in replacing traditional mathematics instruction. A nonequivalent pretest-posttest quasi-experimental design was utilized to measure student mathematics achievement between the experimental and control student groups. The experimental group consisted of 28 students who participated in the technology program. The control group of 28 students did not participate in the technology program. The study occurred over 10 weeks, with 90 minutes of daily mathematics instruction. Ramsay (2014) determined that the use of Study Island influenced the mathematics assessment scores of the experimental student group.

Rich (2016) studied the use of Study Island supplemental math software and third-, fourth- and fifth-grade students' mathematics achievement in a Title I public elementary school in Georgia during the 2011-2012, 2012-2013, and 2013-2014 school years. Data were collected and analyzed to determine the relationship between the use of the software and students' math achievement. The results of the study did not show a significantly significant relationship between the use of Study Island supplemental math software and students' math achievement. Rich conjectured the results might have been caused by faults in the software or an incomplete implementation of the software at the school.

Researchers have concluded that the use of mathematics intervention software is effective for student growth. The primary emphasis in the literature has been student engagement and interest in utilizing technology in the learning process. Secondly, student confidence has increased because of interest and factors embedded within individual programs like anonymity and direct instruction. Intervention software has progressed throughout its existence and continued to evolve to support the needs of students.

Reviews of Carnegie MATHia

Limited research on the mathematics software program by Carnegie Learning, MATHia, has been conducted because of the short time it has been available. The software was released in 2011 as Carnegie Learning's middle school mathematics product. The product was created to provide a "hyper-personalized" intelligent tutoring architecture to tailor to the learner interest outside of the classroom. It is an adaptive software program that presents problems based on cognitive factors, probability, and learner interests (Ritter, Sinatra, & Fancsali, 2014).

Ritter (2011), a Carnegie Learning cognitive psychologist, stated that "their approach to instruction is based on cognition and motivation" (p. 4). Carnegie has confidence that

> students who believe they can get smarter will work harder. The program provides feedback that is focused on success to reward effective learning behaviors. Expectations about performance that reflect stereotypes can lead to anxiety, reduced mental capacity, and diminished performance. (Ritter, 2011, p. 5)

Learning research was applied to incorporate a large variety of activities and approaches that represent decades of research in instructional strategies (Ritter, 2011). Active learning, tasks focused on problem solving, mixed examples of work samples, and fluency tasks are major components of Carnegie's instructional approach. These strategies drive the learning component of the software.

Researchers for Carnegie found "that students' beliefs about the nature of intelligence, their goals within a learning task, and their perception of expectations about them have strong effects on their academic performance" (Ritter, 2011, p. 5). Dweck (1999) described students as having a relatively fixed theory of intelligence. Through the use of Carnegie MATHia, students are encouraged to go beyond their fixed mindset to achieve further goals. Elliot (1999) “emphasized how students’ goals in a learning task affect their performance” (p. 170). For most, a fixed goal “can give students a clear focus, which results in better immediate performance” (Elliot, 1999, p. 181).

An evaluation of the data collected from 240 students using Carnegie MATHia during the 2013-2014 school year was performed. The Miami-Dade County Public schools provided information each quarter to Fontana, Beckerman, Levitt, and Levitt (2014) about their Florida Comprehensive Assessment Test scores and course grades. Sharing of the data was done to address three issues of concern the school district was having regarding mathematical development. A “lull in mathematics achievement, high rates of failure in Algebra 1, and a high number of average students resulting from the State of Florida’s mandatory third retention policy” (Fontana et al., 2014, p. 2) was seen. MATHia software summarized each student’s cumulative activity on the Carnegie MATHia software by the number of skills encountered by the student and the percentage of skills mastered by the student. The quantitative findings showed that, although the difference was not statistically significant, incorporation of Carnegie MATHia software was related to increased academic performance on both the Florida State Standardized Math Assessment and Algebra End-of-Course tests compared to previous years (Fontana et al., 2014).

Fancsali and Ritter (2014) reviewed software programs for the Fourth International Conference on Learning Analytics and Knowledge. The review that the researchers shared of MATHia was that the program is focused on personalizing word problems as a strategy. In their evaluation of MATHia, they determined that students were more invested in the program when they personalized the problems as compared to programs which did not do so. The researchers concluded that the opportunity for personalization allows students to feel more engaged with the activities, thus providing for deeper learning to occur.

Effects of Demographic Variables on Intervention Software

Discussion of the demographic variables as related to instructional software might provide additional information to be considered in the use of Carnegie Learning's MATHia software product. Determining interventions that are effective for students regardless of gender, socioeconomic status, or learning disability is a desired outcome that could assist in closing the achievement gap.

Gender. Differences in achievement and learning based on gender is suggested in the literature. Mathematics ability differences based on gender begin to appear at the elementary level and with each grade, continue to increase. "The bulk of the evidence in the past 50 years suggests that the gender gap in mathematics does not exist before children enter school but is significant in the middle school years and beyond" (Fryer & Levitt, 2010, p. 57). "The gap between boys and girls seems to increase in high school, whereby the twelfth-grade males show very significant advantages over females of the same age in mathematical achievement tests" (Rosselli, Ardila, Matute, & Inozemtseva, 2009, p. 218). Studies focused on the use of technology interventions have shown different results on achievement by gender. This statement would suggest that analyzing interventions to consider that relationship as a part of the study is necessary to determine the effectiveness of gender as a variable (Fryer & Levitt, 2010; Rosselli et al., 2009).

Software intervention programs sometimes tend to be more engaging to one gender over the other. Hodes (1995) reported that 41.7% of the programs evaluated had characters whose gender was identifiable. Only 12.5% of the characters were female in the programs that were reviewed in the study. When female characters are utilized, they are shown in traditional female roles. Hodes suggested that continued research be conducted to evaluate the effects of gender roles and the utilization of them in mathematics software.

Carr and Jessup (1997) reported on the gender differences that are notable in the development of skills and knowledge within the context of computer instruction. In early October, early January, and early May, 58 first-grade students in elementary schools in suburbs of Georgia solved addition and subtraction problems in groups. The students were then assessed individually. Gender differences were found. The results indicated that first-grade boys might be driven to be more competitive in the classroom because of the competition factor thus encouraging them to learn more complex strategies that are necessary for computer use. Boys are more likely to use recall strategies such as memorization. First-grade girls are more likely to count on their fingers.

Chanlin (1999) examined the relationship of visual controls and gender in learning through scientific multi-media instructions, navigation, and visual information of processing of boys and girls. Two types of visual controls (self-controlled vs. system-imposed) were compared in conjunction with the student's strategy use. A total of 20 male and female students in middle school were tested to determine which educational strategies were most effective for them when the teacher used different instructional approaches and materials. The observation results indicated that students utilized different learning strategies based on their cognitive abilities. Boys used cognitive strategies for processing visual information and showed a significant difference in their problem-solving abilities as compared to girls. Chanlin (1999) concluded that the visual strategies were not significant in the academic progress of girls.

Papastergiou (2009) completed a study on learning effectiveness and motivation appeal of computer games for memorizing concepts. The computer games were designed to learn curricular objectives. The sample was 88 students from a Florida suburb who were assigned to one of two groups. The first group of students used computer games to learn memory concepts. The second group of students was taught with standard teaching strategies. Students were observed during the interventions, and student views were collected through a questionnaire. The results of the data analysis showed that the use of gaming techniques was more effective in improving the memorization of concepts than standard teaching strategies.

Arroyo, Woolf, Royer, Tai, and English (2010) studied the effectiveness of Math Facts Retrieval training as a means to improve student performance on standardized math tests. An additional focus of the study was to analyze the effects the program had in relation to student gender. Throughout one semester, 250 middle school students were evaluated. The final analysis revealed that boys tended to use advanced strategies to problem solve and girls used basic strategies. The use of the software was more effective for males.

Later that year, Arroyo, Woolf, Royer, Tai, Muldner, et al. (2010) reported their findings of another study over an additional computer software program, Intelligent Tutoring System for Mathematics. The sample was 100 high school students from a public high school in Massachusetts who utilized the software. The students were compared to a randomized control group of students. The results indicated that for students in general, and particularly female students, effective pedagogical agents within intervention software improved results.

Socioeconomic status. It is important for educators and researchers to understand the significance of the relationship between low socioeconomic status and low academic achievement. In 2006, Malecki and Demaray estimated that one-fourth of our nation's students might be living in poverty by the year 2020. Students who are of low socioeconomic status are found to have consistently lower GPAs, standardized test scores, reading levels, and more (Conger, Iatarola, & Long, 2009). Finding resources for students who are of low socioeconomic status is important to support this subgroup in schools. Intervention software may be effective in raising the educational achievement level for low socioeconomic students.

Becker (2000) conducted a study that compared economically disadvantaged students and higher socioeconomic students. Only the students in the disadvantaged group utilized the software programs. The students were excited to use the computer-assisted instruction drill and practice computer programs. The researchers reported that computer-assisted instruction would assist in improving mathematical skills for socioeconomically disadvantaged students. The students who utilized the computer-assisted instruction showed improved computation skills based on the improvement shown on the posttest from the pretest.

Myers (2009) completed a study to determine "the effects of the use of technology on students' mathematics achievement, particularly the Florida Comprehensive Assessment Test (FCAT) mathematics results" (Myers, 2009, p. 6). Geometers Sketchpad (GSP) was utilized in 11 schools within the Miami-Dade County

Public School System. Three of the participating schools were randomly selected for the study. Teachers were trained on how to utilize the program during in-service to teach geometry. The teachers' students in their classes were utilized as the sample group. Students' scores were compared based on assignment to the control (no GSP) or experimental group (GSP) as well as SES and gender (Myers, 2009). The researcher found that between the experimental and control groups there was a "significant difference in the FCAT mathematics scores of students who were taught geometry using GSP. No significant differences existed between the FCAT mathematics scores of the students based on SES or gender" (p. 9).

Burns, Kanive, and DeGrande (2012) examined the effects of the computer-based mathematics fluency intervention program, Math Facts in a Flash (Renaissance Learning, 2003), on the mathematics skills of students. A total of 472 third- and fourth-grade students from 26 states and 104 elementary schools were the sample. Of those, 231 students who were at-risk for mathematics failure were the experimental group and 241 students who were not at-risk were included in the control group. Students in both groups were administered a pretest and posttest to measure academic growth. The program was used with the students three times each week for up to fifteen weeks. The difference in growth between the sample receiving the intervention and the control group were compared. Results indicated that the third and fourth-grade students who were in the control group experienced less academic growth than those who were in the sample group. Burns et al. (2012) suggested that the Math Facts in a Flash computer intervention was successful in improving the mathematics skills of students.

