EFFECT OF TI NSPIRE ON RESOURCE ALGEBRA STUDENTS'

MATHEMATICS ACHIEVEMENT AND ATTITUDE

A Dissertation

by

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ABSTRACT

The use of the calculator in a mathematics class has been studied and debated since the calculator was first introduced into the classroom. As the technology of calculators have evolved into interactive learning tools, little research could be found about the effects of an interactive calculator on the mathematical achievement and attitudes of students with disabilities. To determine if the TI Nspire handheld calculator is effective in increasing mathematical achievement and attitudes of students with disabilities, a qualitative-dominant mixed method approach was used. Interviews with an Algebra I teacher of students with disabilities were held to determine the teacher's perception of teaching with the TI Nspire. Interviews with students in Resource Algebra I classes were held to ascertain the mathematical attitudes of the students while pre- and post-test scores from students at the beginning and end of the course were analyzed quantifiably.

Pre- and post-tests from the control group were administered during the second half of their Algebra I course. The intervention group were administered the pre- and post-tests during the first half of their Algebra I course with an additional pre-test given at the beginning of the second half of their Algebra I course. Analysis resulted in no statistically significant differences; however, with effect sizes of Cohen's *d* between 0.121 and 0.541, a level of practical significance was found.

Interviews with six students from the control group and eight students from the intervention group were held to ascertain student attitudes towards mathematics.

Statements from the interviews were coded as positive, negative, and neutral. Results determined the overall statements provided by the intervention group contained 6% more positive than negative statements. Statements provided by the control group were more negative than positive by 2%.

A pre-intervention and post-intervention interview was conducted with the teacher of the Algebra I classes. Statements provided by the teacher were coded as positive, negative, neutral, and example. The teacher's attitude toward the use of the TI Nspire as a teaching tool became more positive as evidenced by the increase in positive statements from the pre-intervention to post-intervention interview.

DEDICATION

To my late parents, Christine Michalka and Florance Gilbert Karnowski (TAMU ’50) who instilled in me the importance of a good education.

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NOMENCLATURE

IEP	Individualized Education Program
TI	Texas Instruments
NCTM	National Council of Teachers of Mathematics

TABLE OF CONTENTS

LIST OF FIGURES

FIGURE Page

LIST OF TABLES

TABLE Page

CHAPTER I

INTRODUCTION

Overview

Technology continues to be integrated into both general education and special education in all content areas at the elementary and secondary levels. The calculator is one particular type of technology that has been used in mathematics classrooms since hand-held calculators were introduced in 1967 (TI, 2008; Valentine, 2016). These calculators have evolved throughout the years. Even the graphing calculator, first created by Casio in 1985 (Valentine, 2016), has evolved into the graphing calculator that many secondary and postsecondary students now use. Graphing calculators created by Casio, Hewlett-Packard (HP), and Texas Instruments (TI) are now interactive, creating a technology tool that helps students better understand mathematical concepts (Greenhaus, n.d.; Hill, 2010; Olley, 2013). Interestingly, TI has captured the majority of the school market (McFarland, 2014).

The current TI graphing calculators include the TI-84 family (TI-84 Plus, TI-84 C, etc.) and the TI Nspire (which includes the TI Nspire Numeric, TI Nspire CX and the TI Nspire CAS). Researchers have conducted studies with TI graphing calculators and found students' mathematical achievements as well as mathematical attitudes improved (Noraini, 2006; Rivera, 2007). In 2007, TI created a program known as the MathForward Program to help teachers use graphing calculator technology (specifically the TI Nspire Numeric) in their mathematics classroom which resulted in student success (Penuel, Singleton, & Roschell, 2011; Penuel, 2008a; Penuel, 2008b). However, little research has been conducted as to the benefits of the TI Nspire with students with disabilities.

Statement of the Problem

The TI Nspire calculator was designed to assist students at all levels in learning and understanding mathematical concepts. However, the researcher of this study has found that students in many high schools enrolled in upper level mathematics are the ones who use the school's class set of TI Nspires. The TI Nspire has the potential to provide students learning opportunities in both general and special education classes.

Purpose and Significance of the Study

Although many research studies have focused on the use of the calculator and students' mathematical achievements and attitudes, little research has been conducted regarding calculator use by students with learning disabilities except for use in assessments (Yakubova & Bouck, 2014). The researcher's goal for this study was to determine the effect the TI Nspire handheld calculator had on the mathematical achievement and attitudes of students with learning disabilities.

In addition, teachers' attitudes toward the use of the calculator in a mathematics classroom were found to have an effect on student mathematical achievement and attitude (Hartsell, Herron, Fang, & Rathod, 2009; Heller, Curtis, Jaffe, & Verboncoeur, 2005). Therefore, this study also included an interview with the resource teacher to determine the attitude of the teacher regarding the use of the TI Nspire as a teaching tool and to ascertain if the teacher's attitude aligns with the students' mathematical attitudes.

Research Design

A qualitative-dominant mixed method approach was used during this research study because qualitative techniques were more suitable due to goodness of fit between the research questions and the method of finding the answers regarding the teacher's perception of teaching with the TI Nspire and the students' attitudes toward mathematics. Interviews with the students were conducted to determine students' attitudes toward the use of the TI Nspire in the learning of mathematics (A. Onwuegbuzie & R. Friels, personal communication, February 4, 2015; Onwuegbuzie, Johnson, & Collins, 2009). Pre- and post-test scores from students at the beginning and end of the course were analyzed using quantitative methods.

Research Questions and Hypotheses

The purpose of this study was to ascertain the effectiveness of the TI Nspire with students in a Resource Algebra I class on both students' mathematics achievement and attitudes toward mathematics. The results from this research will answer the following:

1. Does using the TI Nspire handheld calculator in a resource Algebra I class increase mathematics achievement?

   Hypothesis: The use of the TI Nspire handheld calculator in a resource Algebra I class will increase mathematics achievement of students.

2. What is the effect of the TI Nspire handheld calculator on the attitudes of students in a resource Algebra I class toward mathematics learning?

   Hypothesis: Students with identified disabilities who use the TI Nspire handheld calculator will develop more positive attitudes toward mathematics.

3. a. What is the effect of the TI Nspire handheld calculator on the attitudes of the Algebra I resource teacher when teaching with the calculator?
   Hypothesis: The teacher of the resource Algebra I students will develop a more positive attitude toward using the TI Nspire handheld calculator as part of her classroom instruction.
   b. What is the effect of the TI Nspire handheld calculator on the attitudes of the Algebra I resource teacher towards students' mathematical learning?
   Hypothesis: The Algebra I resource teacher will develop a more positive attitude towards students' mathematical learning when using the TI Nspire handheld calculator.
4. How is the teacher's attitude toward teaching with the TI Nspire handheld calculator aligned with the students' attitudes toward mathematical learning with the TI Nspire handheld calculator?
   Hypothesis: Both the teacher and students of the Algebra I resource class will show improvement in their attitudes toward mathematical learning when using the TI Nspire handheld calculator.

Assumptions and Limitations of the Study

As with any research, there are assumptions and limitations in this study. The researcher assumes that the Algebra I resource teacher received sufficient training on the TI Nspire handheld calculator and adequately utilized the training received. The TI

Nspire was introduced into the curriculum at the same time that the study began in 2017. Another assumption is that the participants will answer questions posed in the pre- and post-surveys honestly. The participants are volunteers and have the right to end the interview at any point after they have started. When taking the pre- and post-tests, it is assumed that the students will concentrate on answering the questions to the best of their ability. The researcher assumes that the teacher is using the calculator with fidelity and is adhering to the curriculum set forth by the school district and state. Also, the researcher assumes that the students in the class qualify to be a part of the special education program, attend class, and work to the best of their abilities.

The limitations of the current study involve sample size, time, and learning abilities. The control group consisted of students in two resource Algebra I classes that were held in the fall semester of 2016. The classes contained a total of 20 students who were under the age of 16; therefore, parental permission was required resulting in a reduction in sample size. The intervention group consisted of students in two resource Algebra I classes that were held in the spring semester of 2017. These classes also contained a total of 20 students who were under the age of 16, requiring parental permission resulting in a reduction in sample size. Conducting the intervention for one semester limits the opportunity for the students to become proficient in the use of the TI Nspire handheld calculator. The students in the classes were students who were diagnosed with learning disabilities which could limit their abilities to learn, not only the calculator, but also the subject matter. Limitations also exist for the teacher with the amount of training that was provided with the TI Nspire and the confidence the teacher had with teaching mathematical concepts with the calculator.

Potential Ethical Concerns

Several potential ethical concerns in relation to the conduct of this study have been identified. The participants in the study are students between the ages of 14 and 17 who are enrolled in a resource algebra class and who may have learning, emotional, or physical disabilities. The students' pre- and post-test scores were used to determine if their mathematics achievement improved; therefore, parental permission was obtained. Although the test scores will be reported without the students' names, there would be potential for loss of confidentiality because the parents and students' names are on the permission form. To alleviate the loss of confidentiality, forms were placed in a locked filing cabinet and the permission forms will be the only way to connect the student to the study.

Due to the researcher being the sole researcher of the study, ethical concerns regarding coding and confidentiality could exist. The researcher was a PhD Candidate in Curriculum and Instruction specializing in mathematics education. As part of the doctoral program, 12 hours of study in statistics were required. These hours included six hours of quantitative statistics and three hours of qualitative statistics. The remaining three hours were not specified; however, the researcher completed three hours of mixed methods study. In addition, the researcher attended workshops that pertained to mixed methods research.

Operational Definitions Used in the Study

IEP – Individualized Education Program. "A written statement for each child with a disability that is developed, reviewed, and revised in a meeting" (Education, 2007).

Resource Algebra I. A class that is designed for students who require more than one year to complete an algebra class. Criteria are used to determine who is enrolled in the Resource Algebra I class included state test scores, individualized education programs (IEP), and referral by the student's eighth grade teacher.

Special education. "…the academic, physical, cognitive and social-emotional instruction offered to children who are faced with one or more disabilities." (https://teach.com/what-is-special-education/)

TI Nspire Handheld Calculator. "A robust, hands-on learning tool that satisfies math and science curriculum needs from middle school through college" (Texas Instruments, n.d.)

The Expected Outcomes

The expected outcomes for the current study include an increase in mathematical achievement and more positive student attitudes toward mathematics. In addition, the teacher will possess a more positive attitude when integrating the TI Nspire into Algebra I mathematics topics. Students who use the TI Nspire will have statistically significant higher post-test scores than students who did not use the TI Nspire during an Algebra I course. Also, students using the TI Nspire will possess beliefs that mathematics is a necessary and one that is enjoyable to study. The teacher of the Resource Algebra I class will exude more confidence when teaching with the TI Nspire and believe that the calculator has positive merits when teaching students with special needs.

CHAPTER II

LITERATURE REVIEW

A review of the literature concerning calculator use by students in both general education and special education classes revealed three main topics. Research has been conducted to determine effects of the calculators while being used in the classroom. A second research topic was found dealing with calculator use by students with disabilities. A third research topic dealt with teachers' comfort with calculators. These three topics provide the background literature for the current research study.

Calculator Use in the Classroom

Much research has been conducted concerning the use of calculators by elementary and secondary students. A comprehensive, well-cited meta-analysis conducted by Hembree and Dessart (1986) focused on the usage of calculators in the classroom. A similar meta-analysis was conducted in 2003 by Ellington. Hembree and Dessart (1986) evaluated articles and dissertations written between 1978 and 1982 while Ellington (2003) analyzed research between 1983 and March 2002. Ellington took Hembree and Dessart's lead concerning the structure of her meta-analysis reporting on achievement and attitudes. Both meta-analyses used the method by Glass including effect sizes and significance with inferential statistics developed by Hedges (Ellington, 2003; Hembree & Dessart, 1986). The criteria for both studies included reports of calculator use in K-12 mainstream classrooms and the reports provided enough information to determine effect sizes. Hembree and Dessart analyzed 79 studies while Ellington analyzed 54 studies.

Results from these meta-analyses were mixed. Hembree and Dessart (1986) found that calculators had no significant effect on achievement of concepts while Ellington (2003) found improvement only when the calculators were used in combination with testing and instruction. Both studies revealed an improvement in the selection of problem-solving strategies with the use of the calculator; Hembree and Dessart found greater effect with the low- and high-ability students over average students. Retention skills also showed improvement in both analyses; however, Ellington found greater improvement when the calculator was used over a long period of time (more than 8 weeks). Student attitudes regarding the use of the calculator were found to be positive in each meta-analysis.

Other researchers have also conducted meta-analyses focusing on calculators. Khoju, Jaciw, and Miller's (2005) meta-analysis for Empirical Education, Inc contained eight studies (four published studies and four unpublished dissertations) concentrating on graphing calculators and five studies pertaining to non-graphing calculators. The report concentrated on graphing calculator studies; however, only four studies used the criterion of studying the effect of calculators on algebra skills. Two of those four studies reported two independent effect sizes that the authors used to provide six outcomes. The results of the systematic review gave evidence that enhanced performance in algebra skills was achievable with the use of a graphing calculator (Khoju et al., 2005).

Additional research conducted since 2002 looked at the use of calculators and their effect on access, achievement, and attitude. Those studies examined students' achievement and attitudes when the students had access to calculators or used calculators. Students in a study who used the TI-84 Plus graphing calculator showed significant differences on improving achievement and reducing anxiety (Noraini, 2006). Another study by Heller et al. (2005) that included 458 students and 11 teachers found that students who had access to a graphing calculator for their individual use had a higher mean algebra score as opposed to those students who did not use graphing calculators in their mathematics class. Results indicated that students who were instructed with graphing calculators more often had higher test scores. These researchers also compared students who were allowed to use graphing calculators at all times to those students who were not allowed to use the graphing calculator all the time and found the mean algebra test score to be higher for students who had restricted use of the graphing calculator (Heller et al., 2005).

While most researchers who conducted studies in the late 20th and early 21st century have confirmed what the early meta-analyses found—that calculator use in mathematics classrooms does improve achievement and reduce anxiety—other researchers have conducted studies resulting in calculator use having a negative effect. This research was in the form of dissertations that were reviewed by Barton (2000) who found five specific topics in which the control group performed better. These five topics included translation of functions, slope of linear functions, trigonometry functions, calculus graphical problems, and integrals and area.

Within the calculator use in the classroom, three areas of interest have emerged. One area of interest was the effective use of calculators. Another area of interest was promotion of mathematical discourse. The third area of interest was content area vocabulary.

Effective use of calculators. The advantages of using a calculator occur only when the calculator is utilized effectively. The National Council of Teachers of Mathematics (NCTM) (2000) has recommended students use calculators with problem-solving, when computational skills are beyond the students' current level, to develop and explore concepts, to discover patterns, and when using real data that is cumbersome. Elementary and middle school students should be encouraged to use calculators when exploring patterns, testing conjectures and solving problems, conducting investigations, and visualizing solutions (Van de Walle, Karp, & Bay-Williams, 2016).

The effectiveness of calculators depends on how the calculators are used. Evidence presented showed when students used calculators constantly the effectiveness is diminished (Golden, 2000; Heller et al., 2005). In the study by Heller and colleagues (2005), students who were not allowed to use calculators at various times (e.g., testing for understanding and developing conceptual understanding) had a mean score higher than students who were consistently allowed to use calculator. When calculators are used effectively, students' mathematical knowledge is deepened (Cavanagh, 2005). Noraini (2006) found that students were better able to make connections between their previous knowledge and new information when calculators were used in an efficient manner.

Promotion of mathematical discourse. Effective use of the calculator in the classroom has been shown to promote mathematical discourse. The goal of mathematical discourse in the classroom is to raise the level of thinking through verbal interactions while students are learning (Van de Walle et al., 2016). Communication and exchange of ideas are enhanced when calculators are used as tools in mathematics classrooms (ISTE, 2007; Lee & McDougall, 2010; Pomerantz & Waits, 1997).