Francis (2014) conducted a study using the SuccessMaker Mathematics program that utilized a quantitative non-experimental correlational design using archival data. The study sample was 260 tenth-graders during the 2010-2011 school year who were identified as being academically at-risk for failing the FCAT and of low socioeconomic status. The researcher's focus was to determine the relationship between time on task and the amount of achievement gain after receiving computer-assisted instruction. Francis (2014) determined that the length of time students used the program was not related to the amount of achievement gain.

O'Brien (2014) conducted a quasi-experimental study to determine if computer software could improve math achievement among low socioeconomic students. A pre and posttest was used to measure math achievement. There were 166 students in the sample. The treatment group who received computer-assisted instruction included 94 students. The control group of 74 students received traditional mathematics instruction. According to O'Brien (2014), the control group's scores were better than the computer-assisted instruction group, but not significantly different.

Gilmore (2018) performed a study to investigate the impact of Math 180, a computer-based learning software, on middle school math achievement of students at-risk of academic failure and students of low socioeconomic status. The sample included 83 at-risk middle school students in a public school in southeastern Georgia. Computer-based instruction was introduced as an intervention to increase academic achievement in mathematics. The study used a pretest-posttest control group design. Gilmore (2018) concluded that the use of the Math 180 program did not result in a significant increase in achievement of at-risk students. Gilmore (2018) also concluded that the sample sizes were potentially too small to detect the increase because the power of each of the tests was very low.

Learning disability. Differences in academic achievement and learning disabilities are mentioned in the literature. To understand the impact and effectiveness of the software, the literature review must also include studies which have evaluated the use of technology with students who have learning disabilities. Snow (2002) defined students with learning disabilities as students who have a documented discrepancy between potential and actual achievement. The characteristics of the student include (a) difficulty in computation; (b) short attention span; (c) difficulty in comprehension skills; and (d) poor self-esteem. Waxman, Connell, and Gray (2002) stated that students with learning disabilities competency scores, in general, reflect that students have little understanding of mathematical concepts. The researchers also shared that students with learning disabilities have an even more minimal chance of success. High school teachers have strategies and professional development that assist them in meeting the needs of these students. Computer software interventions may provide an additional form of instruction that will assist in providing an effective strategy for students with learning disabilities.

Okolo (1999) conducted a study comparing a math intervention on a computer with a drill and practice approach to the acquisition of math facts. A total of 41 fourth through sixth-grade students with learning disabilities were the subjects for the study. Okolo reviewed the impact of the drill and practice and the computer software and how the two strategies motivated the students. Three groups were created: drill and practice, computer software, and a control group. The three groups all improved their math facts, but the main finding was that the students in the drill and practice and the software intervention groups were able to acquire the knowledge faster than the control group, which only had teacher instruction. Okolo (1999) concluded that the evidence suggested that the approaches of drill and practice and intervention software are effective in the educational growth of students with disabilities.

Bangert-Drowns and Becker (1999) conducted a study to evaluate the differences in the effectiveness of computer software between learning-disabled students and higher achieving students. The researchers used data from a national survey of fourth through twelfth-grade students. The researchers were focused on academic classes with at least five computers and teachers who have reported an average knowledge of technology. Three-fourths of the teachers incorporated the regular use of introductory software that involved skill-based games. Most of the students were regular users of at least one other type of software besides skill-based games. Other factors analyzed were depth in teaching, block scheduling structures, and teacher philosophies of teaching. The researchers found that computer-assisted instruction and intervention were more effective with lower-achieving and learning-disabled students than with higher-achieving students. The drill and practice instruction, privacy, and immediate feedback and reinforcement associated with software programs were more effective strategies with learning-disabled students (Bangert-Drowns and Becker, 1999).

Studies to examine special education students with learning disabilities were conducted by Becker (2000), Bangert-Drowns and Becker (1999), and Schmidt (1999). These three studies were similar in that the sample involved students with learning disabilities and the variable of computer-assisted instruction. At the end of each of these research studies, the data indicated that the special education students' academic achievement levels were greater with the use of computer-assisted instruction. The researchers also provided information informing educators on the use of educational technology in the classroom for those students who have disabilities. These instructional techniques included the use of drill and practice and tutorials delivered through computer-assisted instruction.

Christensen and Gerber (2000) conducted a study to compare the effects of drill and practice instruction on learning disabled students using two computer games: Plain Vanilla and Alien Addition. These two games were similar except that Alien Addition had auditory components and visual graphics. Students were evaluated on various math topics by a timed written test, oral test, and keyboard test. The researchers concluded that Plain Vanilla was more effective for students with learning disabilities because of the less distractive format of the game.

Miller and Mercer (2000) conducted a study on the effects of intervention software on high school students with learning disabilities. The purpose of the study was to determine whether students with learning disabilities could benefit from a computer software intervention program to comprehend problem-solving techniques. The program had a seven-step strategy for solving word problems; (a) finding keywords in the problem, (b) reading the problem more than one time, (c) determining what you already know, (d) determining what the problem is asking, (e) discovering the unknown, (f) finding a pattern, and (g) observing the problem in real life terms. The data that was gathered showed that seniors with learning disabilities plateaued at a seventh-grade mathematics level. Miller and Mercer (2000) concluded that computer-assisted instruction could help students with learning disabilities.

Fitzpatrick (2001) reviewed Destination Math and surveyed students using the software throughout a semester. Destination Math is a comprehensive K-12 mathematics program that is aligned with state and national standards. The objective of this program is for students to master skills and concepts to solve real problems. Students were included in the study if they were learning disabled and low-achieving eighth-graders. The researcher discovered that Destination Math's choice of activities, multiple formats for learning, and the peer discussions of math concepts with each other increased the students' interest in math. Fitzpatrick's (2001) final evaluation supported that the program motivated the students to enhance learning.

Ridgway, Zawojewksi, Hoover, and Lambdin (2002) conducted a study to determine if computer-assisted math instruction software provided students with learning disabilities individualized and quality mathematics instruction. The focus of the study was to determine how the students using the Connected Math Project curriculum performed on the standards that were aligned with the National Council of Teacher for Mathematics standards. The most important element of the program was to assist in skills practice in areas of deficit. The software contained 24 units. Within each unit were four to seven parts with one to five sets of problems. At the end of each part was an activity. The teachers received professional development prior to implementation. The findings indicated that the computer software program did assist in improved achievement for learning disabled students (Ridgway et al., 2002).

Bottge and Heinrichs (2004) conducted a study of a simulation computer program that focused on word problem-solving. The sample compared two groups of learning-disabled students who had math deficits. They used two different experimental conditions: (a) one group solved word problems via a videodisc and (b) one group received traditional instruction. The results of the study showed that the students who used the videodisc attained scores that were significantly higher than those students who utilized traditional instruction.

Seo and Bryant (2012) studied the computer-based intervention, Math Explorer, focusing on the word problem-solving skills students with learning disabilities. The strategies utilized in the program are metacognitive and cognitive applications for one-step and two-step addition and subtraction word problems. Four students who had been identified by their teacher to have disabilities in mathematics and performance on the state standardized test were the subjects. The sample consisted of one white female student, two male Hispanic students, and one male African American student (Seo & Bryant, 2012). Students were moved to a quiet space to receive the intervention. The researchers provided both computer-based and paper and pencil tests for the screening, baseline, intervention, and follow-up assessments. Word problems were taken from the Math Explorer software. Eighteen problems were chosen, and students were given 10 minutes to complete the assessment. The problems were one- or two-step addition or subtraction problems. All students scored below 30% on the screening assessment. After the screening, baseline data were collected weekly until a consistent baseline was determined. At that point, computer training was conducted to begin preparing the student for the intervention software (Seo & Bryant, 2012). The computer-based intervention was based on a four-step strategy for completing word problems. Each four-step strategy contained a three-step metacognitive strategy that students learned. The intervention program engaged the student in academic goals, explicit modeling, guided and independent practice, prerequisite math skill review, vocabulary skill review, visual representations, feedback, and a text-to-speech function (Seo & Bryant, 2012). The four subjects completed up to five intervention sessions per week. Students spent 20-30 minutes using the software, which was followed by a ten-minute computer or paper-based assessment. After the intervention, follow-up was presented once per week to evaluate the maintenance of skills (Seo & Bryant, 2012). The results indicated that there was an immediate increase in academic achievement for all participants. The students exceeded the criterion level on both the computer and paper-based tests. On the follow-up assessments, three of the four students maintained their academic skills. Seo and Bryant (2012) determined that computer-based instruction was effective for improving the addition and subtraction word-problem-solving performance of students with math difficulties.

In conclusion, the literature provides evidence that software programs are an effective intervention strategy for students who have learning disabilities in mathematics instruction. Keeping up with classroom instruction is difficult for students with learning disabilities (Gersten et al., 2009). Students with learning disabilities have found success in self-paced computer-assisted instruction.

Usage. The usage of computer intervention software and its effects on student achievement is also a factor to consider. Jarrell (2000) stated in his study that time with technology does have varying effects on student achievement. The study consisted of seventh- and eighth-grade students who had one-to-one technology access for a semester. During the second semester, the ratio of computers to students was 1:2. Jarrell studied the achievement gains between the semesters in math and reading. There was not a control group. Achievement gains were compared between males and females. Significantly better scores occurred with males with less computer access. Female students with unlimited technology access scored significantly better with unlimited computer access and significantly poorer with limited access (Jarrell, 2000).

Norris, Sullivan, Poirot, and Soloway (2003) researched how the amount of time utilizing computer software affected reading and mathematics achievement outcomes. They created the Snapshot Survey. It evaluated the current position of educators on the appropriateness and effectiveness of technology for children. Large and small district teachers around the country took the survey, totaling 4,000 teachers. The survey included questions that connected to motivation and test scores as related to computer usage for academic purposes. The researchers found that motivation and test scores of students improved with increased time on software programs.

Taepke (2007) studied the effects of student usage of Destination Math on Algebra students. Over three years, 1,452 students and six teachers were involved. The study begun in 2002. Usage during the first year of the program was classified as seldom used. Each year, time on the program by students increased as directed by the classroom teacher (Taepke, 2007). Over the three years of the study, students who utilized the mathematics intervention software more received higher grades in Algebra I (Taepke, 2007).