Discussions occur in several different ways when students use a calculator. For example, when a student performs a miscalculation, these mistakes afford the teacher opportunities to discuss the method or strategy students used when entering calculations into the calculator (Knuth & Peressini, 2001). The whole class can be involved in discussions of different strategies involved in solving problems with dialogue focusing on reasoning, thinking, and justifying solutions (Moss & Grover, 2007). A second example is the use of calculators with a lesson on division. Lucas and Cady (2012) explained how students could use calculators with division. Having students repeatedly subtract a number that is not a factor of the beginning number will elicit a discussion of the remainder. Depending on the context of the problem, discussion could include when and how the remainder might be a part of the solution.

Teachers play an active role in classroom discourse when using calculators. Teachers are able to ask more open-ended questions about meaning and relationship (Doerr & Zangor, 2000). By asking open-ended questions, further discussions develop creating a more student-centered classroom (Simonsen & Dick, 1997). Promoting a more student-centered classroom opens the door for students to contribute and share more of their mathematical knowledge, which is a goal of discourse (Hillman, 2014).

Content area vocabulary. Content area subjects have vocabulary particular to the subject matter being taught. Mathematics contains vocabulary distinctive to the subject as well as common words with mathematical definitions (e.g., table) (Dunston & Tyminski, 2013). Calculators bring into play additional vocabulary if students are to properly input problems (Rubenstein & Thompson, 2001). Mathematical vocabulary is believed to be enhanced with technology; however, not enough research is available to make a definitive claim (Riccomini, Smith, Hughes, & Fries, 2015). Learning the vocabulary of mathematics is an important element of mathematical learning (Capraro & Capraro, 2006; Capraro, Capraro, & Rupley, 2010; Dunston & Tyminski, 2013; Riccomini et al., 2015). Combining mathematical vocabulary with technology such as the graphing calculator could enhance mathematical learning.

Calculator Use for Students with Disabilities

According to the United States Department of Education, special education is defined as "specially designed instruction, at no cost to the parents, to meet the unique needs of a child with a disability" (http://idea.ed.gov/explore/view/p/,root,regs,300, A,300%252E39). Students who need special education receive an Individual Education Plan (IEP) and typically have learning disabilities (LD), emotional/behavior disorders (EBD), communication disorders (CD), attention deficits/hyperactivity (ADHD), or intellectual disabilities (ID) (Center for Technology in Learning, 2009; Steele, 2006; Steele, 2007). Special education instruction in the mathematics classroom may be provided to students who struggle to sort out information in a word problem, have low-motivation or self-esteem concerns related to recurrent academic weaknesses which leads to reluctance to take on new tasks, and/or laboring with arithmetic and computational gaps (Center for Technology in Learning, 2009).

The National Council of Teachers of Mathematics (NCTM) introduced revised standards in 2000 which included equity in learning (Cawley, Parmar, Foley, Salmon, & Roy, 2001; NCTM, 2000). With the passing of the 1975 Individuals with Disabilities Education act (IDEA) and its 1997 amendments, students with special needs moved from their special education classrooms into general education classes (Sharpe, 2014). No Child Left Behind (NCLB) signed in 2002 and Every Student Succeeds act (ESSA) in 2015 (a reauthorization of NCLB) confirmed the inclusion of students in special education into mainstream education classes (Bouck, 2010).

Although technology became a part of the NCTM revised standards (NCTM, 2000), there has not been much research conducted on the subject of technology in special education mathematics classes (Yakubova & Bouck, 2014). Bouck and Flanagan (2009) reviewed 17 research articles that were published between 1996 and 2007 on the use of assistive technology (AT) in special education mathematics classes. Their criteria for the review involved participants who had high-incidence disabilities and were students in the United States, K-12 classrooms, articles published in English language refereed journals, mathematically focused, and research based. Three main areas of research were deduced from the articles found: anchored instruction, computer-assisted instruction, and calculators.

The third area that Bouck and Flanagan (2009) found was the use of calculators as a tool. Debate surrounds the use of calculators no matter if the research was conducted for special or general education students. The prevailing research on students with disabilities has been with the calculator as an accommodation for assessment (Bouck & Flanagan, 2009; Bouck & Yadav, 2008; Thompson & Sproule, 2005); however, when calculators should be used in instruction is also an issue. Bouck and Flanagan (2009) provided no conclusions regarding calculator use because educators and scholars do not agree when students should be allowed to use calculators. Even though research was reviewed between 1996 and 2007 and studies were found on the calculator as an accommodation, a study conducted by Horton in 1985 used the calculator as an intervention to examine the effects the calculator had on computational performance. In the study, students with disabilities showed improvement with correct computational performance and with the aid of the calculator were able to accurately complete complex arithmetic problems. Since 2007, researchers have studied the use of calculators by special education students other than its use as an accommodation and continue to disagree on the instructional benefit. Two studies resulted in contradictory conclusions regarding calculator use for computation and word problem solving (Bouck, Bouck, & Hunley, 2015; Yakubova & Bouck, 2014). As long as there are researchers and willing participants, the calculator debate will continue.

There are a number of disadvantages of calculator use by students with disabilities. Students with visual processing problems may have problems with a calculator (Steele, 2006). These problems might include remembering what purpose the buttons have, confusion resulting from the negative and subtraction keys looking similar or from all the buttons that have an "X" on them, and following the correct sequence of buttons for multi-step problems. For students with auditory processing disabilities, following and understanding directions given by the teacher when learning to use the calculator could be a struggle (Steele, 2006). Using a calculator does require the use of fine motor skills; therefore, students who have difficulties with motor processing skills may have difficulty accessing the buttons on a calculator. Additionally, those students with fine motor coordination may find difficulty using the calculator with precision (Steele, 2006). Teachers should be aware of each child's disabilities so that strategies and resources (such as adapted calculators) may be made available for the students to be successful (Center for Technology in Learning, 2009).

Teachers' Comfort With Calculators

Part of the debate surrounding the use of calculators in classrooms deals with teachers' attitudes towards calculator use. Research literature concerning teachers' attitudes is mixed but generally revolves around five main themes: (1) dependency on calculators, (2) students' attitudes and mathematical knowledge, (3) time constraints, (4) teachers' knowledge of the calculator, and (5) teachers' comfort level. Much of this research is qualitative consisting of surveys, observations, and interviews.

One argument by teachers against the use of calculators is the diminished knowledge of basic mathematical facts and mental mathematics and the fear that students will become dependent on the calculator. This argument is a belief of many teachers (Bouck, 2007; Gogus, 2008; Simonsen & Dick, 1997). If a teacher believes that a student learns best with paper-and-pencil or the student must show an understanding of mathematics without the aid of technology, the teacher may have a disapproving opinion towards the use of calculators in mathematics classrooms (Pierce & Ball, 2009). Using interview protocol, Simonsen and Dick (1997) determined fear of a dependency on calculators to be a minor trend. Teachers who had this fear were hesitant about integrating technology into their classrooms. Some teachers also believed that learning how to use calculators will have a negative effect on students' learning of mathematics (Bouck & Bouck, 2008; Reys & Arbaugh, 2001). Although NCTM (2000) has encouraged the use of calculators in the classroom, effective use depends on the teacher. Teachers are encouraged to strike a balance between calculator, paper-and-pencil, and mental mathematics (Lucas & Cady, 2012).

Students' attitudes toward mathematics have been found to improve with the use of calculators (Center for Technology in Learning, 2009; Ellington, 2003; Hembree & Dessart, 1986; Noraini, 2006). Researchers have noted that teachers' attitudes toward the amount of calculator use has been positive when students have shown positive attitudes (Berry, Graham, Honey, & Headlam, 2007; Brown et al., 2007; Tan & Forgasz, 2006). Researchers have also noted that interactions between teachers and students can play a pivotal role in determining if technology is used in the classroom (Goos, Galbraith, Renshaw, & Geiger, 2003). Thus, teachers have an important job in deciding how calculators are used in the classroom.

Teachers' attitudes toward the calculator in the classroom have been determined by the amount of time it takes both the teacher and students to learn the technology.

Teachers and students required extra time to adequately learn to use calculators (Berry et al., 2007; Goos & Bennison, 2008; Pierce & Ball, 2009; Simonsen & Dick, 1997). Teachers needed time to explore how technology should be integrated into their lessons (Goos & Bennison, 2008). Issues of time were also involved with the logistics of calculator use (e.g., needing to change batteries, distribute the devices, etc.) (Berry et al., 2007). This additional time for learning to use calculators, plan lessons, and for logistical reasons can cause negative attitudes on the part of the teacher towards technology use.

Some research surrounding teachers' attitudes toward calculator usage in the classroom included teacher knowledge—of both the content and of the calculator itself. Teachers were found to be reluctant to use calculators if they considered themselves to have insufficient training on how to use the calculator (Berry et al., 2007; Patterson & Norwood, 2004). In one study, teachers' workshop attendance was found to make a difference in how calculators were used (Yoder, 2000). Teachers who attended at least one workshop used calculators for discovery and were less likely to believe that their students would develop a dependency on the calculator. Another study showed students' scores were significantly higher when teachers attended calculator training sessions as opposed to those teachers who were self-taught (Heller et al., 2005). Attendance at a four-week in-service program provided teachers with more confidence in applying the use of calculators in their classrooms (Hartsell et al., 2009). Thus, professional development on the use and integration of the calculator may make a difference in teachers' perceptions toward using technology in mathematics classrooms.

The comfort level of teachers' use of calculators in their mathematics lessons vary. Some teachers are on the side of the debate that calculators should not be used for computation (Gogus, 2008; Reys & Arbaugh, 2001). Educators with this view argue that calculator use limits the development of reasoning and thinking skills and should not be used for computation (Papadopoulos, 2013; Reys & Arbaugh, 2001). Direction and support should be provided for teachers uncomfortable with the use of calculators for computation (Hartsell et al., 2009). Other teachers were comfortable using calculators and effectively used them as instructional tools (Gogus, 2008). These teachers were generally experienced with calculators and agreed with the positive effects of using the calculator (Papadopoulos, 2013).

In order for calculator use to increase, the comfort level of teacher's usage of calculators needs to improve. Teachers should change their pedagogy and be comfortable with whatever calculator they use (Noraini, 2004). Heller et al. (2005) found that students who learned from teachers who were self-taught on the calculator performed significantly worse than those students whose teachers were trained during organized professional developments on the use of calculators. Attention should be focused on the proper professional development for integrating calculators into the mathematics classroom (Gogus, 2008; Koehler & Mishra, 2009).

Conclusion

Calculator use in both general and special education mathematics classrooms is becoming more common. Many researchers have indicated that students' mathematics achievement and attitude toward mathematics have improved with the use of calculators.

There is evidence that the effective use of calculators in mathematics classrooms also contributes to greater discourse, better problem solving, and enhanced vocabulary. Educators and scholars have discussed teachers' comfort with the use of calculators and their effect on student achievement. Whether teachers use calculators, paper-and-pencil, or a combination of both, mathematics competency is of primary importance.

CHAPTER III

METHOD OF STUDY

Research Design

Research Diagram. This study utilized both quantitative and qualitative data, the two most common methods of research in the educational field. Before the late 20th century, educational research was mostly quantitative (Rossman & Wilson, 1985). Naturally, as qualitative methods became more dominant in the educational research field, a debate arose between the two camps, referred to in research literature as the "paradigm wars," (Denzin, Lincoln, & Giardina, 2006; Johnson & Onwuegbuzie, 2004; Rossman & Wilson, 1985). Literature regarding research using both quantitative and qualitative methods is abundant.

Quantitative research deals with numerical analysis of data; it is what the layperson may refer to as statistics. Numerical data are often collected by means of polls, questionnaires, surveys, or scores (Research Guides, n.d.; Thompson, 2006) and analyzed commonly through descriptive statistics, factor and cluster analyses, *t*-test, ANOVA, and regression (Skidmore & Thompson, 2010). The purpose of quantitative research is to find the relationship between dependent and independent variables (Research Guides, n.d.). Quantitative research is considered to belong to a positivist, or postpositivist, paradigm (Firestone, 1987; Onwuegbuzie, Johnson, & Collins, 2009). Postpositivist researchers believe in the use of probability and statistics to make generalizations (Onwuegbuzie et al., 2009).

Qualitative research has been defined by Denzin and Lincoln (1994) as "multimethod in focus, involving an interpretive, naturalistic approach to its subject matter" (p. 2). Qualitative researchers generate data through words in an attempt to gain a deeper understanding of natural phenomena (Denzin & Lincoln, 1994; PPA 696, n.d.). Some common methods of qualitative research include observation through in-depth interviews and with focus groups (Mack, Woodsong, MacQueen, Guest, & Namey, 2005). In-depth interviews allow for collection of data regarding personal history, view point, and experience; focus groups aid research by gathering cultural norms or concerns about issues (Mack et al., 2005).

Along with the strengths of both qualitative and quantitative research, there are also limitations. Quantitative research does not allow for answering the "how" or "why" questions, the data cannot explain the relationships that were identified by the researcher (A. J. Onwuegbuzie & R. Frels, personal communication, February 4, 2015). As Onwuegbuzie and Frels stated, "Quantitative research is better suited to answering questions of who, where, how many, how much, and what is the relationship among specific variables" (personal communication, February 4, 2015). Qualitative research is limited to the size of its sample which usually cannot be generalized (Marshall, 1996).

One of four mixed method designs is the embedded design (Creswell & Plano-Clark, 2011). A researcher uses embedded design when quantitative and qualitative data are "nested" (Caracelli & Greene, 1997) within a conventional design or procedure (Creswell & Plano-Clark, 2011). Qualitative and quantitative data are collected with one paradigm being primary. The secondary paradigm is included so that diverse questions can be asked and answered (Creswell & Plano-Clark, 2011).

An embedded design is frequently used when qualitative data are applied with an experimental design (Creswell & Plano-Clark, 2011). The primary design is quantitative with the qualitative data being the lesser design (Creswell, 2006). According to Creswell & Plano-Clark (2011), the general steps for an embedded design include

> (1) designing the overall experiment and deciding the reason why qualitative data need to be included, (2) collecting and analyzing qualitative data to enhance the experimental design, (3) collecting and analyzing quantitative outcome data for the experimental groups, and (4) interpreting how the qualitative results enhanced the experimental procedures and/or understanding of the experimental outcomes (p. 92).

The purpose of this mixed methods study was to address the lack of research that has been conducted on the TI Nspire graphing calculator with special education students. Both quantitative and qualitative data were used in an embedded mixed methods design (Creswell & Plano-Clark, 2011). An embedded design which included a convergent design was used to gather initial data. The data were collected at the same time yet analyzed separately and then merged (See Figure 1). In the current study, the pre- and post-test scores of students in a resource algebra class were used to determine the effectiveness of the calculator with the students' mathematics achievement. Students from both the intervention and control groups were interviewed using a cognitive lab to determine the students' mathematics attitude. The qualitative data also consist of interviews with the classroom teacher to explore her attitude toward teaching using the TI Nspire and the teacher's attitudes towards the students' use of the calculator. The quantitative data were used to ascertain if the use of the TI Nspire will increase students' mathematics achievement and will change students' attitudes toward mathematics. The qualitative data were used to determine if the use of the TI Nspire will change the teacher's perception of teaching with the TI Nspire (A. Onwuegbuzie & R. Friels, personal communication, February 4, 2015; Onwuegbuzie, Johnson, & Collins, 2009).