Kajamies, Vauras, and Kinnunen (2010) conducted a study with eight students who struggled with mathematical word problem-solving skills. The researchers combined intensive, systematic, and explicit teacher scaffolding in the cognitive, metacognitive, and motivational activities involved in the word problems in a computer-supported adventure game. The results from the pretest, posttest, and follow-up test indicated that the eight students showed gains in word problem-solving abilities.

Bruse-Simmons (2013) conducted a study to examine the impact of computer-assisted instruction in mathematics on underachieving fifth-grade students in a rural school district in South Carolina. The sample included 449 fifth-grade students from eight public schools in the school district. During the academic year of 2011-2012, students participated in the Study Island Academic Assistance Program. Student data from their scores on the Palmetto Assessment of State Standards (PASS) Test in Mathematics was utilized. The scores on the achievement test were collected three times: at the beginning of the study, five months later, and one month after the PASS test (Bruse-Simmons, 2013). Participants were divided into two groups, those who scored above standard on the PASS test and those who scored below standard on the PASS test. Students who were in the below standard group participated in two or more computer-assisted instruction labs a week. The above standard group utilized the program once per week. Bruce-Simmons (2013) concluded that the results yielded no significant difference in academic growth in mathematics for those students who attended the computer lab once per week. There was a significant difference in academic growth in mathematics for those students who attended two or more times a week.

Woody (2013) conducted a study with the intent to evaluate "the impact of a web-based mathematics program, Education Program for Gifted Youth (EPGY) Stanford Math, on mathematics achievement of 25,000 fourth- through eighth-grade students in a metropolitan school district in Tennessee" (p. 8). The researcher used the Tennessee Comprehensive Assessment Program (TCAP) to collect data for evaluation purposes. The total time students spent using the EPGY Stanford Math Program was compared with academic gains in mathematics for the school years 2009-2010 and 2010-2011. Woody (2013) reported that the correlation between total time spent utilizing the program and the TCAP Mathematics gains were not significant.

Lopez (2015) completed a study to determine whether a learning program changed the learning trajectories of students by utilizing the computer-based program, Lexia. The sample included 906 elementary students from second- through fifth-grades. Students from San Bernardino County with scores from a yearly reading assessment from the spring of 2015 were included in the study. The amount of time the program was utilized by students was one of the variables examined in the study. The findings showed that there were no significant differences in the mean scores of reading growth when comparing high and low usage groups. The study did reveal significant differences between levels of use among classes, grade levels, and schools (Lopez, 2015).

Guseman (2016) evaluated the impact that the amount of time spent on computer-enhanced instruction affected mathematics achievement utilizing a quantitative non-experimental design. The sample was two cohorts of ninth-grade students in a suburban public high school district located southwest of Chicago, Illinois. The study took place during the 2013-2015 school years. The first student cohort was the control group. The group included students enrolled in Algebra 1, Honors Algebra 1, or Algebra 1 Support during the 2013-2014 school year. The second student cohort received computer-enhanced instruction. The group included students enrolled in Algebra 1, Honors Algebra 1, or Algebra 1 Support during the 2014-2015 school year (Guseman, 2016). The results of the study did not indicate computer-enhanced instruction to have a significant impact on student mathematics achievement. Guseman (2016) did find that the "teachers who reported high usage of computer-enhanced instruction did have students who demonstrated a statistically significant higher mean change score for student achievement" (p. 1).

Mathematics software intervention in the classroom has improved in effectiveness over the years. This intervention has been recognized as a successful educational strategy that impacts student achievement. Mathematics software can impact motivation, interests, and engagement in student learning (Jeffs, Morrison, Messenheimer, Rizza, & Banister, 2003). Student mathematics growth can be affected positively regardless of gender, socioeconomic status, or learning disability with the right software intervention and usage of said intervention. Although, for some studies, the results indicated that there was not an impact on academic growth that was positive or negative as a result of the intervention software. Researchers continue to discover, create, and refine the interventions related to mathematics progression in the classroom.

Summary

Chapter 2 provided literature about the history of intervention software in schools. Current studies about intervention software's impact on student gender, socioeconomic status, learning disability status, and the amount of time spent using intervention software were discussed as well. Chapter 3 includes the research design, selection of participants, measurement, and data collection procedures. The data analysis and hypothesis testing for the study are described as well as the limitations of the study.

Chapter 3

Methods

The first purpose of this study was to determine the extent to which high school students using the MATHia intervention program in Tier 2 and Tier 3 classes grew academically from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score. The second purpose of the study was to determine to what extent there was a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from fall to winter and winter to spring, as measured by the NWEA MAP Mathematics assessment, between males and females, between students with a free/reduced lunch status and those without a free/reduced lunch status, and between students with a learning disability and students without a learning disability. The final purpose of the study was to determine the extent to which high school students using the MATHia intervention program in Tier 2 and Tier 3 classes grew academically from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software. Contained in this chapter are the research design, selection of the participants, measurement, data collection, data analysis and hypothesis testing, and the limitations of the study.

Research Design

This research is a quantitative descriptive study using archived data to understand the relationship between the intervention software MATHia and the mathematical growth of high school students receiving Tier 2 and Tier 3 mathematics intervention. The dependent variable utilized to calculate growth scores of the students was the MAP mathematics assessment that is administered in the fall, winter, and spring of each year. The independent variables were student gender, socioeconomic status, learning disability, and the amount of time spent using the MATHia program.

Selection of Participants

The participants for this study included students from both high schools in District D during the 2017-2018 school year. The purposive selection of participants was based on students who were placed in and remained in Tier 2 or Tier 3 math intervention courses for the entire year. A cut score on the MAP assessment for each grade level was set by the district to determine which students should be placed in the intervention courses as well as the student's state assessment score. Students transitioning to ninth grade were evaluated for tier placement prior to starting their first semester in high school. Students who scored level 1 or 2 on the state assessment or between the 17^{th} and 31^{st} percentiles on the MAP assessment were placed in the Tier 2 section (see Appendix A). Students who scored level 1 on the state assessment or below the 16^{th} percentile on the MAP assessment were placed in the Tier 3 section (see Appendix A). Students who fell in the cut score ranges listed above were enrolled in Tiered support intervention classes. Some students who fell within the cut scores had an IEP with goals related to improving math skills.

Measurement

MAP assessment scores from fall, winter, and spring were utilized as one of the instruments of measurement for this study. The assessment is a computerized adaptive test used to measure a student's growth target in mathematics based on their academic level, independent of their current grade level. The test contains approximately 52 questions but varies for each student because of its adaptive design (NWEA, 2018). The assessment includes a variety of question types, such as multiple choice, fill in the blank, and drag and drop answers that are based on current state standards (NWEA, 2018, p. 4). MAP reveals how much growth has occurred between testing dates and assists the teacher in differentiating instruction to meet individual student needs (NWEA, 2018, p. 3). NWEA and Carnegie Learning (2017) results are aligned in their growth scales (Carnegie, 2017).

Scores are reported using the RIT scale, which is an equal-interval scale. Each RIT point is stable and is the same value for every grade group or grade level; this makes it possible to use the scale to measure individual academic progress for every student. On a continuous scale of learning, each score indicates a point. The scores are not to be used as target scores, but as benchmarks of a student's academic skill level. Questions on the MAP were assigned their RIT rating "after being tested on thousands of students across the United States. Responses to items throughout a student's test were used to produce the final RIT score for that student" (NWEA, 2018, p. 6). Growth data was calculated by subtracting the fall RIT score from the winter RIT score and the winter RIT score from the spring RIT score.

> The numerical (RIT) value assigned to a student predicts that at that specific difficulty level, a student is likely to answer about 50% of the questions correctly. Results are scored across an even interval scale, meaning that the difference between scores remains consistent regardless of whether a student scores high or low. It also means that grade level is not a factor. Since the MAP test is

> administered on a computer, once the child finishes the test, scores are immediately available. (NWEA, 2018, p. 18)

The MAP assessment was tested for validity and reliability by using marginal reliability, concurrent validity, and test-retest reliability (NWEA, 2018). Marginal reliability is a system test that is used as an index of precision in computer adaptive tests, like the MAP. It uses a Pearson correlation coefficient to measure the strength of the relationship between two data points (like a MAP Growth test score and a state summative test score). A correlation is recognized to be strong when the coefficient is at least .80, with 1 being a perfect positive correlation. The correlation, in this case, was found to be .85, which is reasonable considering that the parallel tests given at the same time were equivalent (NWEA, 2018). Concurrent validity, which refers to the performance of a test as it spans other forms, included correlation coefficients that ranged from 0.72 to 0.90. Test-retest reliability was measured by administering two equivalent tests (different individual tests, but with the same number and type of items) to students over a period of weeks. NWEA reported test-retest coefficients to be in the mid .80s to the low .90s. NWEA MAP test data that was reviewed provided evidence that provides a reliable measurement of student achievement.

For this study, gender (male, female) was determined from data gathered by the school district upon enrollment, which is stored in the district data operating system. Student socioeconomic status (free/reduced lunch, non-free/reduced lunch) was determined by the family reported income of the household to the school district where the student resides to qualify. Learning disability was determined by whether the student had been evaluated and placed on an individualized education plan (IEP) specific to learning disabilities. The time students spent utilizing the MATHia intervention program (high, moderate, low) was determined by data collected from the software. The range for high usage in a semester is considered to be time on task greater than 350 minutes. A moderate user would utilize the software between 150 and 350 minutes. A low user would spend fewer than 150 minutes on task during the semester (Ritter, 2011). Student use was influenced by how many days a week a student could potentially access the program. The availability was affected by student attendance and the number of days in the week students had the support class.

Data Collection Procedures

Before the research was conducted, permission was obtained to conduct the study in District D by e-mailing the superintendent on October 30, 2018 (see Appendix B). A thorough explanation of the study and the information that would be requested was included in the communication. The superintendent replied on the following day, October 31, 2018, approving the request to conduct the study and copied the district data operator informing her that the researcher was allowed access to information about the students (see Appendix B). The director of curriculum and instruction was also copied on the e-mail reply with instruction to assist the researcher with access to the students, by ID number, in order to collect utilization time data on the MATHia program. Finally, the director of assessment and school improvement was asked to provide approval for the researcher to collect MAP score data for the student numbers that were identified. The process to obtain permission from Baker University to conduct the research was initiated on October 31, 2018, in the form of an Institutional Review Board (IRB) request. The

Baker University IRB committee approved the research study on November 1, 2018 (see Appendix C).