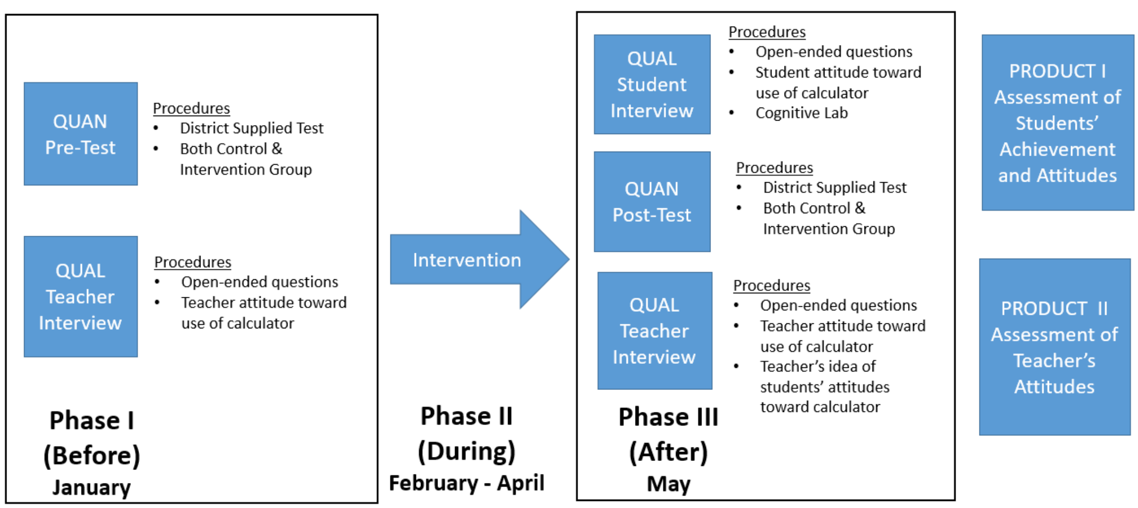

Figure 1. Embedded mixed methods design.

Research Questions and Hypotheses. The purpose of this research study was to ascertain the effectiveness of the TI Nspire with students in a Resource Algebra I class on both students' mathematics achievement and attitudes toward mathematics. The results from this research will answer the following:

1. Does using the TI Nspire handheld calculator in a resource Algebra I class increase mathematics achievement?

Hypothesis: The use of the TI Nspire handheld calculator in a resource Algebra I class will increase mathematics achievement of students.

2. What is the effect of the TI Nspire handheld calculator on the attitudes of students in a resource Algebra I class toward mathematics learning?

   Hypothesis: Special needs students who use the TI Nspire handheld calculator will develop more positive attitudes toward mathematics.

3. a. What is the effect of the TI Nspire handheld calculator on the attitudes of the Algebra I resource teacher when teaching with the calculator?

   Hypothesis: The teacher of the Algebra I resource class will develop a more positive attitude toward using the TI Nspire handheld calculator as part of her classroom instruction.

   b. What is the effect of the TI Nspire handheld calculator on the attitudes of the Algebra I resource teacher towards students' mathematical learning?

   Hypothesis: The Algebra I resource teacher will develop a more positive attitude towards students' mathematical learning when using the TI Nspire handheld calculator.

4. How is the teacher's attitude toward teaching with the TI Nspire handheld aligned with the students' attitudes toward mathematical learning with the TI Nspire handheld calculator?

   Hypothesis: Both the teacher and students of the Algebra I resource class will show improvement in their attitudes toward mathematical learning when using the TI Nspire handheld calculator.

Participants

Students. Students participating in the study were enrolled in a Resource Algebra I course at an East Tennessee high school. The Resource Algebra I class is designed for students who require more than one year to complete an algebra class. Criteria used to determine who was enrolled in the Resource Algebra I class included state test scores, individual education programs (IEP), and referral by the student's eighth grade teacher. The students in the control class completed the first part of the Resource Algebra I course the previous year, their freshman year of high school, and completed the second part of the Resource Algebra I course the year of the study, their sophomore year. The students in the intervention class were freshmen and completed the first part of the Resource Algebra I course during the year of the study.

The total number of students in the intervention class and the control class were approximately 34 (N_I = 18 N_C = 16). The intervention class contained a total of 11 males (61%) and seven females (39%) while the control class consisted of 10 males (62%) and six females (38%). Ninety-seven percent of the students in both the intervention and control classes were classified as White while the other 3% in both classes were classified as African-American students. The students were divided between two classes. The intervention groups were split with 10 students in one class and eight in the other class. Within the first class, seven were male (39% of total intervention participants) and three were female (17% of total intervention participants). The class was 100% White. The second class contained four females (12% of total participants) and four males (12%). Twelve percent of this class was African-American.

The control group was also divided into two classes: six students in one class and 10 students in the second class. The first class contained four males (25% of total control group participants) and two females (12% of total control group participants). The second class contained six males and four females (38% and 25% respectively of total control group participants). Both classes of the control group were classified 100% as White students.

Teacher. The teacher included in the study taught both the control and intervention classes. A certified special education teacher, the teacher is certified to teach Algebra I and has been trained in teaching with the TI Nspire. The teacher is a white female and has been teaching special education classes for 16 years with the year of study being her second-year teaching resource Algebra.

The teacher received her Bachelor of Arts in Speech/Language Pathology from the University of Tennessee (Knoxville) and a Master's in Education from East Tennessee State University specializing in special education. She holds certifications for Special Education Modified K-12, Special Education Comprehensive K-12, Middle Grades Mathematics 6-8, and Beginning Administrator PreK-12. The teacher is certified to teach Algebra I at any level through middle school certification and through a one-week training session by the State of Tennessee. She has continuing professional development through IEP and transition trainings as well as attendance at her district Math academy (professional development for math teachers facilitated by an associate professor of mathematics education at a nearby university). Having taught for a total of 16 years, the teacher taught two years at an Upper East Tennessee high school teaching job and life skills courses. She has been in her current position the remaining 14 years teaching resource and intervention mathematics and during the last two years she has taught a resource Algebra I classes.

Classroom Environment. The resource teacher's classroom is approximately 26.92 feet by 23.75 feet. The students sit at tables instead of individual desks. Each table accommodates two students and the tables are arranged so that two students can turn around into groups of four (see Figure 2). Technology available for the students include a ēno interactive whiteboard, laptops, and TI Nspire handheld calculators. The ēno is located at the front of the classroom along with a pair of dry-erase boards. The laptops are available for student use on a daily basis in addition to Algebra I textbooks (Charles, Kennedy, & Hall, 2012) which are used as reference texts. Motivation posters are hanging on the wall along with student work. Two teacher assistants aid the classroom teacher on a daily basis providing additional one-on-one aid for the students.

Figure 2. Resource Algebra I classroom.

Intervention

The control group used the TI-84 Plus as the class calculator. The TI-84 Plus is the calculator used in 9 of the 11 regular Algebra I classes. Released in 2004 by Texas Instruments, the TI-84 family of calculators continues to be the top graphing calculator used by schools (McFarland, 2014). The TI-84 is permitted on the SAT, ACT, PSAT/NMSQT, AP, and IB exams (Texas Instruments, 2017). In addition to Algebra I, the calculator is used in many other mathematics classes, such as Algebra II, Geometry, Trigonometry, and Calculus, as well as science classes such as Biology, Chemistry, and Life Science (Texas Instruments, 2017).

In 2007 Texas Instruments introduced their TI Nspire Technology which includes the TI Nspire Clickpad, Touchpad, CX, and CX CAS handheld calculators. The intervention group used the TI Nspire Touchpad handheld calculator. The TI Nspire Touchpad is similar to the Casio Prizm fx-CG10 (http://www.casio.com/ products/Calculators_%26_Dictionaries/Graphing/ PRIZM_fx-CG10/) and the Hewlett-Packard Prime graphing calculators (http://www8.hp.com/ us/en/campaigns/ prime-graphingcalculator/ overview.html? jumpid=va_a5cqf1p9xi). The TI Nspire Touchpad handheld calculator was also used in 2 of the 11 regular Algebra I classes. Like the TI-84, the TI Nspire Touchpad is permitted on the SAT, ACT, PSAT/NMSQT, AP, and IB exams and is used in many other mathematics classes, such as Algebra II, Geometry, Trigonometry, and Calculus, as well as science classes such as Biology, Chemistry, and Life Science (Texas Instruments, 2017).

Students in the intervention group used the TI Nspire as the class calculator and were not allowed to take a calculator home. The students used the TI Nspire during the first semester of their Algebra I course. As part of the class procedures, students picked up their assigned calculators as they came into the classroom. Mathematics concepts covered during the spring semester included percent of change; ratios, rates, and conversions; proportions and similar figures; one-, two-, and multi-step equations; literal equations; inequalities (including absolute value and compound); domain and range; and the real number system.

Design of Study

A pre- and post-test exam created by the school system that aligns with Tennessee TNReady standards with ACT questions was administered to both the control group and to the intervention group. The same pre-test was administered to the intervention group at the beginning of the fall semester, 2017. Descriptive statistics (mean, SD, median, IQR) were used to compare the pre- and post-test scores of the intervention group with the pre- and post-test scores of the control group as well as comparing both pre-test scores of the intervention group. Descriptive statistics were used to analyze the pre- and post-test scores to determine if using the TI Nspire handheld calculator improved student mathematical achievement.

Students in both the control and intervention groups were interviewed using a protocol and were also given two mathematics problems to solve—one solved with the calculator and one solved without the calculator. Students in the intervention group volunteered to be interviewed and parental approval was given to the researcher. The resource teacher recommended students in the control group and the researcher received permission from their parents. The interview protocol (see Appendix A) was modeled after the *Attitudes Toward Mathematics Inventory* (ATMI) (Tapia & Marsh, 2004) and the *Attitude of Students Toward Learning in Mathematics* survey by Noraini (2004). Survey questions that pertained to students' attitudes and beliefs concerning mathematics and questions pertaining to the graphing calculators were shortened and modified to be easier for the students to understand. The interview protocol was not piloted before use. The researcher took copious notes during the interview process to record the answers from the students and teacher.

As the sole analyzer of the student interview data, the researcher coded the students' statements using positive, negative, and neutral on three separate days. Statements that were considered to be positive were coded positive. Statements that contained the word "not" and that were negative in nature were coded negative. Neutral statements were neither positive nor negative. A count of each code was tabulated for each day and an average for each code was calculated. Comparing the average counts between the intervention group interviews and the control group interviews determined if the students' who used the TI Nspire had a more positive attitude.

The teacher of record for both the control group and the intervention group was interviewed at the beginning of the second semester and again at the end of the semester. The interview data supplied a qualitative aspect to the study. The interview protocol (See Appendix B) was modified from teacher interview questions by Yakubova and Bouck (2014) and Rich (1991). Interviews were used to determine the teacher's perception of teaching and use of the TI Nspire in a resource Algebra I class. These interviews supplied rich data to better understand the attitudes of the teacher toward the technology.

The researcher was the sole analyzer of the pre-intervention and post-intervention interview data. The researcher coded the teacher's statements using positive, negative, example, and neutral. Statements that were considered to be positive were coded positive. Statements that contained the word “not” and that were negative in nature were coded negative. The teacher provided examples to help explain her answers; these statements were coded example. Neutral statements were neither positive nor negative and were not examples. All statements from both the pre-intervention and post-intervention interviews were coded on three separate days. A count of each code was tabulated for each day and an average for each code was calculated. Comparing the average counts between the pre-intervention and the post-intervention interviews determined if the teacher’s overall attitude had changed. Questions were then separated into those pertaining to the use of the calculator and those pertaining to the students’ mathematical learning. The same procedure to analyze the statements was used to ascertain if the teacher’s attitude toward the use of the calculator had changed as well as the teacher’s attitude about the students’ mathematical learning had changed.

In order to determine if students’ attitudes toward mathematical learning with the TI Nspire handheld calculator and the teacher’s attitude toward teaching with the calculator were aligned, the teacher’s interview answers were compared to the results of the students’ pre- and post-test results as well as the students’ interview answers. This method will provide an elaboration with the use of the TI Nspire (Rossman & Wilson, 1985).

CHAPTER IV

RESULTS

Parental permission and student ascent were acquired. Due to the participants being under the age of consent (i.e., they were 14 - 16 years-of-age), parental permission was required in order to allow the students to be interviewed and to gain access to the students' pre- and post-test scores. The researcher obtained permission from 34 parents to examine the pre- and post-test scores (18 for the intervention group and 16 for the control group). Permission to interview the students was received for all students who were interviewed.

Pre- and Post-Tests

Students in both the intervention and control groups completed a pre- and post-test. The intervention group was administered the pre-test at the beginning of their first semester of Algebra I and the post-test at the end of the semester. Students in the control group completed the pre-test at the beginning of their second semester of Algebra I and the post-test at the end of the semester. In addition, the students in the intervention group undertook the same pre-test at the beginning of their second semester of Algebra I.

The researcher used R, "a language and environment for statistical computing and graphics" (https://www.r-project.org/about.html), to analyze the quantitative data. R was created in 1991 by Ross Ihaka and Robert Gentleman (Peng, 2016) to be open source (i.e., free). Version 1.0.0 was released to the public in 2000 (Peng, 2016). R is used by many organizations including the United States Food and Drug Administration, National Oceanic and Atmospheric Administration as well as Google and Microsoft (J. Reising & T. Faxon, personal communication, June 5, 2017). The researcher used version 3.4.3.

Testing Normality. In order to determine if the means of the variables could be compared, the researcher used Shapiro-Wilk normality test $p > 0.05$ to ascertain whether the data within the variables formed a normal distribution. All variables were found to be normally distributed with the exception of the second pre-test scores within the intervention group (*p*-value = 0.009). Transforming the scores using natural log to reduce skewness created a normal distribution (*p*-value = 0.184); however, transforming the control group pre-test scores to compare against the second intervention group pre-test scores did not create normally distributed scores (*p*-value = 0.000).

In addition, the difference of the post-test scores and pre-test scores for the control group and the difference of the post-test scores and the first pre-test scores for the intervention group were found. The statistics for the new variable from each group were found to be normally distributed (*p*-value = 0.493 and 0.696, respectively) and were used for analysis.

Control Group. Students in the control group were administered the pre-test at the beginning of their second semester. The students completed the post-test at the conclusion of the Algebra I course. The mean of the pre-test scores was 18 ($SD = 8.351$) with the mean of the post-test scores being 21 ($SD = 6.282$), a difference of 3 points (16.7% increase) (see Figure 3). The range was 30 for the pre-test scores and 27 for the post-test scores. Standard errors for pre- and post-test scores were 2.088 and 1.571, respectively (see Table 1). The effect size for the means of the pre- and post-test scores was Cohen's $d = 0.406$ indicating practical significance for these variables.

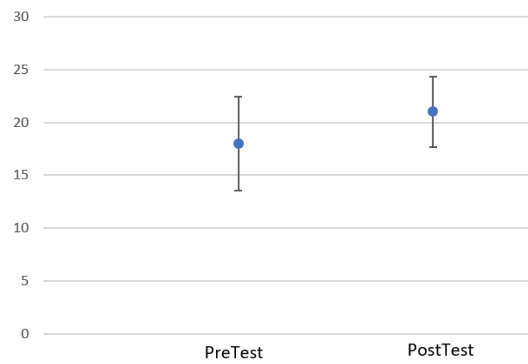

Figure 3. Confidence intervals for control group's pre- and post-test scores.

Table 1

Control Group Pre- and Post-Test Descriptive Statistics

Control Group	Mean	Standard Deviation	Range	Standard Error
PreTest	18	8.351	30	2.088
PostTest	21	6.282	27	1.571

The 5-number summary for the control group scores resulted in a median of 17 for the pre-test and 19 for the post-test. The Interquartile Range (IQR) for the pre-test scores and the post-test scores were 11 and 5.2, respectively (see Table 2). The minimum and maximum scores for the pre-test were 0 and 30 while the minimum and maximum scores for the post-test were 10 and 37, respectively. According to the boxplots in Figure 4, there was an outlier in the post-test scores. Removal of the outlier in the post-test scores resulted in a mean of 19.933 (SD = 4.773), a decrease of 5.1%, and a median of 18 (IQR = 5.5), a decrease of 5.3% (see Figure 5).

Table 2

Control Group Pre- and Post-Test 5-Number Summary

	Range					
Test	Minimum	Maximum	1st Quartile	Median	3rd Quartile	IQR
PreTest	0	30	13	17	24	11
PostTest	10	37	17.8	19	23	5.2

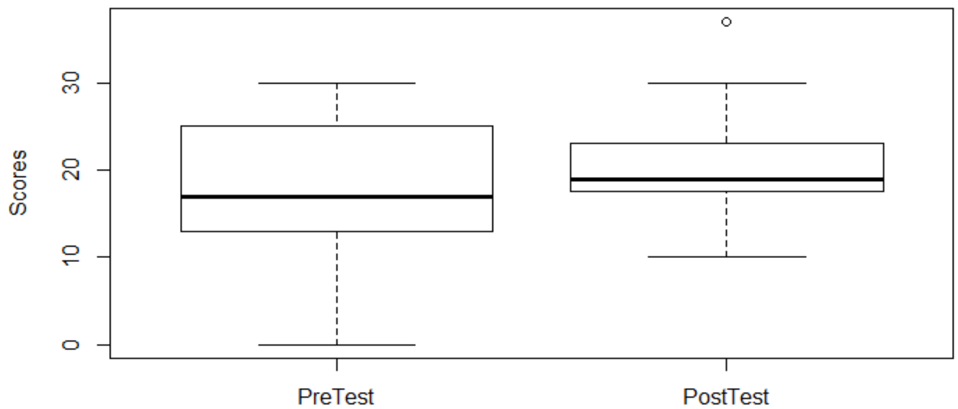

Figure 4. Boxplots comparing control group pre- and post-tests scores.

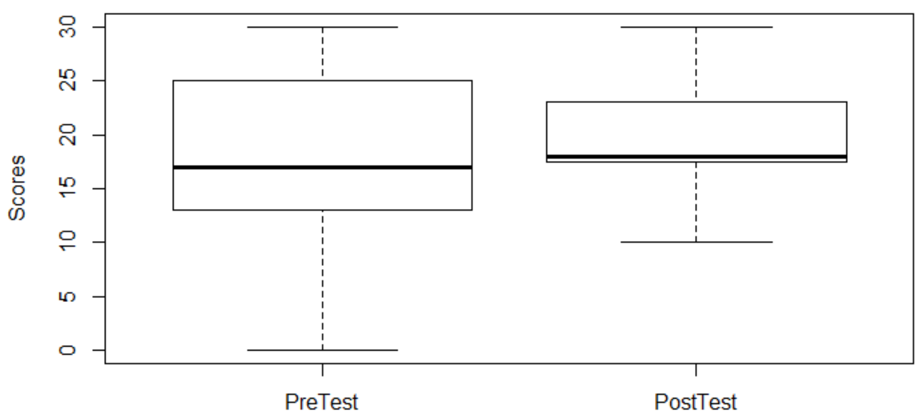

Figure 5. Boxplots comparing control group pre- and post-tests scores with outlier removed from post-test scores.

Intervention Group Students in the intervention group were administered the pre-test at the beginning of their first semester of Algebra I. The students completed the post-test at the conclusion of the first semester. The pre-test was administered a second time at the beginning of their second semester of the Algebra I course. The mean of the first pre-test scores was 21.056 (*SD* = 8.941), the mean of the second pre-test scores was 22.000 (*SD* = 6.426), and the mean of the post-test scores was 24.111 (*SD* = 6.606).

The difference between the means of the first pre-test and the post-test was 3.055 (14.5% increase) (see Figure 6). The effect size of the difference of the variables was Cohen's *d* = 0.389 indicating practical significance. The difference between the means of the first pre-test and the second pre-test was 0.945 (4.5% increase) (see Figure 7). The effect size of the difference of the first pre-test and the second pre-test was Cohen's *d* = 0.121 indicating slight practical significance. The difference between the post-test and the second pre-test was 2.111 (8.8% decrease) (see Figure 8). The effect size of the post-test and the second pre-test was Cohen's *d* = 0.324 indicating a practical significance.

Other descriptive statistics for the intervention group included the range for the first pre-test scores of 26 and 27 for the second pre-test scores. The range for the post-test scores was 24. Standard error for the first pre-test scores was 2.107, for the second pre-test scores was 1.515, and for the post-test scores was 1.557 (see Table 3).

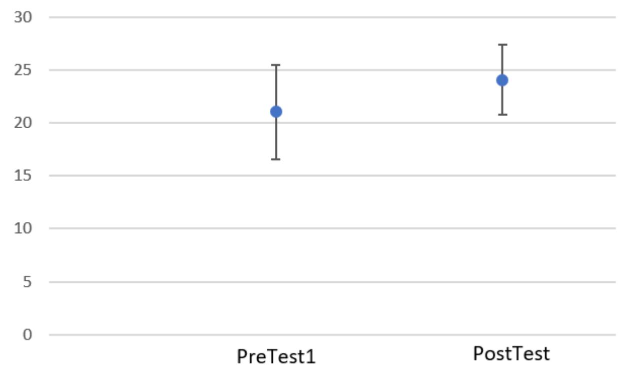

Figure 6. Confidence intervals for intervention group pre-test1 and post-test.

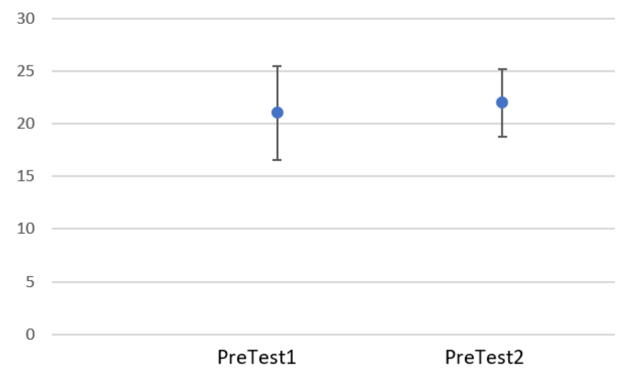

Figure 7. Confidence intervals for intervention group pre-test1 and pre-test2.

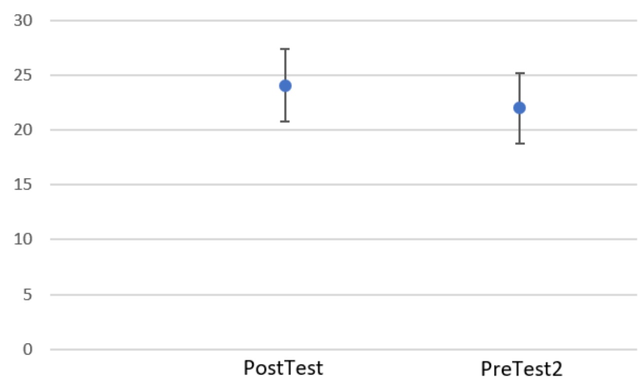

Figure 8. Confidence intervals for intervention group post-test and pre-test2.

Table 3

Intervention Group Pre- and Post-Test Descriptive Statistics

Test	Mean	Standard Deviation	Range	Standard Error
PreTest1	21.056	8.941	26	2.107
PostTest	24.111	6.606	24	1.557
PreTest2	22.000	6.426	27	1.515

The 5-number summary for the intervention group scores resulted in a median of 23 for the first pre-test, 20 for the second pre-test, and 23.5 for the post-test. The Interquartile Ranges (IQR) were 16, 5.2, and 9.2, respectively (see Table 4). The minimum and maximum scores for the first pre-test were 7 and 33, for the second pre-test was 13 and 40, while the minimum and maximum scores for the post-test were 13 and 37, respectively (see Figure 9).

Table 4

Intervention Group Pre-Test1, Post-Test, and PreTest2 5-Number Summary

	Range					
Test	Minimum	Maximum	1st Quartile	Median	3rd Quartile	IQR
PreTest1	7	33	14.0	23.0	30.0	16.0
PostTest	13	37	20.0	23.5	29.2	9.2
PreTest2	13	40	17.8	20.0	23.0	5.8

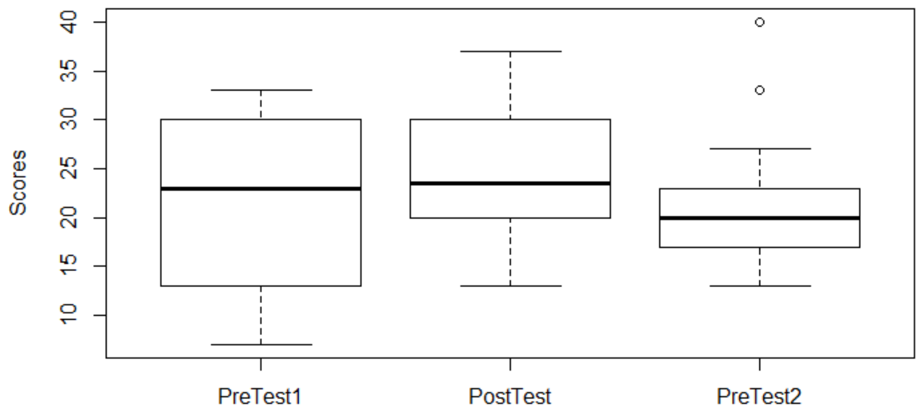

Figure 9. Boxplots comparing intervention group pre-test1, post-test, and pre-test2 scores.

According to the box plots in Figure 9, there are two outliers in the pre-test2 scores. Removal of the outliers in the pre-test2 scores resulted in a mean of 20.941 (*SD* 4.736), a decrease of 4.8%. The median remained at 20; however, the IQR changed to 6, a difference of 0.8 (3.4% increase) (see Figure 10).

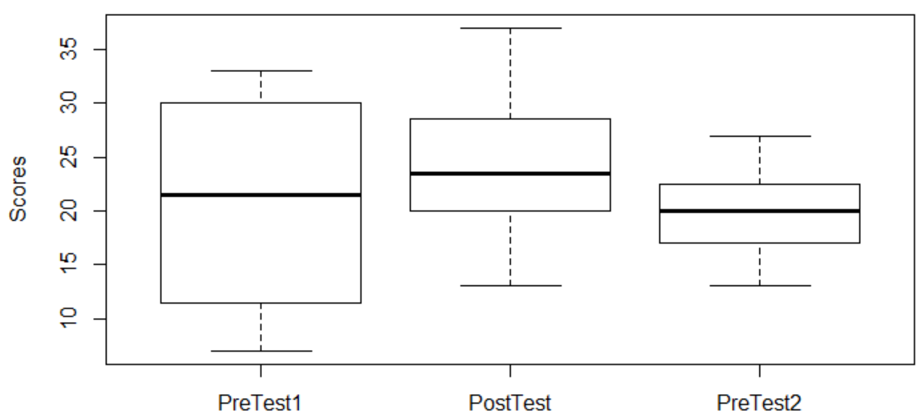

Figure 10. Boxplots comparing intervention group pre-test1, post-test, and pre-test2 scores with outliers removed.

Control Group vs. Intervention Group. The researcher compared the pre- and post-test scores of the control group and the intervention group to determine if the TI

Nspire increased mathematical achievement. Two sample *t*-tests were used for the variables that proved to be normally distributed for hypotheses testing (see Table 5). The null hypothesis tested was H_0: $\mu_C = \mu_I$ and the alternative hypothesis tested was H_A: $\mu_C < \mu_I$ with a significance level of $p < 0.05$. The *t*-tests comparing control pre-test scores and the first intervention pre-test scores resulted in a *t*-statistic of -1.064, degrees of freedom = 32, and a *p*-value = 0.148. The effect size for the variables was Cohen's *d* = 0.352 indicating practical significance (see Figure 11). The *t*-tests comparing control post-test scores and intervention post-test scores resulted in a *t*-statistic of -1.475, degrees of freedom = 32, and a *p*-value = 0.075. The effect size for the post-test scores of both the control group and the intervention group was Cohen's *d* = 0.482 indicating practical significance (see Figure 12).

Table 5

Two-sample t-Tests

Group	*t*-statistic	Degrees of Freedom	*p*-value
Control PreTest vs Intervention PreTest1	-1.064	32	0.148
Control PostTest vs Intervention PostTest	-1.475	32	0.075
Control Difference of Scores vs Intervention Difference of Scores	-0.015	32	0.494

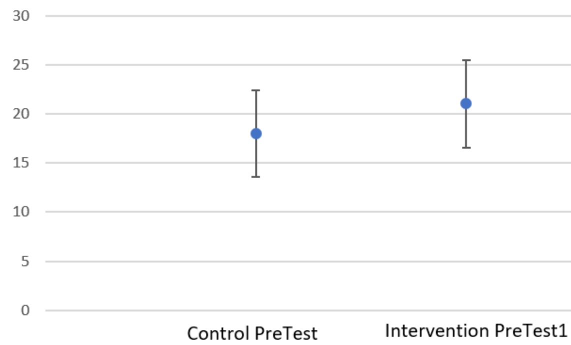

Figure 11. Confidence intervals comparing control group pre-test and intervention group pre-test1.

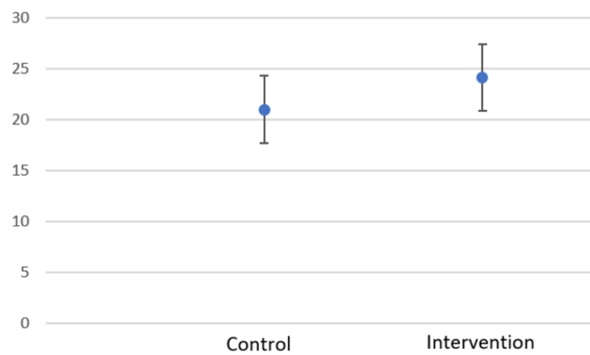

Figure 12. Confidence intervals comparing control group post-test and intervention group post-test.

Due to the second intervention pre-test scores not being normally distributed, a non-parametric test, specifically Wilcoxon rank sum test with continuity correction, was conducted between the control group pre-test scores and the second intervention pre-test scores. The *p*-value from the test was 0.083. The effect size of the variables intervention pre-test2 and control pre-test was Cohen's $d = 0.541$ indicating practical significance (see Figure 13).

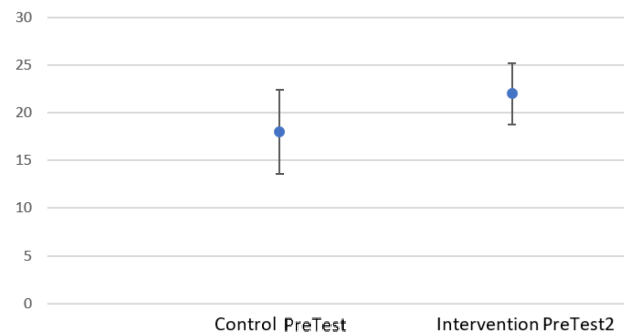

Figure 13. Confidence intervals for control group pre-test scores and intervention group pre-test2 scores.

For the differences in the pre- and post-test scores of the control group (post-test minus pre-test) and the differences in the first pre-test and post-test scores of the intervention group (post-test minus pre-test1), the *t*-statistic was -0.015, degrees of freedom = 32 with a *p*-value = 0.494. The effect size for the variables was Cohen's *d* = 0.005 (see Figure 14) indicating no practical significance.

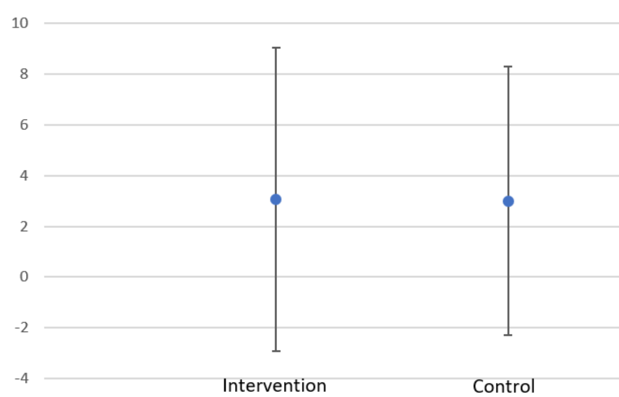

Figure 14. Confidence intervals comparing difference of scores.