The first contact was made through e-mail on November 1, 2018, with the director of curriculum and instruction to gather the student identification numbers of the students who were using the MATHia intervention program and request the time the students spent on the program per semester. The director e-mailed the researcher the information on November 3, 2018. The student identification numbers and time utilized on the MATHia program were then added to an Excel spreadsheet.

The researcher then shared the spreadsheet with the district data operator to obtain student gender (male, female), socioeconomic status (free/reduced lunch, non-free/reduced lunch), and disability (with a learning disability, without a learning disability) on November 3, 2018. The data operator completed the spreadsheet with the requested information and returned it on November 10, 2018, by e-mail communication. The last contact was made by e-mailing the Director of Assessment and School Improvement a document that included a list of the student identification numbers and requested the MAP scores for the fall, winter, and spring assessments for the identified students onto the document. This correspondence was submitted on November 10, 2018 and was completed and returned by e-mail on November 12, 2018. The data collection process was completed on November 12, 2018.

Data Analysis and Hypothesis Testing

Included in this section are the research questions and the corresponding hypothesis statements and data analysis. Prior to conducting the analyses, growth scores were calculated. The fall to winter growth score was calculated by subtracting the fall

RTI score from the winter RTI score. The winter to spring growth score was calculated by subtracting the winter RTI score from the spring RTI score.

RQ1. To what extent do Tier 2 and Tier 3 high school students using the MATHia intervention program grow fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score?

H1. Tier 2 and Tier 3 high school students using the MATHia intervention program grow from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score.

A one-sample *t* test for the mean was conducted to test H1. The sample mean was tested against a null value of 0. The level of significance was set at .05.

H2. Tier 2 and Tier 3 high school students using the MATHia intervention program grow from winter to spring, as measured by the NWEA MAP Mathematics assessment score.

A one-sample *t* test for the mean was conducted to test H2. The sample mean was tested against a null value of 0. The level of significance was set at .05.

RQ2. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between males and females?

H3. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, between males and females.

A two-sample *t* test for the mean was conducted to test H3. The sample mean of males was compared to the sample mean of females. The level of significance was set at .05.

H4. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between males and females.

A two-sample *t* test for the mean was conducted to test H4. The sample mean of males was compared to the sample mean of females. The level of significance was set at .05.

RQ3. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with free/reduced lunch and students without free/reduced lunch?

H5. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, between students with free/reduced lunch and students without free/reduced lunch?

A two-sample *t* test for the mean was conducted to test H5. The sample mean of students who are free/reduced lunch was compared to the sample mean of non-free/reduced lunch. The level of significance was set at .05.

H6. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with free/reduced lunch and students without free/reduced lunch?

A two-sample *t* test for the mean was conducted to test H6. The sample mean of students with free/reduced lunch was compared to the sample mean of students without free/reduced lunch. The level of significance was set at .05.

RQ4. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with a learning disability and students without a learning disability?

H7. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, between students with a learning disability and students without a learning disability.

A two-sample *t* test for the mean was conducted to test H7. The sample mean of students with a learning disability was compared to the sample mean of students without a learning disability. The level of significance was set at .05.

H8. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with a learning disability and students without a learning disability.

A two-sample *t* test for the mean was conducted to test H8. The sample mean of students with a learning disability was compared to the sample mean of students without a learning disability. The level of significance was set at .05.

RQ5. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software?

H9. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software.

A one-factor analysis of variance (ANOVA) was conducted to test H9. The categorical variable used to group the dependent variable, mathematical growth on the MAP, was utilization of the MATHia software (high, moderate, low). The level of significance was set at .05.

H10. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software.

A one-factor ANOVA was conducted to test H10. The categorical variables used to group the utilization of the software are high, moderate, and low. The level of significance was set at .05.

Limitations

Limitations, which were out of the researcher's control, may influence the findings of the study. The researcher was not able to control the time that each student spent on the software, how instruction was delivered, or the importance that was placed on student effort by the teacher. The time that teachers spent developing their knowledge of the program outside of the professional development provided by the software company and district is also a factor that potentially provides limitations.

Summary

This chapter included the research design and the selection of the participants. Additionally, the instrumentation, data collection procedures, and the data analysis and hypothesis testing were described. Lastly, the limitations of the study were presented. The descriptive statistics and analysis of the data collected that addressed the research questions of this study are included in Chapter 4.

Chapter 4

Results

The purpose of this study was to determine the extent Tier 2 and Tier 3 high school students using the MATHia intervention program grew academically in mathematics from fall to winter and winter to spring, as measured by the change in the Northwest Evaluation Association (NWEA) Measures of Academic Progress (MAP) score. The second purpose of the study was to determine to what extent there was a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from fall to winter and winter to spring, as measured by the NWEA MAP Mathematics assessment, between males and females, between students with a free/reduced lunch status and those without a free/reduced lunch status, and between students with a learning disability and students without a learning disability. The final purpose of the study was to determine to what extent there is a difference in Tier 2 and Tier 3 high school students using the MATHia intervention program growth from fall to winter and winter to spring, as measured by the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software. This chapter contains the descriptive statistics and the results of the hypothesis testing.

Descriptive Statistics

There were 134 participants in this study. All the participants received MATHia computer-assisted instruction during the 2017-2018 school year. Participant demographic variables that were used in this study were gender, SES, and IEP status. The frequencies of these participant characteristics and the equivalent percentages are found in Table 2.

Table 2

Frequencies and Percentages for Student Characteristics

Student Characteristic	*F*	%
Gender		
Female	60	45.1
Male	73	54.9
Socioeconomic Status		
With Free/Reduced Lunch	18	13.5
Without Free/Reduced Lunch	115	86.5
Individualized Education Plan		
With a Learning Disability	29	21.8
Without a Learning Disability	104	78.2

Hypothesis Testing

The results of the testing which addressed the five research questions utilized in this study are discussed in this section. Each research question addressed in the study is followed by the corresponding hypotheses, the methods used to teach each hypothesis, and the results of each hypothesis test.

RQ1. To what extent do Tier 2 and Tier 3 high school students using the MATHia intervention program grow fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score?

H1. Tier 2 and Tier 3 high school students using the MATHia intervention program grow from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score.

A one-sample *t* test for the mean was conducted to test H1. The sample mean was tested against a null value of 0. The level of significance was set at .05.

The results of the analysis indicated the mean (M = 1.323, SD = 1.329) was significantly different from the null value (0), t = 11.484, df = 132, p = .000. Tier 2 and Tier 3 high school students using the MATHia intervention program grow fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score. H1 was supported. A Cohen's *d* was calculated to index the effect size. The average fall to winter growth was .995 standard deviations. According to J. Cohen (1988), this is a large effect.

H2. Tier 2 and Tier 3 high school students using the MATHia intervention program grow from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score.

A one-sample *t* test for the mean was conducted to test H2. The sample mean was tested against a null value of 0. The level of significance was set at .05.

The results of the analysis indicated the mean (M = 1.722, SD = 1.010) was significantly different from the null value (0), t = 19.656, df = 132, p = .000. Tier 2 and Tier 3 high school students using the MATHia intervention program grow winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score. H2 was supported. A Cohen's *d* was calculated to index the effect size. The average winter to spring growth was 1.704 standard deviations above 0. According to J. Cohen (1988), this is a large effect.

RQ2. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between males and females?

H3. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, between males and females.

A two-sample *t* test for the mean was conducted to test H3. The sample mean of males was compared to the sample mean of females. The level of significance was set at .05.

The results of the analysis indicated no statistically significant difference between the two values, $t = -1.129$, $df = 131$, $p = .261$. The sample mean for male students ($M = 1.206$) was not different from the sample mean for female students ($M = 1.467$). See Table 3 for the means and standard deviations for this analysis. There is no difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, between males and females. H3 was not supported.

Table 3

Descriptive Statistics for the Test for H3

Gender	*M*	*SD*	*N*
Male	1.206	1.166	73
Female	1.467	1.501	60

H4. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between males and females.

A two-sample *t* test for the mean was conducted to test H4. The sample mean of males was compared to the sample mean of females. The level of significance was set at .05.

The results of the analysis indicated no statistically significant difference between the two values, $t = 0.053$, $df = 131$, $p = .958$. The sample mean for male students ($M = 1.726$) was not different from the sample mean for female students ($M = 1.717$). See Table 4 for the means and standard deviations for this analysis. There is no difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between males and females. H3 was not supported.

Table 4

Descriptive Statistics for the Test for H4

Gender	*M*	*SD*	*N*
Male	1.726	1.004	73
Female	1.717	1.027	60

RQ3. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with free/reduced lunch and students without free/reduced lunch?

H5. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, between students with free/reduced lunch and students without free/reduced lunch?

A two-sample *t* test for the mean was conducted to test H5. The sample mean for students with free/reduced lunch was compared to the sample mean for students without free/reduced lunch. The level of significance was set at .05.

The results of the analysis indicated no statistically significant difference between the two values, $t = -0.727$, $df = 131$, $p = .468$. The sample mean for free/reduced lunch students ($M = 1.111$) was not different from the sample mean for non-free/reduced lunch students ($M = 1.357$). See Table 5 for the means and standard deviations for this analysis. There is no difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, between students with free/reduced lunch and students without free/reduced lunch. H5 was not supported.

Table 5

Descriptive Statistics for the Test for H5

SES	*M*	*SD*	*N*
With Free/Reduced Lunch	1.111	1.605	18
Without Free/Reduced Lunch	1.357	1.285	115

H6. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with free/reduced lunch and student without free/reduced lunch?

A two-sample *t* test for the mean was conducted to test H6. The sample mean of students with free/reduced lunch was compared to the sample mean of students without free/reduced lunch. The level of significance was set at .05.

The results of the analysis indicated no statistically significant difference between the two values, $t = -1.002$, $df = 131$, $p = .318$. The sample mean for free/reduced lunch students ($M = 1.500$) was not different from the sample mean for non-free/reduced lunch students ($M = 1.757$). See Table 6 for the means and standard deviations for this analysis. There is no difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with free/reduced lunch and students without free/reduced lunch. H6 was not supported.

Table 6

Descriptive Statistics for the Test for H6

SES	*M*	*SD*	*N*
With Free/Reduced	1.500	1.04	18
Without Free/Reduced	1.757	1.01	115

RQ4. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with a learning disability and students without a learning disability?

H7. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, between students with a learning disability and students without a learning disability.

A two-sample *t* test for the mean was conducted to test H7. The sample mean for students with a learning disability was compared to the sample mean for students without a learning disability. The level of significance was set at .05.

The results of the analysis indicated no statistically significant difference between the two values, $t = 1.854$, $df = 131$, $p = .066$. The sample mean for students with a disability ($M = 1.724$) was not different from the sample mean for students without a disability ($M = 1.212$). See Table 7 for the means and standard deviations for this analysis. There is no difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, between students with a learning disability and without a learning disability. H7 was not supported.

Table 7

Descriptive Statistics for the Test for H7

Learning Disability	*M*	*SD*	*N*
Learning Disabled	1.724	1.250	29
Not Learning Disabled	1.212	1.334	104

H8. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with a learning disability and students without a learning disability.

A two-sample *t* test for the mean was conducted to test H8. The sample mean of students with a learning disability was compared to the sample mean of students without a learning disability. The level of significance was set at .05.

The results of the analysis indicated no statistically significant difference between the two values, $t = -1.447$, $df = 131$, $p = .150$. The sample mean for students with a learning disability ($M = 1.483$) was not different from the sample mean for students without a learning disability ($M = 1.789$). See Table 8 for the means and standard deviations for this analysis. There is no difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, between students with a learning disability and students without a learning disability. H8 was not supported.

Table 8

Descriptive Statistics for the Test for H8

Learning Disability	*M*	*SD*	*N*
Learning Disabled	1.483	1.090	29
Not Learning Disabled	1.789	0.982	104

RQ5. To what extent is there a difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software?

H9. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software.

A one-factor ANOVA was conducted to test H9. The categorical variable used to group the dependent variable, mathematical growth on the MAP, was utilization of the MATHia software (high, moderate, low). The level of significance was set at .05.

The results of the analysis indicated a statistically significant difference between at least two of the means, F = 10.211, df = 2, 130, p = .000. See Table 9 for the means and standard deviations for this analysis. A follow-up post hoc was conducted to determine which pairs of means were different. The Tukey's Honestly Significant Difference (HSD) post hoc was conducted at α = .05. Two of the differences were statistically significant. The low utilization mean growth (M = 0.641) was lower than the moderate utilization mean growth (M = 1.404) and the high use mean growth (M = 1.919). H9 was supported. The index of the effect size, partial eta-squared, indicated that 13.6% of the variability in growth is explained by the level of utilization. According to J. Cohen (1988), this is a large effect.

Table 9

Descriptive Statistics for the Testing of H9

Utilization	*M*	*SD*	*N*
Low	0.641	1.530	39
Moderate	1.404	1.015	57
High	1.919	1.233	37

H10. There is a statistically significant difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth, from winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software.

A one-factor ANOVA was conducted to test H10. The categorical variables used to group the utilization of the software are high, moderate, and low. The level of significance was set at .05.

The results of the analysis indicated a statistically significant difference between at least two of the means, $F = 19.648$, $df = 2, 130$, $p = .000$. See Table 10 for the means and standard deviations for this analysis. A follow-up post hoc was conducted to determine which pairs of means were different. The Tukey's HSD post hoc was conducted at $\alpha = .05$. Two of the differences were statistically significant. The low use mean growth ($M = 1.128$) was lower than the moderate use mean growth ($M = 1.694$) and the high use mean growth ($M = 2.429$). H10 was supported. The index of the effect size, partial eta-squared, indicated that 23.2% of the variability in growth is explained by the level of utilization. According to J. Cohen (1988), this is a large effect.

Table 10

Descriptive Statistics for the Testing of H10

Utilization	*M*	*SD*	*N*
Low	1.128	0.978	39
Moderate	1.694	0.914	59
High	2.429	0.739	35

Summary

Chapter 4 began with a presentation of the descriptive statistics related to this study. The second section provided the results of the hypothesis testing related to the five research questions. Chapter 5 includes the study summary, findings related to the literature, and the conclusions.

Chapter 5

Interpretation and Recommendations

This research was focused on the academic growth in mathematics of Tier 2 and Tier 3 high school students who received the computer-based intervention, MATHia, in tiered classes. This chapter begins with the study summary, which includes an overview of the problem, purpose statement and research questions, a review of the methodology, and the major findings of the study. Following the study summary, the findings related to the literature and the conclusions are presented.

Study Summary

This section provides a summary of the research that was conducted for this study. The summary begins with an overview of the problem. Following this section, the purpose of the study and the research questions are stated. The summary section concludes with the overview of the methodology and the major findings of the study.

Overview of the problem. Students' high school mathematics scores continue to deteriorate forcing school districts to seek effective interventions. Flores (2007) stated that studies have shown that the gaps in mathematics achievement become more prevalent at the high school level by gender, socioeconomic status, and disability. Interventions that could reverse the decline in these various sub-groups may lie in the MATHia software program. If student academic growth is evident when disaggregated by gender, socioeconomic status, learning disability, and the amount of utilization of the MATHia intervention software at the high school level, this data might be a determining factor of the decision for District D to purchase the software.

Purpose statement and research questions. The purpose of this study was to determine the extent to which high school students using the MATHia intervention program in Tier 2 and Tier 3 classes grew academically from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score. The second purpose of the study was to determine the extent to which high school students using the MATHia intervention program in Tier 2 and Tier 3 classes grew academically from fall to winter and winter to spring, as measured by the NWEA MAP Mathematics assessment, between males and females (gender), between students with a free/reduced lunch status and those without a free/reduced lunch status (socioeconomic status), and between students with a learning disability and students without a learning disability (LD). The final purpose of the study was to determine the extent to which high school students using the MATHia intervention program in Tier 2 and Tier 3 classes grew academically from fall to winter and winter to spring, as measured by the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software. To achieve the purposes of the study, five research questions were posed, and 10 related hypotheses were tested.

Review of the methodology. This research was a quantitative descriptive study using archived data to understand the relationship between the treatment intervention software, MATHia, and the mathematical growth of high school students receiving the mathematics intervention in Tier 2 and Tier 3 classes. The participants for this study included high school students enrolled in District D who were placed in Tier 2 or Tier 3 math intervention courses. The independent variables of this study were student gender, socioeconomic status, learning disability status, and the amount of time spent using the

MATHia program. The dependent variable used to calculate growth scores of the students was the NWEA MAP Mathematics assessment that is administered in the fall, winter, and spring. To measure student mathematics achievement, the difference in student RIT scores from fall to winter and winter to spring on the NWEA MAP Mathematics assessment were utilized. Two one-sample *t* tests for the mean, six two-sample *t* tests for the mean, and two one-factor ANOVAs were conducted to test the 10 hypotheses.

Major findings. The results of the data analysis for the current study yielded mixed results. The first was that the Tier 2 and Tier 3 high school students using the MATHia intervention program grew fall to winter, as measured by the change in the NWEA MAP Mathematics assessment score. The second major finding was that Tier 2 and Tier 3 high school students using the MATHia intervention program grew winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score. The results of the study did indicate that there was not a significant difference in academic growth between students by gender, socioeconomic status, or learning disability status. Finally, the results revealed there was a significant difference in Tier 2 and Tier 3 high school students' growth from fall to winter and winter to spring, as measured by the change in the NWEA MAP Mathematics assessment score, among students with high, moderate, and low utilization of the software.

Findings Related to the Literature

The findings from this study related to the literature on the impact of the MATHia intervention software on overall student growth; differences in growth based on student gender, socioeconomic status, learning disability status; and the amount of time spent using the program are included in this section. The literature related to the individual variables of this study was limited in quantity, as studies related to mathematics software programs have only been available for a short time.

The first variable examined in the study was overall student growth as measured by the MAP assessment from fall to winter, winter to spring. The results of the current study supported the research conducted by Sandholtz et al. (1997), Simkins (2006), Schwartz and Beichner (1999), and Trotter (2007). These researchers were the first to share that technology was an effective tool that could alter the way content areas were taught, students had more initiative and independence, and a greater desire to perform to expectations. These studies revealed that technology in the classroom also improved student academic achievement. Several researchers conducted studies similar to this study. Kulik and Kulik (1991), Hannafin et al. (2001), Xin (1999), Funkhouser (2002), Moyer and Reimer (2005), and Biesinger and Crippen (2008) found that the use of computer software programs improved the academic achievement of students, which was in correlation to the findings of this study. The results of this study indicated academic growth during each semester. Ysseldyke et al. (2005) performed an analysis of Math Facts in a Flash by Renaissance Learning. A large group of participants and schools were included in this study. The methods were similar to the current study and yielded similar results. The students who utilized the software each day had greater academic gains at the end of each semester, which also coincided with the data collected in the current study. Townsend (2012) and Ramsay (2014) also revealed that the results of their studies over intervention software showed a statistically significant increase in mathematics scores. Their results were based on growth in student state assessment data. The analysis of the data from the current study revealed that the use of the intervention software program, MATHia, was associated with significant growth each semester.

One study included in the literature that was not supported by the results of the current study was conducted by Rich (2016). He studied the relationship between the use of the intervention software program, Study Island, and mathematics achievement of third-, fourth- and fifth-grade students. Data collected from the mathematics achievement test scores did not show a significant relationship as a result of the utilization of the software intervention program.

Student gender as it related to student academic growth was examined in the current study. The results of this study were in contrast to Carr and Jessup (1997), Chanlin (1999), and Woolf et al. (2010), who reported the results of their similar studies related to gender-focused, metacognitive strategies associated with software programs. The researchers evaluated male and female groups of students who utilized the computer intervention software programs and compared the academic achievement of each group. Each study found that males were more likely to be successful utilizing strategies learned from the software intervention, whereas females were less likely. The literature also provided that game-like or relatable characters in the program showed positive results for both; however, Papastergiou (2009) found that game-like software intervention programs tend to be more engaging to males. Arroyo, Woolf, Royer, Tai, Muldner, et al. (2010) reported that of the students who utilized the Intelligent Tutoring System for Mathematics, it was particularly helpful to female students. The results of the study are in contrast to the findings of the current study. In the current study, overall academic growth was evident as a result of utilizing the intervention software; however, student gender was not a factor in academic growth.

Academic achievement of students with free/reduced lunch status or those who qualify for free/reduced lunch was also examined in the current study. Myers (2009), Harris (2011), Francis (2014), O'Brien (2014) and Gilmore (2018) conducted studies similar to the current one to determine if computer software could improve math achievement among low socioeconomic students. In these studies, the control group's scores were higher than those of the low socioeconomic group, but not significantly different. The current study's results support these findings because there was not a statistically significant gain in the mathematics achievement of either group. In contrast to the current findings, two studies in the literature review included results that showed socioeconomic status affected student achievement when using a software intervention program. Becker (2000) and Burns, et al. (2012) conducted studies that compared economically disadvantaged students and higher socioeconomic students. The researchers determined that the students with free/reduced lunch grew more academically as a result of the technology that was utilized in conjunction with teaching strategies. The current study differs from these findings because the results revealed that from fall to winter and winter to spring the use of intervention software were not different from students with low socioeconomic status when compared to students who were of higher socioeconomic status.