Descriptive statistics for the control group difference of scores and the intervention group difference of scores indicated a range for the control group of 31 and the range for the intervention group of 50. The means of the scores were 3.000 (*SD* = 9.920) and 3.056 (*SD* =12.037) for the control group and intervention group, respectively (see Table 6). Medians for the differences in the scores were 0.5 (IQR 15.000) for the control group and 2.19 (IQR 15.250) for the intervention group (see Table 7). The minimum and maximum values for the control group were -13 and 18, respectively. For the intervention group, the minimum and maximum values were -20 and 30, respectively (see Figure 15).

Table 6

Difference of Pre-Test and Post-Test Scores Descriptive Statistics

Group	Mean	Standard Deviation	Range	Standard Error
Control	3.000	9.920	31	2.480
Intervention	3.056	12.037	50	2.837

Table 7

Difference of Pre-Test and Post-Test 5-Number Summary

	Range					
Group	Minimum	Maximum	1st Quartile	Median	3rd Quartile	IQR
Control	-13.33	17.68	-4.167	0.50	10.25	14.42
Intervention	-20.00	30.00	-5.833	2.19	10.00	15.83

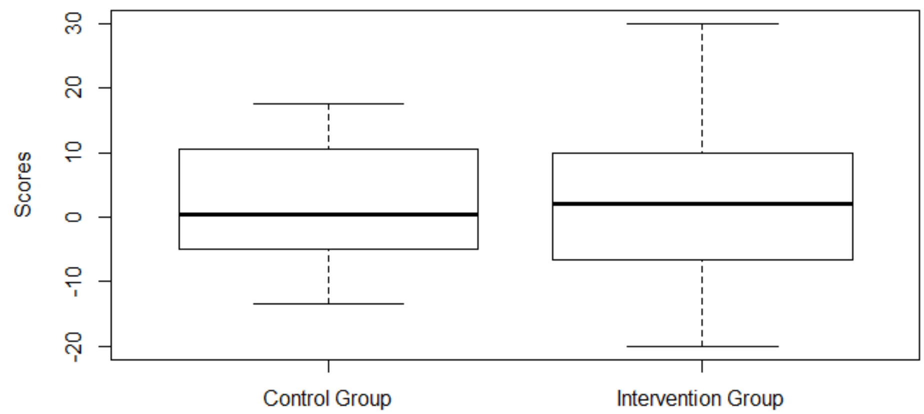

Figure 15. Boxplots comparing the differences of the post-test scores and the pre-test scores.

Student Interviews

In order to delve more deeply into the question if students with special needs who use the TI Nspire handheld calculator developed more positive attitudes toward mathematics, six students in the intervention group and four students in the control group were interviewed. The researcher took copious notes to record the interviews. The interview included two mathematical tasks, one task was completed without a graphing calculator and the second task was completed with a graphing calculator. The intervention group was given the TI Nspire graphing calculator to complete the second task while the control group was given the TI 84 graphing calculator to complete the second task. For Task 1, the student had to determine the cost of a $10 shirt with a 20% discount and an additional 10% discount taken at checkout. For Task 2, the student was asked to find the total bill given the cost of a meal and the tax percent. Part 2 of the task asked the student to determine the tip the server should receive.

As the sole analyzer of the student interview data, the researcher coded the students' statements using positive, negative, and neutral on three separate days.

Statements that were considered to be positive were coded positive. Statements that contained the word "not" and that were negative in nature were coded negative. Neutral statements were neither positive nor negative. A count of each code was tabulated for each day and an average for each code was calculated. Comparing the average counts between the intervention group interviews and the control group interviews determined if the students' who used the TI Nspire had a more positive attitude.

In order to adhere to the confidentiality of the students' identities, the students were assigned pseudonyms: StudentAI, StudentBI … for the intervention group and StudentAC, StudentBC … for the control group.

Student Intervention Group

Three males and three females from the intervention group were interviewed during their second semester of Algebra I. The TI Nspire was introduced to the intervention group during their first semester of Algebra I. During the course of the interviews, 38% of the total statements were positive with 30% of the statements being negative (see Table 8). The females provided 37% of the positive statements and 30% of the negative statements. The males provided 39% of the positive statements and 31% of the negative statements (see Table 9).

Table 8

Intervention Student Statements

Code	StudentAI	StudentBI	StudentCI	StudentDI	StudentEI	StudentFI
positive	34%	45%	34%	45%	32%	38%
negative	28%	26%	28%	32%	34%	32%
neutral	38%	29%	38%	24%	34%	30%
totals	100%	100%	100%	101%*	100%	100%

*totals > 100% due to rounding

Table 9

Intervention Student Statements by Gender

Code	Females	Males
positive	37%	39%
negative	30%	31%
neutral	34%	30%
totals	101%*	100%

*totals > 100% due to rounding

After separating the questions into those about mathematics (including statements made during completion of Task 1 and Task 2) and those about calculators, the overall total percentage was 41% positive. The percentage of positive mathematical statements was higher than the negative statements which was 34%. This is a difference of 7%. For StudentCI, the negative statements were slightly higher than the positive statements by 1% (38% negative to 37% positive) (see Table 10). The males gave slightly more positive statements (42%) than the females (41%). Both males and females gave more positive statements than negative statements (see Table 11).

Table 10

Intervention Student Mathematical Statements

Code	StudentAI	StudentBI	StudentCI	StudentDI	StudentEI	StudentFI
positive	35%	52%	37%	42%	36%	45%
negative	29%	32%	38%	40%	34%	31%
neutral	36%	17%	26%	17%	30%	24%
totals	100%	101%*	101%*	99%*	100%	100%

*totals do not equal 100% due to rounding

Table 11

Intervention Student Mathematical Statements by Gender

Code	Females	Males
positive	41%	42%
negative	31%	37%
neutral	28%	21%
totals	100%	100%

Task1. During the interview, the students were asked to complete two tasks. For Task 1, students were asked to compute the cost of a $10 shirt given a 20% discount with an additional 10% discount given at check out. The students completed the task without the use of a calculator.

Student comments during completion of Task 1 were 49% positive and 36% negative. Student BI provided 9% more negative statements than positive statements (see Table 12). The male students had more positive statements than the female students (59% and 41%, respectively) (see Table 13).

Table 12

Task 1: Intervention Student Statements

Code	StudentAI	StudentBI	StudentCI	StudentDI	StudentEI	StudentFI
positive	35%	44%	60%	52%	48%	72%
negative	28%	53%	37%	36%	39%	22%
neutral	37%	3%	3%	12%	12%	6%
totals	100%	100%	100%	100%	99%*	100%

*total < 100% due to rounding

Table 13

Task 1: Intervention Student Statements by Gender

Code	Females	Males
positive	41%	59%
negative	38%	33%
neutral	20%	8%
totals	99%*	100%

*total < 100% due to rounding

No student from the intervention group was able to determine the correct price of the $10 shirt. The students used different methods to solve the problem. Two students used proportions, three students converted percents to decimals, and one student used estimation and reasoning. Half of the students determined the price to be less than the actual price while the other half found the price to be more than the actual price. Of the students who found the price to be less than the actual price, one student used a proportion. The student set up the proportion correctly but was not sure what to do with the answer. She decided the answer to the proportion was the cost of the t-shirt which was less than the cost of the t-shirt. The second student who found the answer to be less than the actual price added the percents together and converted all amounts, including the price of the t-shirt, to decimals and subtracted resulting in a price less than the actual price. The third student used estimation and reasoning to determine the price of the t-shirt. The student determined one-half of ten was five and since the percent was less than 50, the price would be higher. The student guessed the price to be between $6 and &7.

For the other half of the students who found the price to be more than the actual price, one student set up the proportion incorrectly and found the price to be over the actual price. Another student converted the percents to decimals and subtracted the decimals, incorrectly, from the original cost of the t-shirt resulting in a cost more than the actual cost. The third student decided to divide the price of the t-shirt by the percent then decided to use the estimation. The student first figured one-half of the original price would be $5 so the price would need to be higher. Using estimation, the student determined the price to be a little more than the actual price.

Task 2. For Task 2, the students were asked to determine the total cost of dinner including tax and tip. The bill for the dinner was $14.28, tax was given as 9.75%, and the tip was at the discretion of the student. The students were allowed to complete the task with the aid of the TI Nspire.

During completion of Task 2, the students commented more negatively than positively. The total negative statements were 53% with the total positive statements being 32%. StudentBI offered 20% more positive statements than negative statements. StudentCI provided 66% more negative statements than positive statements (see Table 14). Both males and females communicated more negative statements than positive students (57% and 49%, respectively) (see Table 15).

Table 14

Task 2: Intervention Student Statements

Code	StudentAI	StudentBI	StudentCI	StudentDI	StudentEI	StudentFI
positive	24%	56%	7%	33%	27%	29%
negative	48%	36%	73%	54%	58%	54%
neutral	27%	8%	20%	12%	15%	17%
totals	99%*	100%	100%	99%*	100%	100%

*totals do not equal 100% due to rounding

Table 15

Task 2: Intervention Student Statements by Gender

Code	Females	Males
positive	35%	28%
negative	49%	57%
neutral	16%	15%
totals	100%	100%

One student found the correct total for the bill with tax. The student used a proportion to determine the tax and added the amount to the dinner bill. Two students added the percent to the bill to find the total bill. Another student converted the tax to a decimal and added that decimal to the dinner bill. The remaining student estimated the tax and added to the dinner bill. Half of the students did not attempt to calculate the tip. Two students divided to find the tip while one student guessed the tip based on whether the service was good or not.

Student Control Group

Two males and two females from the control group were interviewed after they had completed Resource Algebra I. The students used the TI 84 during the entire length of the course. The total number of positive statements given during the course of the interviews was 35% with 37% of the statements being negative (see Table 16). The females provided 33% of the positive statements and 40% of the negative statements. The males provided 38% of the positive statements and 35% of the negative statements (see Table 17). StudentAC gave 21% more negative statements than positive statements

(22% positive, 43% negative). The difference between positive and negative statements for StudentDC was 1% (38% positive, 37% negative).

Table 16

Control Student Statements

Code	StudentAC	StudentBC	StudentCC	StudentDC
positive	22%	37%	40%	38%
negative	43%	31%	38%	37%
neutral	35%	32%	23%	25%
totals	100%	100%	101%*	100%

*total > 100% due to rounding

Table 17

Control Student Statements by Gender

Code	Females	Males
positive	33%	38%
negative	40%	35%
neutral	27%	28%
totals	100%	101%*

*total > 100% due to rounding

After separating the questions about mathematics (including statements made during completion of Task 1 and Task 2) from those about calculators, the overall total percentage was 38% positive. The percentage of positive mathematical statements was higher than the negative statements which was 37%. This is a difference of 1%. For StudentAC, the negative statements were higher than the positive statements by 28%

(48% negative; 20% positive) (see Table 18). StudentBC gave 27% more positive statements (51% positive; 24% negative). The females provided slightly more negative statements (39%) than the males (35%). The males furnished more positive statements than negative statements (see Table 19).

Table 18

Control Student Mathematical Statements

Code	StudentAC	StudentBC	StudentCC	StudentDC
positive	20%	51%	44%	35%
negative	48%	24%	34%	40%
neutral	31%	25%	22%	25%
totals	99%*	100%	100%	100%

*total < 100% due to rounding

Table 19

Control Student Mathematical Statements by Gender

Code	Females	Males
positive	36%	40%
negative	39%	35%
neutral	25%	25%
totals	100%	100%

Task1. During the interview, the students were asked to complete two tasks. For Task 1, students were asked to compute the cost of a $10 shirt given a 20% discount

with an additional 10% discount given at check out. The students completed the task without the use of a calculator.

Student comments during completion of Task 1 were 20% positive and 60% negative. StudentAC and StudentBC provided no positive statements (see Table 20). Both males and females offered more negative statements than positive statements (62% for females and 58% for males) (see Table 21).

Table 20

Task 1: Control Student Statements

Code	StudentAC	StudentBC	StudentCC	StudentDC
positive	0%	0%	26%	31%
negative	83%	100%	48%	47%
neutral	17%	0%	26%	22%
totals	100%	100%	100%	100%

Table 21

Task 1: Control Student Statements by Gender

Code	Females	Males
positive	16%	24%
negative	62%	58%
neutral	22%	18%
totals	100%	100%

No student from the control group was able to determine the correct price of the $10 shirt. The students used different methods to solve the problem. Two students added the discounts together. One student then divided the sum of the discounts by the price of the shirt. Both students guessed the price of the shirt. Of the remaining two students, both students subtracted the discounts. One student reasoned that the difference was half the first discount thus the price would be half. The other student divided the difference into the original price of the shirt.

Task 2. For Task 2, the students were asked to determine the total cost of dinner including tax and tip. The bill for the dinner was $14.28, tax was given as 9.75%, and the tip was at the discretion of the student. The students were allowed to complete the task with the aid of the TI 84.

During completion of Task 2, the students commented more negatively than positively. The total negative statements were 63% with the total positive statements being 14%. StudentAC offered no positive statements. StudentDC offered 3% of his statements as positive. StudentCC provided twice as many negative statements as positive statements (see Table 22). Both males and females communicated more negatively than positively (67% and 59%, respectively) (see Table 23).

Table 22

Task 2: Control Student Statements

Code	StudentAC	StudentBC	StudentCC	StudentDC
positive	0%	33%	26%	3%
negative	75%	33%	52%	76%
neutral	25%	33%	22%	21%
totals	100%	99%*	100%	100%

*total < 100% due to rounding

Table 23

Task 2: Control Student Statements by Gender

Code	Females	Males
Positive	18%	10%
negative	59%	67%
neutral	23%	24%
totals	100%	101%

*total > 100% due to rounding

None of the control students found the correct total for the bill with tax. Two students divided the cost of the meal by the tax. Both searched unsuccessfully for a key on the calculator to convert the tax percent. One ended work on the problem with the quotient. After obtaining the quotient, the other student subtracted the tax percent from the cost of the meal and added the difference to the cost of the meal to achieve the total bill. He then proceeded to round the sum up to determine the tip. The third student added the cost of the meal and the tax percent to establish the total bill. She remarked that she always gave either $3 or $5 as a tip. The fourth student declared he “was lost” and did not attempt to complete the task. He did comment that the tip would be a percent of the bill.

Student Interview Narratives

StudentAI. A female taking Algebra I during the last class period of the day. StudentAI feels good when she enters her mathematics classroom. At the time of the interview, she was studying for a quiz on quadratics which the student believes is an easy concept. StudentAI believes mathematics is important to her future because she is planning to attend college to prepare to be a kindergarten teacher. Her aspirations of being a kindergarten teacher can be attributed to her “liking kids.”

Mathematics is used most often by StudentAI at school. Outside of school, she uses mathematics when shopping where she indicated she uses mathematics to check to see if she has enough money to purchase an item. StudentAI solves mathematics problems by looking at the problem, writing the problem down, and completing some computations in her head.

The calculators that StudentAI has used are the TI Nspire, TI 34 II, and the calculator on her cell phone. Of these calculators, she prefers the calculator on her cell phone best because she believes it is the easiest to use especially if she is only multiplying or adding. If she has to find a percent, take the square root of a number, or square a number she prefers the TI Nspire. For concepts that require her to solve problems that she does not know or for graphing linear and quadratic equations, she opts for the TI Nspire graphing calculator. For StudentAI, the calculator makes mathematics easier by allowing her to solve more complex functions.

Task 1 was completed without the calculator. After reading the problem, the student asked herself if she should divide, then decided that she had forgotten how to do the procedure. She continued to solve the problem by writing $\frac{20}{10}$. She commented that the discount "needs to be less than 10." Using the common teaching of $\frac{IS}{OF} = \frac{\%}{100}$, she wrote $\frac{x}{10} = \frac{20}{100}$. StudentAI started to complete the proportion correctly by finding the cross products of 200 and 100x; however, when using the Equality Property of Division, she incorrectly divided both sides by 100x. The answer she wrote, x = 2, was correct. (See Figure 16.)

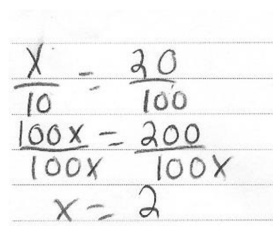

Figure 16. StudentAI work

She continued by saying "half of 100% is 50%" and dividing 10 by 2. Her answer was 5 dollars. She wrote $\frac{5}{10}$, crossed it out, and wrote $\frac{10}{5} = \$2$. She replied, "Two dollars is the price of the shirt."

Task 2 was completed with the calculator. StudentAI used the scratchpad function of the TI Nspire.[1] She entered 14.28 ÷ 9.75 and received 1.46 as the answer.

[1] The scratchpad function has two tabs—calculator and graphing. The Program Editor is the only calculator function unavailable under the scratchpad calculator function (McCalla & Ouellette, 2011).

She commented, “I don’t think that’s right.” She began questioning herself as to whether that was the total but decided she found the tip. After thinking that percent gave her the tax and asking herself what she should do with the tax, she entered 14.28 + 1.46 and received an answer of 15.74. She stated, “Fifteen dollars and 74 is the total bill. The dollar forty-six came from when I divided.” StudentAI did not attempt to determine the amount of the tip.

StudentAI found Task 1 to be the more difficult task to solve. She stated it was harder to solve without a calculator and needed to be solved by dividing. She continued by saying that she had trouble doing the actual division.

StudentAI likes using the TI Nspire; however, she finds that it is “sometimes hard to use” because “it won’t work.” (The students are using an older version of the TI NSpire that has an updated operating system. The calculators use replaceable batteries as opposed to the newer version which uses a chargeable battery.)

StudentBI. A female who takes Algebra I during the second period of the school day with “a lot of friends.” StudentBI has good feelings when she enters her mathematics classroom. She believes that “math is easy” for her and that mathematics is important to know for her future career as a veterinarian.

Mathematics is used most by StudentBI when she bakes. She stated that she does not have all the measuring cup sizes and has to “measure differently” which causes her “measurements to not always be accurate.” When given a mathematics problem, StudentBI will try to determine what the problem is asking, work her way through the problem by finding the keywords and form an equation. She will then solve the equation to obtain the answer to the problem.

The calculators that StudentBI has used are the TI Nspire, the TI 30II, and the calculator on her cell phone; however, she does not use the calculator on her cell phone often. She likes the TI NSpire the best because it is “easy to work with” and has more functions. StudentBI uses the calculator for graphing, “help in solving problems,” finding square roots, and “anything [she] cannot do in [her] head.” Other concepts she uses with the calculator include turning fractions into decimals, turning decimals into fractions, and graphing quadratics. StudentBI believes that the calculator helps with finding answers quicker and making sure her answers are correct. She stated that she is “more positive about the answer” when she uses a calculator.

While reading the problem for Task 1, StudentBI wrote down key information from the problem. She wrote “$10, 20% off, 10% off.” Upon completion of reading through the problem, her next step was to sum 20% and 10% and create the proportion $\frac{10}{x} = \frac{30}{100}$. After cross multiplying, she conducted long division dividing 1000 by 30 and arrived at the answer 33.3 “repeating so round up. The answer is $34.”

StudentBI wrote down key information while reading Task 2. She wrote 14.28 and 9.75% then $\frac{14.28}{x}\ \frac{9.75}{100}$. Using the scratchpad on the TI Nspire, she entered 14.28 x 100 resulting in 1428 which was divided by 9.75. She stated this “ended up being a crazy number.” To correct her mistake, she rewrote the proportion as $\frac{x}{14}\ \frac{9.75}{100}$. (See Figure 17.) On the calculator, she entered 14.28 x 9.75 to obtain 139.23 then divided by

100 resulting in 1.39 for the tax which she added to 14.28 for a total of $15.67. She commented that she did not know how to calculate the tip.

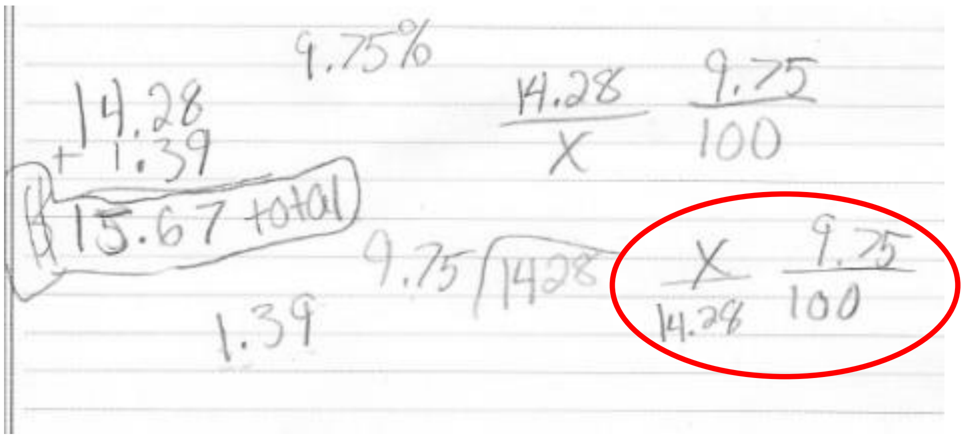

Figure 17. Student BI work for task 2.

StudentBI found completing Task 1, the problem without the calculator, to be the most difficult. However, she stated the difficulty of the tasks were about the same because they both required basic math. She concluded the problem with the calculator (Task 2) was harder because she did not know how to correctly complete the task which caused her to become frustrated.

StudentCI. A male who takes Algebra I during the second period of the school day. StudentCI has no special feelings when walking into his mathematics class. He stated that walking into his mathematics class was "like all my other classes." He does not think that mathematics will be important to him in the future; however, he claimed that the importance of mathematics will depend on what he does after high school, but for now, he has "no idea" what he wants to do.

Mathematics is used most by StudentCI when he makes purchases and counts money. When given a mathematics problem, StudentCI will look at the problem and "go through and put numbers together." If he is unable to arrive at an answer, he will ask his teacher for help. StudentCI commented that he will ask his teacher questions whenever he solves a mathematics problem which "happens often."

The calculators that StudentCI has used are the TI Nspire, a non-graphing calculator, and the calculator on his cell phone. He likes the TI NSpire the best because he is able "to do more stuff on the TI Nspire." StudentCI uses the calculator for graphing and calculations. He stated that "when he doesn't know something, [he] usually gets on the calculator." Using the calculator helps makes mathematics easier for StudentCI because he "has trouble with multiplying and dividing."

To complete Task 1, StudentCI began by reading the problem. He wrote 20% and then converted the percent to the decimal 0.2. His next step was to write "- 0.10" under the 0.2 and placed a 10 above the 0.2. He commented at this point, "I don't know how to do this." Thinking aloud, he said "20% turn into decimal, 10% turn into decimal, subtract and get 8.10." (See Figure 18.)

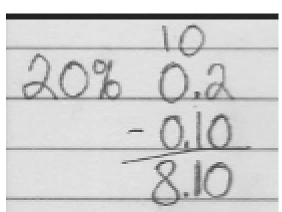

Figure 18. StudentCI work.

Completing Task 2 with a TI Nspire, StudentCI entered 14.98 + 9.75 resulting in 24.03. He then commented, “I don’t know how to do that [tip].” He continued by stating that he really did not know how to use the calculator and that he was not used to “doing it [solving the problem] by myself.”

StudentCI felt that the first task was more difficult because he could not use the calculator. However, he stated that when he did use the calculator he had more difficulty solving the problem because he did not know how to use the calculator well enough to get the right answer.

StudentDI. A male who takes Algebra I during the second period of the school day. StudentDI is “doing pretty good” in his mathematics class and is “learning a lot.” However, when he enters his mathematics classroom, he feels “exhausted and bored” because he knows he is going to be working on mathematics problems and he “know[s] [he] is going to be lazy.” StudentDI does not know what he will be doing in the future yet knows that mathematics will be used because he “always uses math in everyday life.”

Mathematics is used most by StudentDI when he goes to the grocery store with his family. He stated that he will determine which item is the better deal for his family to purchase. In order to solve a mathematics problem, StudentDI will try to determine what the problem is asking and “go through possible solutions through guessing and checking.” If trial and error does not help him arrive at the solution, he will work the problem “the way it was to be worked in the first place.” The calculators that StudentDI has used are the TI Nspire, the TI 30II, and the calculator on his cell phone. He stated that in middle school he did not use a calculator but instead “used his brain.” He commented that his middle school teacher said “the calculator will make you lazy.” His cell phone is used when he is at home or not at school. He likes the TI NSpire the best particularly as he is becoming more familiar with it. He likes the wide variety of

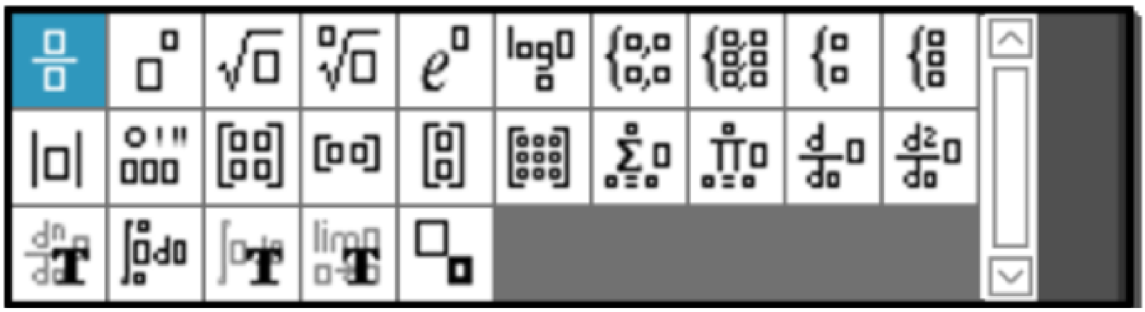

Figure 19. Math template from TI Nspire numeric calculator.

functions available on the TI Nspire to find problems and to graph equations. StudentDI uses the calculator for all concepts especially “the fancy ones” (referring to the trigonometric functions and the math template (see Figure 19). He believes that the calculator helps provide more time to focus on other problems.

To complete Task 1, StudentDI read the problem. He stated he “always uses the calculator on problems like this.” As he said “know price of shirt is 10,” he wrote 10$ on the paper. He continued, “with 20% means minus 20%; at register additional minus 10%.” On the next line, he rewrote $10 followed by 30% (see Figure 20). He converted 30% to .3 and subtracted .3 from .10. Upon arriving at the answer of $7, StudentDI replied that the answer is “way not correct. I combine 10 and 20 that’s 30%; 10 minus 30%. Using the calculator makes you lazy and not remember these things. I’m just going to go for 10 minus .3 is $7.”

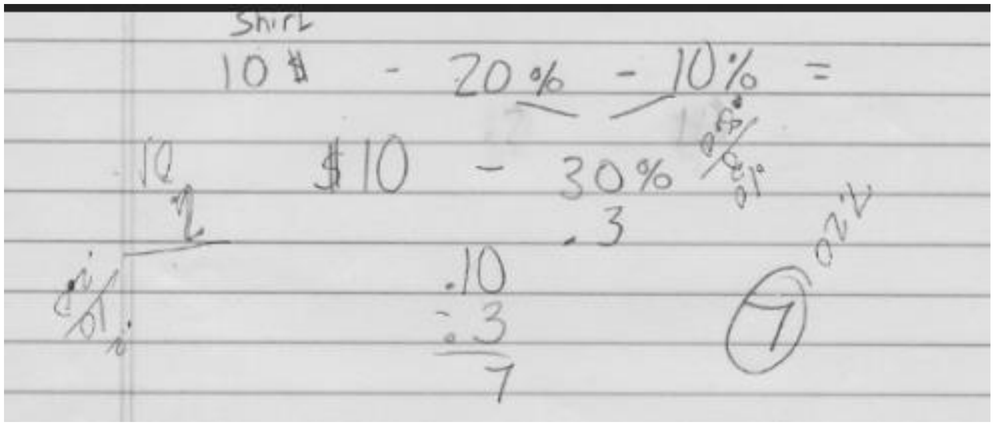

Figure 20. StudentDI work.

While reading Task 2, StudentDI wrote 14.28 + 9.75% on his paper. He crossed out the plus sign and wrote the multiplication symbol “x.” Using the scratchpad function on the calculator, he entered 14.28 + 9.75 and stated, “I have to find out the total bill and final tip.” He began to get anxious saying, “I know percent is on here.” After struggling for a few seconds, he divided 9.75 by 5 but then added 9.75 to 14.28 receiving 24.03. He revealed that $24.03 was the total bill and began determining the amount of the tip. Starting with dividing 24.03 by 14.28, he surmised that the result of 1.68 was not correct and that the tip needed to be “more than that.” He decided that he needed to “rethink” the problem; however, he concluded that 1.68 was the tip but stated, “which is incorrect.”

StudentDI felt that both tasks were equally difficult because he did not know how to complete the problem. While working on the tasks, he stated that he felt dumb because he did not know how to complete the tasks. The feelings of embarrassment and incompetency were also expressed. StudentDI’s final comment was “I don’t like math.”

StudentEI. A female who takes Algebra I during the second period of the school day. StudentEI is confident when she enters her mathematics classroom and takes the attitude “I got this.” She believes that “math is easy” for her and that mathematics is important because it “makes me smart.” However, she does not feel that she will need mathematics in her future career on Broadway or her work with Disney.

Mathematics is used most by StudentEI in mathematics class or when she is helping her siblings with their mathematics homework. StudentEI works mathematics problems differently depending on the problem. For linear equations, she will rewrite the equation in slope-intercept form ($y = mx + b$). If the problem is a word problem, she will determine what the problem is asking to decide if she needs to add, subtract, multiply, or divide.

The calculators that StudentEI has used are the TI Nspire (which she used in middle school) and the calculator on her cell phone. She likes the TI NSpire the best because it is “a lot easier” to use and has more functions. StudentEI uses the calculator to solve problems she “cannot do off the top of [her] head” or when the teacher “tells us to.” She uses the calculator to graph and to “answer simple little answers.” StudentEI believes that the calculator helps make mathematics easier when the “work is hard” and when she needs to “show work.” She does not believe that she has to work hard when using the calculator but she still needs to “show [her] work.”

To complete Task 1, StudentEI began by reading through the problem. She wrote $10 \div .10$ but erased the .10 and replaced it with .20. Using mental math, she received the quotient 7.40. She commented, “Figuring that half of 10 is 5, it is easier to figure if need to go higher or lower. I need to go higher." Her next step was to divide 7.40 by .1. She decided to take half of 7.40, which she determined was 3.5, and add .4 for a total of 3.90 (see Figure 21). Although she wrote that 3.90 was half of 7.40, she did not complete the problem because she "could not figure it out."