The next variable examined in the study was student disability. The results of the current study revealed that there was no difference in Tier 2 and Tier 3 high school students' using the MATHia intervention program growth from fall to winter and winter to spring for students with a learning disability and without a learning disability. The findings were in contrast to Bottge and Heinrichs (2004). The researchers completed a study using a software program with both a control group of regular education students and a group of students with learning disabilities. They found that the group of students with learning deficiencies attained scores showing significantly more growth in comparison to the students in the control group. Bangert-Drowns and Becker (1999) also found the use of software programs for students with learning disabilities to be effective in their study as they gained confidence, reinforcement, and feedback. Becker (2000), Bangert-Drowns and Becker (1999), and Schmidt (1999) focused on students with and without learning disabilities. The researchers found that the use of computer-assisted instruction was more effective for students with learning disabilities. Christensen and Gerber (2000), Miller and Mercer (2000) Fitzpatrick (2001) and Ridgway et al. (2002) completed studies that found that students with disabilities who utilized computer software with auditory and visual graphics, drill and practice instruction, and interactive formats showed more academic growth than those not receiving the intervention. An additional study that was similar in focus was conducted by Okolo (1999). The study was based on the comparison of a math intervention on a computer versus a drill and practice program on math facts with students with learning disabilities. Okolo (1999) concluded, based on the results, that evidence suggested that the use of intervention software was effective in the educational growth of students with disabilities. The findings of the current study are in contrast to these studies because there was not a significant difference in academic growth between students with a learning disability and students without a learning disability.

Finally, the study examined the usage of the MATHia intervention software and its effects on student achievement. The current study revealed that there was a statistically significant difference in growth from fall to winter and winter to spring based on the amount of utilization of the software. The results of the study support other findings in the literature in that increased use of the software did improve mathematics achievement. Norris et al. (2003), Taepke (2007) and Bruce-Simmons (2013) conducted studies that were similar to the current study. The researchers evaluated how the amount of time on computer intervention software affected student academic growth. Kajamies et al. (2010) conducted a study that combined many teaching techniques in a computer-supported adventure game. The researchers determined that students using computers more often learn quicker, which is supported by the current findings. However, Jarrell (2000), found that time utilizing educational technology had varying effects on student achievement. The researcher did not utilize a control group to make determinations but compared the same group of participants over two semesters with and without unlimited technology. The researcher found that the availability of technology did not affect academic growth. Results might have differed had the researcher utilized a control group. The findings of a study conducted by Woody (2013) showed that the amount of usage of the program EPGY Stanford Math Program did not affect achievement, which is in contrast to the findings of the current study. Woody's (2013) study was similar to the current study in methods and purpose. The usage of the intervention software program, MATHia, did show academic growth in students from fall to winter and winter to spring, which supports these studies.

Conclusions

The section that follows includes the conclusions drawn by the researcher based on the research regarding the effects of mathematical software on overall student growth and the effects of student gender, socioeconomic status, learning disability, and usage on the growth. Implications for actions and recommendations for future studies are included. This section concludes with remarks from the researcher.

Implications for action. Based on the findings of this study, District D is provided with data to evaluate the impending purchase of the intervention software program, MATHia. Considerations of the effectiveness for all students should be reviewed when making a purchase of this financial weight. Overall, Tier 2 and Tier 3 students improved mathematics performance. District administrators should consider continuing the use of the software intervention for another year. The cut scores could be adjusted to incorporate additional usage of the intervention software by more students. Intervention data alone could be utilized for placement purposes instead of referencing state assessment results as one of the data points. District administrators should prioritize additional professional development to assist teachers in incorporating the intervention software into their curriculum. The amount of time spent using the program was the only variable that affected student growth. By working with teachers on utilization standards of the intervention software, the district would see further academic growth of students. District leaders need to ensure that teachers are using the software with students at moderate or high levels of usage. Making usage a priority means making sure that all students who qualify for using the software, are using it. There was marked overall growth as a result of the program on the sub-groups that were evaluated. The amount of time spent on any type of program or another educational strategy might provide the same or different results. A student with proper instruction who spends the time learning, regardless of the format, is still working to make academic gains in that subject area.

Recommendations for future research. The purpose of this study was to determine the impact of the intervention software, MATHia, on Tier 2 and Tier 3 students' mathematics growth. Longitudinal studies over the variables analyzed in this study in comparison to intervention software have not been extensively performed, which did not provide for extensive literature and data analysis. Additional studies would have provided for possible opposing viewpoints or strengthened the analysis of the current study. While this study provided the desired information for District D, other studies could be considered for future research. The following are recommendations for future research.

1. The results of the data analysis for the current study revealed that there was a difference in the mathematical academic growth of Tier 2 and Tier 3 students who used the software intervention program, MATHia. Future research could be done comparing another software program with similar populations of students utilizing the same methodology.
2. The results of the study showed that there was academic growth overall in both semesters, with the spring semester showing the most growth. However, the results of the study did indicate that there was not a significant difference in academic growth between students by gender, socioeconomic status, or learning disability status. The current study could be replicated using

additional variables. Suggestions could include variables such as age and grade level. State assessment scores could also be utilized as a measurement.

3. A study could be conducted to determine whether student growth and movement from Tier 2 to Tier 1 and Tier 3 to Tier 2 and Tier 1 occurred.
4. The current study could be conducted using a mixed methods study. Perceptions of both teachers and students could be collected based on the use of the software.

Concluding remarks. The results of the present study provided information on the use of the intervention software, MATHia, in Tier 2 and Tier 3 classes. The study focused on the effects of the intervention program on student academic growth overall and between gender, socioeconomic status, learning disability, and the amount of utilization. The data collected and analyzed revealed that the intervention software program increased the overall mathematics growth of the participants. Of the variables tested, there was not a significant difference in the effectiveness of the MATHia software program, except in the area of utilization. Intervention software has the potential to provide the supports necessary to increase the academic growth of low-achieving students. Continued research on the effects of new intervention software should be further pursued to examine the possible positive effects on students.

References

Anderson, G. L. (1990). Toward a critical constructivist approach to school administration: Invisibility, legitimation, and the study of non-events. *Educational Administration Quarterly, 26*(1), 38-59. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/0013161X90026001003

Arroyo, I., Woolf, B. P., Royer, J. M., Tai, M., & English, S. (2010, June). Improving math learning through intelligent tutoring and basic skills training. In *Lecture notes in computer science* (Vol. 6094, pp.423-432). Retrieved from https://link.springer.com/chapter/10.1007/978-3-642-13388-6_46

Arroyo, I., Woolf, B. P., Royer, J. M., Tai, M., Muldner, K., Burleson, W., & Cooper, D. (2010). *Gender matters: The impact of animated agents on students' affect, behavior and learning*. Retrieved from https://pdfs.semanticscholar.org/0a21/5d1134e18cf60fee796e6c8d05e93b87fc9b.pdf

At-Risk. (n.d.) In *The Glossary of Education Reform online dictionary*. Retrieved from https://www.edglossary.org/at-risk/

Bangert-Drowns, C., & Becker, H. J. (1999). Findings from the teaching, learning, and computing survey: Is Larry Cuban right? *Teaching, Learning and Computing, 7*(4), 23-72. Retrieved from https://epaa.asu.edu/ojs/article/view/442

Becker, H. J. (2000). Pedagogical motivations for students' computer use that lead to student engagement. *Educational Technology 40*(5), 5-17. Retrieved from https://www.jstor.org/stable/44428608?seq=1#page_scan_tab_contents

Becker, W. (1977). Teaching reading and language to the disadvantaged-What we have learned from field research. *Harvard Educational Review*, *47*, 518-542. Retrieved from http://www.hepgjournals.org/ doi/abs/10.17763/haer.47.4.51431w6022u51015

Becker, W., Engelmann, S., & Thomas, D. (1975). *Teaching 1: Classroom management.* Palo Alto, CA: Science Research Associates.

Biesinger, K., & Crippen, K. (2008). The impact of an online remediation site on performance related to high school mathematics proficiency. *Journal of Computers in Mathematics and Science Teaching*, *27*(1), 5-17. Retrieved from http://psycnet.apa.org/record/2008-02233-001

Boice, J. (2000). Technology redefines reading diagnosis instruction. *Technological Horizons in Education Journal*, *28*(4), 86-91. Retrieved from https://www.questia.com/library/journal/1G1-67872772/technology-redefines-reading-diagnosis-instruction

Bottge, B., & Heinrichs, M. (2004). *Research in Middle Level Education*, *27*(1). Retrieved from http://www.nmsa.org/research/rmle/winter_03/27_article_1.html

Brown, J., & Burton, R. (1978). Diagnostic models for procedural bus in basic mathematic skills. *Cognitive Science*, *2*, 155-168. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1207/s15516709cog0202_4

Bruse-Simmons, C. (2013). *The impact of computer-assisted instruction on mathematics achievement of underachieving fifth-grade students.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3581506)

Burns, M. K., Kanive, R., & DeGrande, M. (2012). Effect of a computer-delivered math fact intervention as a supplemental intervention for math in third and fourth grades. *Remedial and Special Education*, *33*(3), 184-191. Retrieved from http://journals.sagepub.com/doi/abs/10.1177/0741932510381652

Carnegie Learning. (2017). *Carnegie Learning and NWEA partners to provide customized learning paths for math instruction*. Retrieved from https://www.nwea.org/content/uploads/2017/11/NWEA_Carnegie-Learning_November-2017.pdf

Carr, M., & Jessup, D. L. (1997). Gender differences in first-grade mathematics strategy use: Social and metacognitive influences. *Journal of Educational Psychology*. *89*(2), 318-328. Retrieved from http://psycnet.apa.org/buy/1997-06271-010

Chanlin, L. J. (1999). Gender differences and the need for visual control. *International Journal of Instructional Media*, *26*, 329-335. Retrieved from https://search.proquest.com/openview/06b22203bc511ecfb150dabf69f259ca/1?cbl=30932&pq-origsite=gscholar

Cheung, A. C., & Slavin, R. E. (2013). The effectiveness of educational technology applications for enhancing mathematics achievement in K-12 classrooms: A meta-analysis. *Educational Research Review*, *9*, 88-113. Retrieved from https://www.sciencedirect.com/science/article/pii/S1747938X13000031

Christensen, E., & Gerber L. (2000). The effectiveness of computer-assisted instruction on the academic achievement of students with learning disabilities. *Computers in the Schools, 8,* 9-15. Retrieved from https://www.researchgate.net/publication/279469045_Effectiveness_of_Computer-Assisted_Instruction_on_Enhancing_the_Classification_Skill_in_Second-Graders_at_Risk_for_Learning_Disabilities/download

Cohen, D. K. (1988). Educational technology and school organization. In R. S. Nicerson & P. P. Zodhiates (Eds.), *Technology in education: Looking toward 2020* (pp. 231-264). Hillsdale, NJ: Erlbaum.