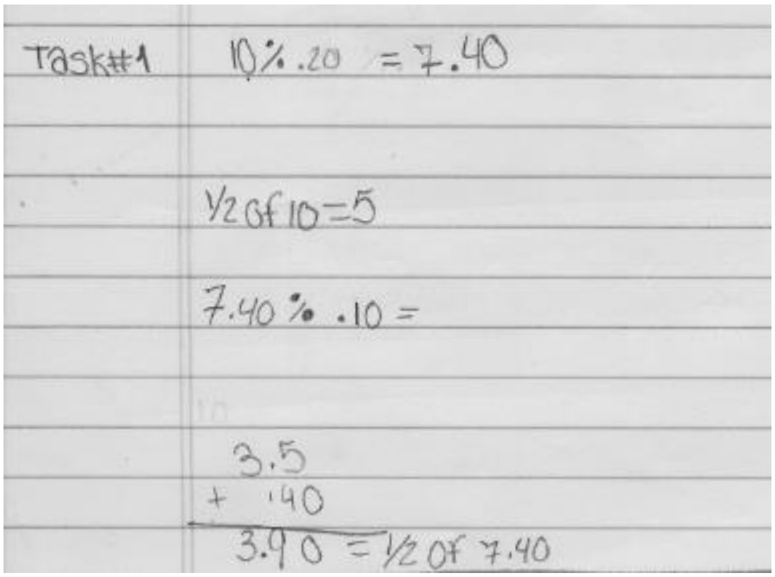

Figure 21. StudentEI work.

After reading Task 2, StudentEI wondered if a tip was 5% of total. She recorded 14.28 + 9.75 on her paper and entered the expression in her calculator. She wrote the answer of 15.25 on her paper. After writing 15.25 ÷ .005 on her paper, she erased .005 while commenting "just kidding" and wrote .5 (see Figure 22) "because a tip is always 5%." Entering the expression in her calculator, she wrote the result of 30.50 on her paper. She remarked, "I think I did something wrong. If tip is $15, that would not be right, so I do not think I divide by .5." She did not attempt to correct the mistake nor complete the problem.

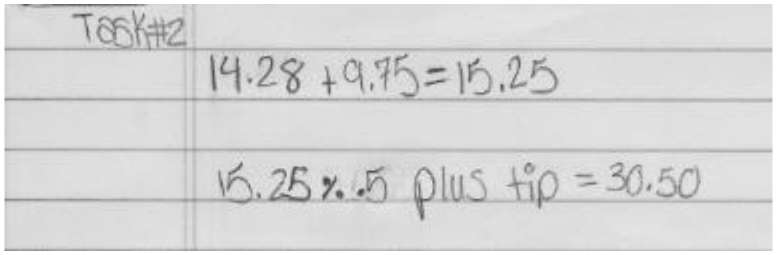

Figure 22. StudentEI work for task 2.

StudentEI believed Task 1 was more difficult "because I did not use calculator and I am not good with percent." She said that she "felt dumb" when completing the tasks because she "did not really know what to do." She believed Task 2 was easier but "still had difficulty" completing the task. She repeated that she was "not good with percent."

StudentFI. A male who takes Algebra I during the final period of the school day. StudentFI feels happy when he enters his mathematics classroom because he likes the class. He finds the class fun and enjoyable. Although he believes mathematics is "pretty important," he does not know what mathematics he will be using in his future career as a welder.

Mathematics is used most by StudentFI during school or when he needs to "calculate money." When given a mathematics problem, StudentFI will write down the key information before solving the problem. He will attempt to find the solution; however, if he needs help, he will ask his teacher.

The calculators that StudentFI has used are the TI Nspire, a scientific calculator, and the calculator on his cell phone "every now and then." He likes the calculator on his cell phone the best because it "does not have a bunch of numbers" and is easy to use.

StudentFI uses the calculator when dealing with money and for any other "reason [when] have to calculate something." He also uses the calculator when he needs to add, subtract, multiply, or divide. StudentFI believes that the calculator helps make mathematics easier because "you do not have to write all the information out and figure it out yourself."

StudentFI began Task 1 by reading the problem. He then stated that the answer would be "somewhere between 6 and 7 dollars." Thinking out loud, he stated, "50% would be 5, only 30 would have to be more." He wrote "10" on his paper but then erased it. He did not write anything more on the paper. He said, "30 is 20 plus 10" then stated again the answer was between 6 and 7 dollars.

After being given the TI Nspire calculator, StudentFI read Task 2. Using the scratchpad function of the TI Nspire, he stated, "I forgot how to put percent in this thing." He determined the total bill with tax was $15.46 without entering anything in the calculator saying the number was "based on 10%." He went on to say that he figured the amount "how you did regular money." For the tip, StudentFI determined the amount was based on "if they [the server] was good or not." He stated the tip would be "probably 5 dollars if good and 2 dollars if not good" but that he was "just guessing."

StudentFI stated he had more difficulty completing Task2. He felt it was more difficult because he did not "know how to put [the numbers] in the calculator." However, he believed that he was incorrect with both tasks. His final comment was that his answers "were not the right answers with both [tasks]."

StudentAC. A female who has completed Resource Algebra I. StudentAC completed the next level of mathematics class in a regular classroom and performed well in the class. She stated she did well in resource algebra and enjoyed being in the special education teacher's class. Mathematics will be important in her future as she will be going to college and entering the medical field.

Mathematics is used most by StudentAC at school. When given a mathematics problem, StudentAC will "write down the formula" if one is given. She will then work out the problem according to the formula.

The calculators that StudentAC has used are the TI 84 and the calculator on her cell phone. She likes the TI 84 the best because the TI 84 "does more." StudentAC uses the calculator for basic operations, graphing, and exponents. She stated the calculator "makes it easier to get the answer."

As soon as StudentAC finished reading Task 1, she exclaimed "Oh gosh!" She then began working out the problem by stating, "I start out with $10 and 20% discount." She then added 10 and 20 (see Figure 23). Next, she divided 30 by 10 and said, "I'm going to guess 5 [dollars]."

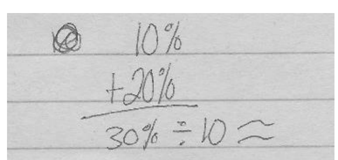

Figure 23. StudentAC work for task 1.

StudentAC began Task 2 by inputting 14.28 ÷ 9.75 into the TI 84. She said, "I do not know how to get percent in calculator." She told the researcher she got 1.46 and believed that was the tax. The student stopped working on the task at that point.

StudentAC stated that the first task was more difficult because she was not allowed to use the calculator. She believed she could have completed the task if she had been shown how to do the task first. Completing the tasks caused StudentAC to be "anxious." She replied that she struggled to complete the tasks. Her final comment was "math just stresses me out."

StudentBC. A male who has completed Resource Algebra I. StudentBC is scheduled to take Resource Geometry I during the upcoming semester. He stated he enjoyed the Resource Algebra I class. The student will be attending a state technology college to obtain certification in construction, plumbing, or electricity. He stated mathematics will be important in his field of study and he will be using mathematics "a lot."

StudentBC uses mathematics most at his place of employment when ordering supplies. When given a mathematics problem, StudentBC will "write down key words then go step-by-step" to arrive at the answer.

The calculators that StudentBC has used are the TI 84 and the calculator on his cell phone. Because the TI 84 "does more," he prefers to use the TI 84. StudentBC uses the calculator for basic operations, graphing, and exponents. Mathematics is easier for StudentBC when he uses the calculator because the calculator "gets the answer for you."

After reading Task 1, StudentBC stated he "[is] not going to be able to do" the problem. He proceeded to add the discounts together (see Figure 24). He stated, "I am going to guess 7 [dollars]."

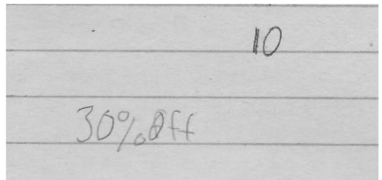

Figure 24. StudentBC work for task 1.

StudentBC began Task 2 by entering 14.28 in the calculator. He stated, "I am lost." He added, "a percent of [the] bill is for the tip." At this point, he stopped working on the problem.

The student stated that both tasks were difficult for him to complete. He commented, "I was lost." He also stated that he needed examples to refresh his memory. When asked how he felt completing the two tasks, he replied, "I had no clue what I was doing."

StudentCC. A female who completed Resource Algebra I. StudentCC is planning to take Resource Geometry I during the upcoming semester. When she was taking Resource Algebra I, StudentCC felt confident: "I felt like I knew what I was doing." She came to class ready to take notes and to listen. She had fun in her class. When she was going to take a test, she would think "I will fail this," but said that she rarely failed a test.

StudentCC believes mathematics is very important because we "use mathematics in life." She is planning to become a veterinarian, zoologist, or a biologist. She believes that mathematics will be very important in her future career when dealing with measurements for medicine or when billing her clients.

StudentCC uses mathematics at her job at a discount clothing store as a cashier. Her position requires her to count money and to "write down numbers a lot." She also uses mathematics when "scanning bar codes on damaged merchandise." When given a mathematics problem, StudentCC believes she "over thinks" the problem. She finds the problems are "harder than [the problems] actually are." She will start to solve the problem by writing down the steps she knows and taking her time to find the answer.

In addition to the calculator she uses at work, StudentCC has used the TI 84, a 10-key calculator, and the calculator on her cell phone. Although she uses her cell phone "all the time," she prefers the TI 84 because "it has more operations." StudentCC uses the calculator "any way that I [was] taught to" use it. She uses the calculator for basic concepts, especially multiplication and division. StudentCC believes the calculator makes mathematics easier by helping her solve problems, getting answers easier, helping her to get her work done, and checking answers. She also believes she does not "spend too much time" on problems when she uses the calculator.

To complete Task 1, StudentCC began by reading the problem. She repeated "20% off" then stated, "I know how to do on the calculator; my mom taught me, but I forgot." She started to guess but then wrote $10, underlined the $10, and wrote 20% (see Figure 25). "Ten percent would be half" she thought but corrected herself, "No, 50% would be half." She then stopped working on the problem and stated, "I am going to say $5."

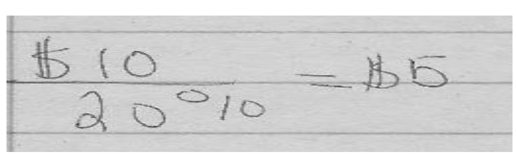

Figure 25. StudentCC work for task 1.

StudentCC began Task 2 by reading the problem and stating “always give $3 or $5 [for tip]; sometime none if they do not do good. [You] will not get arrested if [you] do not.” She then entered $14.98 into the TI 84. She added 9.75 saying, “add and see what happens; probably not right.” After hitting the enter key and getting an answer of 24.03, StudentCC replied, “I wish [the calculator] had percent; probably come out different.”

The task that StudentCC found to be most difficult was Task 1. She stated the problem “was not really hard, [I] forgot how to do [the problem].” She commented that both tasks were hard for her to complete. Completing the tasks made her “nervous” because she “was not sure if [I would] get [the answer] right or not.” StudentCC said completing the tasks also made her feel “dumb” although she did not “feel pressured” to complete the tasks. She did believe that these tasks were “important to know” how to complete.

StudentDC. A male who has completed Resource Algebra I. StudentDC is scheduled to take Resource Geometry I during the upcoming semester. He stated he was happy when he attended his Resource Algebra I class. Mathematics is his third favorite subject with technology and history being his “top 2 favorites.” StudentDC is planning to pursue a career in mechanical engineering where mathematics is “extremely important.”

StudentDC uses mathematics most when he is coding. He stated coding required dimension and mathematics was “good for making menus or creating characters.” He commented that “you have to know your math to do make code and games.” He also uses mathematics when he helps his dad cut wood. To solve a mathematics problem, StudentDC will look for “anything like division” and will perform “that first and work [my] way down.” He stated that “division is hard” particularly numbers with 3 or 4 digits.

The calculators that StudentDC has used are the TI 84 Plus, TI NSpire, TI 34, student calculator, and scientific calculator. The student prefers the TI Nspire because it is “more modern” and he “like[s] working with [the] latest stuff.” StudentDC uses the calculator for algebra and geometry. Mathematics is easier for StudentDC when he uses the calculator because the calculator “eliminate[s] stress” and he does not “have to think” when he uses the calculator. He also commented that the calculator “give[s] me confidence” and gives him a “10% chance of knowing I might pass.”

After reading Task 1, StudentDC began to break down the problem (see Figure 26). He subtracted 20% and 10%. Stating, “seems like a division problem,” he divided $10 by 10%. The 10% was the result of subtracting 10% from 20%. The student stated, “I think I did that wrong.” He wrote 00.10, saying “that is 10%.” He then wrote 0.010 and added 0.010 to $10 resulting in $10.01.

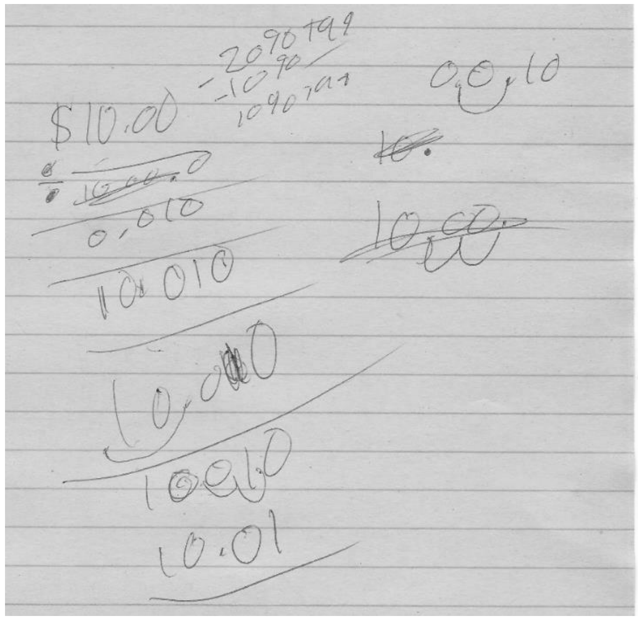

Figure 26. StudentDC work for task 1.

For Task 2, StudentDC entered 14.28 into the TI 84. He then divided 9.75 into 14.28 resulting in 1.37. The student commented he was looking for the percent button and decided 1.37 did not "seem right." He subtracted 9.75 from 14.28 resulting in 4.93. On his paper, he wrote "14.28 + 4.53" resulting in an answer of 18.81 (see Figure 27). He decided to "round up to 20 being your tip" with 18.81 being the meal.

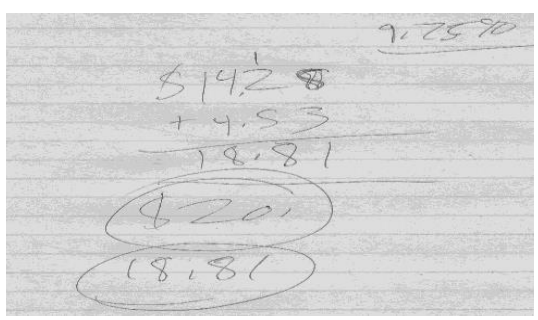

Figure 27. StudentDC work for task 2.

StudentDC found Task 1 to be the most difficult task to complete because he "did not have the assistance" the calculator would have provided. He felt Task 1 was "more logical" than Task 2. He believed that Task 1 would be more difficult without the calculator. StudentDC stated, "I did not have confidence in knowing I would get the answer correct."

Teacher Interviews

The teacher included in the study taught both the control and intervention classes. A certified special education teacher, the teacher is certified to teach Algebra I and has been trained in teaching with the TI Nspire. The teacher is a white female and has been teaching special education classes for 16 years with the year of study being her second-year teaching resource Algebra.

Research questions 3a and 3b pertain to the teacher's attitude toward teaching with the TI Nspire and the use of the TI Nspire toward students' mathematical learning. A pre-intervention interview and a post-intervention interview were conducted to determine if the teacher of the Algebra I resource teacher developed a more positive attitude toward using the TI Nspire handheld calculator as part of her classroom instruction. The interviews were also conducted to determine if the Algebra I resource teacher developed a more positive attitude towards students' mathematical learning when using the TI Nspire handheld calculator. Interviews with the teacher occurred at the beginning of the semester and again at the end of the semester. (See Appendix B for interview protocol.) The researcher took copious notes to record the interviews.