Cohen, J. (1988). *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates.

Conger, D., Iatarola, P., & Long, M. C. (2009). Explaining race, poverty and gender disparities in advanced course-taking. *Journal of Policy and Analysis Management*, *28*(4), 555-576). Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1002/pam.20455

Dietrichson, J., Bog, M., Filges, T., & Klint Jorgensen, A. M. (2017). Academic interventions for elementary and middle school students with low socioeconomic status: A systematic review and meta-analysis. *Review of Educational Research*, *87*(2), 243-282. Retrieved from https://journals.sagepub.com/doi/abs/10.3102/0034654316687036

Dresel, M., & Haugwitz, M. (2008). A computer-based approach to fostering motivation and self-regulated learning. *The Journal of Experimental Education, 77*(1), 3-18. Retrieved from https://www.tandfonline.com/doi/abs/10.3200/JEXE.77.1.3-20

Dweck, C. S. (1999). *Self-theories: Their role in motivation, personality and development.* New York, NY. Taylor & Francis Group.

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist, 34*(3), 169-189. Retrieved from https://www.tandfonline.com/doi/abs/10.1207/s15326985ep3403_3

Fancsali, S. E., & Ritter, S. (2014). *Report that the software that focuses on personalizing word problems as one strategy has a negative association with performance.* Retrieved from http://pdfs.dadeschools.net/portal/August2014Report.pdf

Fitzpatrick, S. B. (2001). *Students' experiences of the implementation of an interactive learning system in their eighth-grade mathematics classes: An exploratory study*. Retrieved from ERIC database. (ED470137)

Flores, A. (2007). Examining disparities in mathematics education: Achievement gap or opportunity gap? *The High School Journal*, *91*(1), 9-42. Retrieved from https://www.jstor.org/stable/40367921?seq=1#page_scan_tab_contents

Fontana, L., Beckerman, A., Levitt, J., & Levitt, M. (2014). *iPrep Math August 2014 report*. Retrieved from http://pdfs.dadeschools.net/portal/August2014Report.pdf

Francis, L. (2014). *The relationship between computer-assisted instruction and academically at-risk high school students' performance on the Florida comprehensive achievement test.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3682678)

Fryer, R. G., Jr., & Levitt, S. D. (2010). An empirical analysis of the gender gap in mathematics. *American Economic Journal: Applied Economics*, *2*(2), 210-240. Retrieved from http://dx.doi.org/10.1257/app.2.2.210

Fuchs, L. S., Fuchs, D., & Zumeta, R. O. (2008). *Educating individuals with disabilities: IDEIA 2004 and beyond*. New York, NY: Springer.

Funkhouser, C. (2002). The effects of computer-augmented geometry instruction on student performance and attitudes. *Journal of Research on Technology in Education, 35*(2), 163-175. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/15391523.2002.10782377

Gersten, R., & Baker, S. (1998). Real world use of scientific concepts: Integrating situated cognition with explicit instruction. *Exceptional Children*, *65*(1), 23-35. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/001440299806500102

Gersten, R., Chard, D. J., Jayanthi, M., Baker, S. K., Morphy, P., & Flojo, J. (2009). Mathematics instruction for students with learning disabilities: A meta-analysis of instructional components. *Review of Educational Research*, *79*(3), 1202-1242. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/00222194050380040301

Gilmore, K. (2018). *The impact of computer-based programs on middle school math achievement.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 10811137)

Glennon, V. J., & Wilson, J. W. (1973). The slow learner in mathematics: Diagnostic-prescriptive teaching. *National Council of Teachers of Mathematics Yearbook*, *34*, 282-317. Retrieved from ERIC database. (EJ078162)

Goldman, S. (1989). Strategy instruction in mathematics. *Learning Disability Quarterly, 12* (1), 43-55. Retrieved from http://journals.sagepub.com/doi/abs/10.2307/1510251

Good, T., Grouws, D., & Ebmeier, H. (1983). *Active mathematics teaching.* New York, NY: Longman.

Guseman, K. (2016). *Increased personalization through the use of technology in the secondary mathematics classroom.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 10123539)

Hannafin, R. D., Burruss, J. D., & Little, C. (2001). Learning with dynamic geometry programs: Perspectives of teachers and learners. *The Journal of Educational Research, 94*(3), 132-144. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/00220670109599911

Haring, N., & Bateman, B. (1977). *Teaching the learning disabled child*. Engelwood Cliffs, NJ: Prentice-Hall.

Harris, T. (2011). *An integrated learning system: Impact on at risk students ninth grade TAKS mathematics achievement.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3483143)

Hasselbring, T. S., Goin, L. I., & Bransford, J. D. (1988). Developing math automaticity in learning handicapped children: The role of computerized drill and practice. *Focus on Exceptional Children*, *20*(6), 1-7. Retrieved from https://www.learntechlib.org/p/139125/

Hodes, C. L. (1995). Gender representations in mathematics software. *Journal of Educational Technology Systems*, *24*(1), 67-73. Retrieved from http://journals.sagepub.com/doi/abs/10.2190/MU0N-Q3J6-4H47-9GMB

Jarrell, D. K. (2000). *The effects of computer access on reading achievement*. (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 9973362)

Jeffs, T., Morrison, W. F., Messenheimer, T., Rizza, M. G., & Banister, S. (2003). A retrospective analysis of technological advancements in special education. *Computers in the Schools*, *20*(1-2), 129-152. Retrieved from https://www.tandfonline.com/doi/abs/10.1300/J025v20n01_10

Jones, P., & Coxford, A. (1970). Mathematics in the evolving schools. In *National Council of Teachers of Mathematics Yearbook* (32nd ed.), (pp. 9-90). Washington, DC: National Council of Teachers of Mathematics.

Kajamies, A., Vauras, M., & Kinnunen, R. (2010). Instructing low- achievers in mathematical word problem solving. *Scandinavian Journal of Educational Research*, *54*(4), 335-355. Retrieved from https://www.learntechlib.org/p/65330/

Kansas State Department of Education. (2018, September 15). *Kansas report card*. Retrieved from https://ksreportcard.ksde.org/demographics.aspx?org_no=D0[redacted]&rptType=2

Kansas State Department of Education. (2019, January 2). *Process handbook*. Retrieved from https://www.ksde.org/Portals/0/SES/PH/PH-complete.pdf?ver=2018-10-19-135351-070

Kelly, A., & Lesh, R. (2000). *Handbook of research design in mathematics and science education.* Mahwah, NJ: Erlbaum.

Kilpatrick, J. (1992). A history of research in mathematics education. In D. Grouws (Ed.), *Handbook of research on mathematics research and teaching* (pp. 3-39). New York, NY: MacMillan.

Kulik, C., & Kulik, J. (1991) *Effectiveness of computer-based instruction: An updated analysis.* Retrieved from https://deepblue.lib.umich.edu/bitstream/handle/2027.42/29534/0000622.pdf

Lagemann, E. (2000). *An elusive science: The troubling history of education research.* Chicago, IL: University of Chicago Press.

Lave, J. (1988). *Cognition in practice*. Cambridge, UK: Cambridge University Press.

Li, Q., & Ma, X. (2010). A meta-analysis of the effects of computer technology on school students' mathematics learning. *Educational Psychology Review*, *22*(3), 215-243. Retrieved from https://link.springer.com/article/10.1007/s10648-010-9125-8

Lopez, A. B. (2015). *Improving learning outcomes for vulnerable populations: Efficacy of a computer-based intervention literacy program.* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses database. (UMI No. 10250386)

Lunenburg, F. C., & Irby, B. J. (2008). *Writing a successful thesis or dissertation: Tips and strategies for students in the social and behavioral sciences*. Thousand Oaks, CA: Corwin Press.

Malecki, K. C., & Demaray, M. K. (2006). Social support as a buffer in the relationship between socioeconomic status and academic performance. *School Psychology Quarterly, 21*(4), 375-395. Retrieved from http://psycnet.apa.org/record/2006-22915-002

McCoog, I. J. (2007). Integrated instruction: Multiple intelligences and technology. *Clearing House*. *81*(1), 25-28. Retrieved from https://www.tandfonline.com/doi/abs/10.3200/TCHS.81.1.25-28

Miller, S. P., & Mercer, C. D. (2000). Educational aspects of mathematics disabilities. *Journal of Learning Disabilities*, *2*(1), 47-57. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1540-5826.2007.00230.x

Monaghan, J., Trouche, L., & Borwein, J. M. (2016). *Tools and mathematics*. Berlin, Germany: Springer International Publishing.

Moon, B. (1986). *The new maths curriculum controversy: An international story*. London, UK: Falmer.

Moyer, P., & Reimer, K. (2005). Third-graders learn about fractions using virtual manipulatives: A classroom study. *Journal of Computers in Mathematics and Science Learning*, *24*(1), 5-25. Retrieved from https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1039&context=teal_facpub

Myers, R. (2009). *The effects of the use of technology in mathematics instruction on student achievement.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3394841)

Niederle, M., & Vesterlund, L. (2010). Explaining the gender gap in math test scores: The role of competition. *The Journal of Economic Perspectives*, *24*(2), 129-144. Retrieved from https://web.stanford.edu/~niederle/NV.JEP.pdf

Northwest Evaluation Association. (2016a). *MAP assessments: Our scale and norms*. Retrieved from https://www.nwea.org/assessments/map/scale-and-norms/NWEA

Northwest Evaluation Association. (2016b). *Measure student progress with MAP*. Retrieved from https://www.nwea.org/assessments/map/

Northwest Evaluation Association. (2018). *Measures of academic progress.* Retrieved from https://www.nwea.org/content/uploads/2014/07/Comprehensive-Guide-to-MAP-K-12-Computer-Adaptive-Interim-Assessment

Norris, C., Sullivan, T., Poirot, J., & Soloway, E. (2003). No access, no use, no impact: Snapshot surveys of educational technology in K-12. *Journal of Research on Technology in Education*, *36*(1), 15-27. Retrieved from http://cmapspublic2.ihmc.us/rid=1133302575890_370798519_3595/norris.pdf

O'Brien, S. (2014) *The effect of computer-aided instruction in mathematics on disadvantaged students.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3636197)

Okolo, C. M. (1999). The effect of computer-assisted instruction format and initial attitude on the arithmetic facts proficiency and continuing motivation of students with learning disabilities. *Exceptionality*, *3*(4), 195-211. Retrieved from ERIC database. (EJ457429)

Ozel, S., Yetkiner, Z., & Capraro, R. (2008). Technology in K-12 mathematics classrooms. *School Science and Mathematics*, *108*(2), 80-85. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1949-8594.2008.tb17807.x

Papastergiou, M. (2009). Digital game-based learning in high school computer science education: Impact on educational effectiveness and student motivation. *Computers & Education*, *52*(1), 1-12. Retrieved from https://www.sciencedirect.com/science/article/pii/S0360131508000845

Pretti-Frontczak, K., & Bricker, D. (2000). Enhancing the quality of individualized education plan (IEP) goals and objectives. *Journal of Early Intervention*, *23*(2), 92-105. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/105381510002300204

Ramsay, M. (2014). *Effectiveness of technology-integrated instruction on high school students' mathematic achievement scores.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3665816)

Renaissance Learning. (2003). *Math facts in a flash* [Computer Software]. Wisconsin Rapids, WI: Author.

Reynolds, J. L. (2010). *The effects of computerized instruction and systematic presentation and review of math fact acquisition and fluency*. (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3440726)

Rich, M. J. (2016). *The relationship between using Study Island supplemental math software and third, fourth and fifth grade students' mathematics achievement*. (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 1780643557)

Riedesel, C. (1967). *Guiding discovery in elementary school mathematics*. New York, NY: Appleton-Century-Crofts.

Ridgway, S., Zawojewksi, D., Hoover, K., & Lambdin, C. (2002). Using a technology-enriched environment to improve higher-order thinking skills. *Journal of Research on Technology Education, 34*(2), 109-119. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/15391523.2001.10782338

Riley, M., Greeno, J., & Heller, J. (1983). Development of children's problem solving ability in arithmetic. In H. Ginsburg (Ed.), *Development of mathematical thinking* (pp. 134-157). New York, NY: Academic Press.

Ritter, S. (2011). *The research behind the Carnegie Learning math series.* Retrieved from https://www.pgsd.org/cms/lib07/PA01916597/Centricity/Domain/43/The%20Research%20Behind%20The%20Carnegie%20Learning%20Math%20Series.pdf

Ritter, S., Sinatra, A. M., & Fancsali, S. E. (2014). *Personalized content in intelligent tutoring systems. Design recommendations for intelligent tutoring systems*. Retrieved from https://books.google.com/books?hl=en&lr=&id=BNWEBAAAQBAJ&oi=fnd&pg=PA71&dq=carnegie+mathia+&ots=jJm4CzGh1M&sig=oh_dCisgR3LuBHpS_0r9xMyodCg#v=onepage&q=carnegie%20mathia&f=false

Rosselli, M., Ardila, A., Matute, E., & Inozemtseva, O. (2009). Gender differences and cognitive correlates of mathematical skills in school-aged children. *Child Neuropsychology, 15*(3), 216-231. Retrieved from http://psycnet.apa.org/record/2009-05283-002

Sandholtz, J. H., Ringstaff, C., & Dwyer, D. C. (1997). *Teaching with technology: Creating student-centered classrooms.* New York, NY: Teachers College Press.

Seo, Y. J., & Bryant, D. (2012). Multimedia CAI program for students with mathematics difficulties. *Remedial and Special Education*, *33*(4), 217-225. Retrieved from https://journals.sagepub.com/doi/abs/10.1177/0741932510383322

Schmidt, C. S. (1999). *Strategies for teaching students with learning and behavior problems*. Boston, MA: Allyn and Bacon.

Schwartz, J. E., & Beichner, R. J. (1999). *Essentials of educational technology.* Needham Heights, MA: Allyn & Bacon.

Shapiro, E. (2018). *Tiered instruction and intervention in a response-to intervention model*. Retrieved from http://www.rtinetwork.org/essential/ tiered instruction/tiered-instruction-and-intervention-rti-model

Silver, E. (1987). Cognitive theory and research. In A. Schoenfeld (Ed.), *Cognitive science and mathematics education* (pp. 33-60). Hillsdale, NJ: Erlbaum.

Simkins, M. (2006, February). Does technology pay? *Technology and Learning*, *26*(7), 22- 25. Retrieved from https://eric.ed.gov/?id=EJ754918

Snow, C. (2002). *Reading for understanding: Toward an R&D program in reading comprehension*. Santa Monica, CA: Rand Corporation.

Special Education Guide. (2018, August 22). *Response to intervention.* Retrieved from https://www.specialeducationguide.com/pre-k-12/response-to-intervention/

Taepke, P. A. (2007). *Effect of computer-aided instruction on grades in middle school algebra* (Doctoral dissertation, University of San Diego). Retrieved from http://gradworks.umi.com/32/66/3266729.html

Technical Assistance System Network. (2018). Multi-tier system of supports (MTSS): KSDE. Retrieved from https://www.ksdetasn.org/mtss

Townsend, M. (2012). *Computer technology, student achievement, and equity: A multilevel analysis of the relationship between high school students' use of computers, gender, and mathematics achievement.* (Doctoral Dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3497217)

Trotter, A. (2007). R & d project on algebra software seen to show promise. *Education Week*, *27*(5), 10. Retrieved from http://www.grantsandresearchhelp.us/research/SimCalc-EdWeek.pdf

Waxman, H., Connell, M., & Gray, J. (2002). A quantitative synthesis of recent research on the effects of teaching and learning with technology on student outcomes. *Learning Point*, 1-19. Retrieved from http://www.coe.ufl.edu/Courses/eme5054/Foundations/Articles/waxman.pdf

Wong, M., & Evans, D. (2007). Improving basic multiplication fact recall for primary school students. *Mathematics Education Research Journal*, *19*(1), 89-106. Retrieved from https://link.springer.com/article/10.1007/bf03217451

Woody, L. (2013). *The effects of a web-based mathematics program on student achievement.* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database. (UMI No. 3571108)

Xin, J. (1999). Computer-assisted cooperative learning in integrated classrooms for students with and without disabilities. *Information Technology in Childhood Education Annual*, (1), 61-78. Retrieved from https://www.learntechlib.org/p/8848/

Ysseldyke, J., Thill, T., Pohl, J., & Bolt, D. (2005). Using Math Facts in a Flash to enhance computational fluency. *Journal of Evidence Based Practices for Schools, 6*(1), 59-89. Retrieved from https://books.google.com/books

Appendices

Appendix A: District D Cut Scores Document - Math

District Cut Scores: Math

When considering student interventions, the following data sources should be utilized. A balanced approach reviewing both current and historical data will assist in identifying the most appropriate support.

1. MAP Scores/percentile
2. State Assessment Scores
3. Classroom performance, such as formative and summative assessments and teacher observations

The tables provide the range of MAP RIT scores within the specified percentiles at each tested grade level.

TIER 1—General Education Classroom (Core Intervention)

State Assessment—Student is scoring Level 2 or above

MAP Criteria—Percentiles from 32nd to 50th

	Fall	Winter	Spring
3rd Grade	184-190	192-198	197-203
4th Grade	196-202	202-209	206-213
5th Grade	205-211	210-217	214-221
6th Grade	210-218	215-222	218-225
7th Grade	215-223	218-226	220-229
8th Grade	218-226	221-229	222-231
9th Grade	222-230	224-232	224-233
10th Grade	221-230	222-232	223-232

TIER 2 Intervention

State Assessment—Student is scoring Level 1 or 2

MAP Criteria—percentiles from 17th to 31st

	Fall	Winter	Spring
3rd Grade	178-184	186-192	190-197
4th Grade	189-195	195-202	199-206
5th Grade	197-204	203-210	206-213
6th Grade	203-210	207-214	209-217
7th Grade	207-214	210-218	212-220
8th Grade	209-217	212-220	213-221
9th Grade	213-221	214-223	215-224
10th Grade	211-220	212-222	212-222

TIER 3 Intervention

State Assessment—Student is scoring Level 1

MAP Criteria—percentiles at or below 16th percentile

	Fall	Winter	Spring
3rd Grade	177	184	190
4th Grade	188	194	199
5th Grade	197	201	205
6th Grade	202	205	209
7th Grade	206	208	211
8th Grade	209	210	212
9th Grade	212	213	214
10th Grade	211	211	212

Appendix B: District Email Approval for Research

Reply Reply All Forward

[redacted]

Wed 10/31/2018 11:41 AM

[redacted]

Re: Ceresa Schaffer IRB Form October 30 2018.pdf

To Ceresa L. Schaffer

Cc CeresaLSchaffer@stu.bakeru.edu

You replied to this message on 10/31/2018 11:46 AM.

Ceresa,

You have permission to use the data requested in the manner described in the IRB application submitted.

[redacted]

Sent from my iPad

On Oct 30, 2018, at 9:59 AM, Ceresa L. Schaffer <CSchaffer@[redacted]> wrote:

> [redacted]
>
> I have completed my IRB form with my advisor. It is attached. If you could please take a moment to review and respond with your answer to my request, I would greatly appreciate it.
>
> Thank you and have a great day!
>
> Ceresa L. Schaffer
>
> <Ceresa Schaffer IRB Form October 30 2018.pdf>

Appendix C: Baker University IRB Approval to Conduct Research Letter

Baker University Institutional Review Board

November 1st, 2018

Dear Ceresa Schaffer and Susan Rogers,

The Baker University IRB has reviewed your project application and approved this project under Exempt Status Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.

Please inform this Committee or myself when this project is terminated or completed. As noted above, you must also provide IRB with an annual status report and receive approval for maintaining your status. If you have any questions, please contact me at npoell@bakeru.edu or 785.594.4582.

Sincerely,

Nathan Poell, MA
Chair, Baker University IRB

Baker University IRB Committee
Scott Crenshaw
Erin Morris, PhD
Jamin Perry, PhD
Susan Rogers, PhD