The researcher coded the teacher's statements using positive, negative, example, and neutral. All statements from both the pre-intervention and post-intervention interviews were coded on three separate days. A count of each code was tabulated for each day and an average for each code was calculated. Questions were then separated into those pertaining to the use of the calculator and those pertaining to the students' mathematical learning. The same procedure to analyze the statements was used to ascertain if the teacher's attitude toward the use of the calculator had changed as well as the teacher's attitude about the students' mathematical learning had changed.

The researcher coded the pre-intervention interview statements as positive an average of 26.33 times. Approximately 41.33 statements were coded as negative with 11.67 statements coded as neutral. The teacher gave approximately 6.33 examples to explain her answers (see Table 24). From the post-intervention interview, the researcher coded an average of 35 statements as positive. An average of 18 statements were coded as negative with approximately 10 statements coded as neutral. The teacher provided approximately 9 examples to explain her answers (see Table 25). The teacher contributed approximately 9 more positive statements (25%) during the post-intervention interview than during the pre-intervention interview. Approximately 23 less negative statements (56%) were given in the post-intervention interview than in the pre-intervention interview.

Table 24

Pre-intervention Interview Coding

Code	Round 1	Round 2	Round 3	Average
positive	29	27	24	26.67
negative	38	45	41	41.33
neutral	11	10	14	11.67
example	8	4	7	6.33

Table 25

Post-intervention Interview Coding

Code	Round 1	Round 2	Round 3	Average
positive	38	33	35	35.33
negative	19	18	17	18.00
neutral	8	13	9	10.00
example	8	8	11	8.67

Questions were separated into those pertaining to the use of the calculator and those pertaining to the students' mathematical learning. Regarding the use of the calculator, the teacher provided 16% more positive statements on the post-intervention interview than the pre-intervention interview. There was a 20% decrease in negative statements from the pre-intervention interview to the post-intervention interview. With respect to the questions pertaining to the students' mathematical learning, there was a 10% increase in positive statements from the teacher on the pre-intervention interview to the post-intervention interview and a 16% decrease in negative statements from the pre-intervention interview to the post-intervention interview.

Pre-Intervention Narrative. The pre-intervention interview began with the researcher asking the teacher what her students use when answering computational and problem solving questions. Students in the resource algebra class used whatever calculator they were given, which was usually a scientific calculator. At the beginning of the semester, the students did not have any real graphing calculator experience. The teacher found that the problem was not how to use the calculator but what to input into the calculator. Processing and understanding the mathematics problem was more of an issue than using the calculator.

The teacher has the students use the calculator approximately 50% of the time although the student has access to the calculator during the entire class period. The calculators are located at the front of the classroom so that when the students arrive they can get a calculator and take it with them to their seats. The calculators are used in several ways. The calculator is used as a demonstration tool with the whole class. The teacher teaches for approximately 15 minutes while the students take notes. An example is presented, then the students receive a similar problem to work while the teacher walks around observing and helping the students. Because the students are seated two to a table, the teacher can show an individual or a "table group" how to use the calculator. She also has the students use the calculator to explore and for problem solving. When the student asks "How do I do this?", the teacher will tell the students to push buttons and see what comes out.

Perhaps the most important reason the teacher uses the calculator is that the calculator "gives the students a lot of comfort." The teacher explained that the students in her class are "scared of math." These students' disabilities are basic mathematics (e.g., computation). Retention, particularly of math facts, is often not proficient. The students often "crawl inside of themselves" when they work on mathematics. To help the students "come out of their shell," the teacher asks every student a question that can be entered into the calculator or for which the students can refer to their notes. None of her students have plans to choose a career in which they will be using high level mathematics, therefore, the calculator provides the students with a sense of comfort when they become anxious about their mathematical solving.

The teacher was asked if teaching with a graphing calculator made a difference in the behavior of the students, the teacher's teaching style, her role as a teacher, and in the content of what she taught. Regarding behavior, the teacher had never given the students a calculator. She believed that if the students did not have a calculator and were asked to graph an equation, the students would whine, say they could not do it, and would refuse to graph the equation. In other words, she felt the students would simply shut down. With regards to teaching style, the teacher believed that she was not able to focus on her teaching style but had to focus more on what needed to be covered in Algebra I. The teacher believed that her role did not change with the use of a graphing calculator. She continued to spend as much time teaching how to use the graphing calculator as she did teaching algebra. Because the teacher in this study does not teach basic computation, which can be done with the calculator, she does not teach some content, such as graphing, without the use of the calculator. She reviews T-charts, a non-calculator representation; however, she does not focus on this type of representation. The teacher commented that she is not able to go in-depth with what the graphing calculator can do because she has had to choose what to focus on.

How the teacher used a calculator in class changed when she began teaching Algebra I. In years past, the teacher taught classes that were referred to as “math resource.” The students were enrolled in a regular mathematics class with the resource class provided for additional instruction. The resource class was considered an intervention and was used as a tool to assist students in learning concepts taught in the regular class.

The years of teaching resource mathematics contributed to the teacher’s negative attitude toward using the graphing calculator. She felt the students became too dependent upon the calculator. She indicated her students thought they should have been able to enter anything into the calculator and obtain the correct answer. The teacher was of the opinion that while the students felt comfort using the calculator, the use of the calculator had become a crutch. The teacher commented that “ninth grade is not the time to start using [a] calculator.” She believes students in special education should begin using the calculator “in the third grade” not as a tool to determine “what you know” but that students should be taught at an earlier age the calculator’s capabilities as a learning tool.

The graphing calculator has helped with student motivation and behavior. The graphing calculator helped motivate the students in the teacher’s classes by eliminating mistakes. With the graphing calculator, the students were “able to come to a conclusion without messing up.” The teacher commented that “without making mistakes,” the students could focus on the mathematics. By using the calculator to perform the basic computations, the students are “able to solve difficult problems.” An example the teacher gave was the concept of quadratics. With the graphing calculator, the students were able to learn to factor because of the difficulty the students have with multiplying and dividing. The graphing calculator has also helped the teacher’s students with their behavior. The students gained success with solving problems with the graphing calculator. “Since they know they can do the problems and have success, most [will] focus on their work.”

Learning to use a graphing calculator can be daunting for many students. The teacher believed that the way the TI Nspire displays the input would be beneficial for the students in overcoming their language barriers. The teacher talked about the students being able to visualize the relationship between fractions and decimals in their original form, such as $16 \div 3 = \frac{16}{3}$ approximating to 5.3333. This enabled her students to be “empowered” and to more fully understand this mathematical relationship between fractions and decimals. The teacher believed that the TI Nspire would increase the use of language and mathematics vocabulary. On the flip side in the pre-intervention interview, the most difficult aspect of the TI Nspire for her students she predicted would be “learning where things are located” as the TI Nspire would be a totally new device. Because retention is a problem for special education students, the teacher believed that the students would have difficulty remembering which application to use and which menu option to choose from as she moved from concept to concept.

The teacher discussed during this pre-intervention interview that the TI Nspire would improve the accuracy of the students' computation and problem solving; however, efficiency of the students' computation and problem solving would not be improved. She explained that the calculator cannot help with the efficiency of problem solving due to the students' difficulty with setting up problems in the calculator based on word problems. Using the concept of percentages as an example, the teacher described how students are taught percentages using $\frac{IS}{OF} = \frac{\%}{100}$ to set up the word problem; however, the calculator cannot perform that task, "the calculator does not help with that." accuracy would be improved because "the majority of the mistakes" that are made fall into the category of computation, and the students "can type that in easily."

During the pre-intervention interview, the teacher stated that she believed that having the students use the TI Nspire would allow them to "have a better understanding of concepts that are covered" as well as a better understanding of functions. She thought the students would be able to see and make sense of functions when images are behind the graphs giving the students the opportunity to see the mathematics "applied to real life immediately." The teacher also commented that she predicted that the students would want to cling to the type of calculator that was used that they had in the past and would not like transitioning to the TI Nspire.

Post-intervention Narrative. At the end of the semester, the researcher interviewed the teacher to ascertain if any changes in the teacher's attitudes toward teaching with the TI Nspire had changed and if the teacher developed a more positive attitude towards students’ mathematical learning when using the TI Nspire handheld calculator.

The first question on the post-intervention interview asked the teacher of the study to explain how the students answered computation and problem solving problems. The teacher stated that the students answered computation and problem solving questions using several methods. These methods included showing work with paper and pencil, having students write on the board, guessing and checking, and using guided notes with verbal instructions. The students used their calculators while using the paper and pencil method. While writing on the board, the students explained how they solved the problems. Although students used guess and check, many stopped after guessing and did not check their answers. The guided notes included an example and three to four problems. The example along with one or two of the problems were worked as a class. The teacher had the students complete the remaining problems while she walked around the classroom checking for students’ understanding.

In addition to using the calculator when the students solved problems using paper and pencil, the teacher explained that the TI Nspire was used to explore rational numbers. Students explored “what they [rational numbers] looked like” and to “compare and contrast” numbers. During the semester, the students used the TI Nspire to aid in finding ratios, rates, and conversions and in finding the percent of change. The teacher led the students in solving equations, inequalities, and absolute value with the TI Nspire “going through [the] steps one at a time.”

The teacher approximated that the TI Nspires were used approximately 30% during class time. The teacher further explained that the low calculator usage was due to “a lot of time” having been spent on guided notes. The students were not given “a ton of problems” because they were not able to finish the problems, “got overwhelmed,” and/or would “shut down.” When asked why the teacher used calculators, she stated that the students’ computational skills were low. She also commented that because the students did not know their basic multiplication facts, the use of the calculator reduced the students’ stress.

The use of the TI Nspire during instruction by the teacher made a difference in the students’ behavior, the teacher’s teaching style, and how the teacher led the class. The students began using the TI Nspire at the beginning of the semester which the teacher stated helped with student behavior. Because the TI Nspire uses menus with numbered options, the students remembered the steps to complete problems which the teacher believed eased the students’ stress. The teacher spent more time showing the students how to use the calculator and what the calculator could do which changed her teaching style. She became more of a facilitator; however, the teacher stated that “with their level” she “still did a lot of teaching.”

The interview data revealed that as the semester progressed, the teacher became more comfortable teaching with the TI Nspire. She revealed that she began to accept the calculator more as a resource than as a basic calculator. She stated that she began to provide her students fewer instructions on how to use the functions of the TI Nspire as they became more comfortable using the calculator. Previously, the students used a 10-

key calculator; using the TI Nspire motivated her students to complete their work. The teacher began using the calculator as a motivational tool. She stated that she would “take the calculator away if [the students] did not work.”

The teacher in the current study commented that the hardest aspect of teaching with the TI Nspire was the learning curve for both her and her students. She stated “the more you know, the better you can explain” how to use the calculator. She believed the students needed to watch as she learned how to use the calculator. The teacher found that she and her students liked the feature of the calculator allowing the user to edit a previous input. When the students realized their mistakes, the feature allowed the students to more easily correct their mistakes.

After a semester of using the TI Nspire, the teacher preferred the TI-84 because she “was more familiar” with that calculator; however, the TI Nspire “does more and is more realistic.” The teacher also commented that the TI Nspire “does more when students graph” and her students were better able to understand transformation of graphs. She now believes the calculator is “better for student learning” and will continue to use the TI Nspire for teaching mathematics. “Once you learn how to use it [TI Nspire], it is easy to use.” She mentioned that all features of the TI-84 are on the TI Nspire. She believes “the exploration capabilities helped her students understand [the concepts] better.”

Teacher and Student Attitudes

For the fourth research question, the researcher explored how the teacher's attitude toward teaching with the TI Nspire handheld aligned with the students' attitudes toward mathematical learning with the TI Nspire handheld calculator. The questions asked of the teacher during both the pre-intervention and post-intervention interviews were separated into questions pertaining to mathematical learning and questions pertaining to teaching with the calculator. The questions asked of the students in the intervention group were separated into those related to mathematical learning and those pertaining to the calculator.

During the pre-intervention interview, the teacher supplied more negative statements than positive statements (44% and 35%, respectively) related to teaching with the calculator. Upon completion of the first semester after using the TI Nspire in her Resource Algebra I classes, the teacher provided 28% more positive statements than negative statements (see Table 26). The students in the intervention group were interviewed at the completion of their second semester of Resource Algebra I. Using only the questions pertaining to mathematical learning (including statements made during completion of Task 1 and Task 2), the students offered more positive statements than negative statements (41% and 34%, respectively).

Table 26

Teacher and Student Mathematical Learning Statements

Code	Teacher Pre-Intervention Interview	Teacher Post-Intervention Interview	Intervention Group Interviews
positive	35%	51%	41%
negative	44%	24%	34%
neutral	12%	9%	25%
example	8%	15%	n/a
totals	99%*	99%*	100%

*totals < 100% due to rounding

Conclusion

The data for the study were collected and analyzed. The inferences of these results follow in the next chapter. Quantitative data were collected from pre- and post-test scores from both the control group and the intervention group. Variables were summarized to obtain means, medians, minimums, maximums, variances, and quartiles. Variables were tested to determine normality to compare the scores of the control group and intervention group. Qualitative data were obtained through interviewing students from the control group and intervention group and through interviews with the teacher of study. Interview statements were coded on three separate days, counted, and averaged to ascertain the number of positive and negative statements provided by the interviewees.

CHAPTER V

CONCLUSIONS

Students in the current study were participants of a Resource Algebra I class. The control group completed the course using a TI 84 as the class calculator. Students in the intervention group completed the course using a TI Nspire handheld calculator. To answer research question 1, the researcher analyzed the scores of a pre-test and post-test created and administered by the school system. The control group was administered the tests at the beginning and end of the second semester of the course. The intervention group was administered the test at the beginning and ending of their first semester of the course. An additional pre-test was given to the intervention group at the beginning of the second semester of the course. To answer research question 2, the researcher interviewed 6 students from the intervention group and 4 students from the control group. All interviews were conducted after the students had completed their second semester of the Resource Algebra I class. The teacher of the Resource Algebra I course was interviewed at the beginning and ending of the semester the intervention group began the Resource Algebra I class to answer research questions 3a and 3b. The student and teacher interviews were analyzed to answer research question 4. Outcomes and recommendations on four relevant topics are discussed: (1) mathematical achievement, (2) student attitude, (3) teacher attitude, and (4) teacher and student attitude.

Mathematical Achievement

Researchers who have studied calculator use in the mathematics classroom found higher mathematical achievement of students on test surveys. Students who used TI-84 Plus graphing calculators showed improvement with mathematical achievement according to studies conducted by Noriani (2006) and Rivera (2007). Penuel et al. (2011) found students were successful in mathematics with the TI MathForward Program which uses the TI Nspire. Researchers who studied the use of the calculator with special education students concentrated on the use of the calculator as an accommodation (Bouck & Flanagan, 2009; Bouck & Yadav, 2008; Thompson & Sproule, 2005). Horton (1985) found students in special education who used a calculator showed improvement with computational performance. Little research could be found as to the effect of the interactive calculators (such as the TI Nspire) on the mathematical achievement of students with disabilities. The current study sought to provide this missing research of students.

The student participants in the current study who used the TI-84 Plus showed improvement according to their pre- and post-test scores which agreed with the findings of Noriani (2006) and Rivera (2007). The participants in the control group showed a 16.7% increase in the means of their pre-test and post-test scores with the standard deviation decreasing by 24.8%. Unlike Noriani's 2006 study, however, the findings were not statistically significant. The confidence intervals (refer to Figure 3) indicated that no statistical significance was evident. However, the effect size was Cohen's $d = 0.406$ which indicated practical significance for the pre-test and post-test variables.

One possible reason the control group did not show statistical significance could be attributed to the small sample size (n = 16). Also, the students had a two month break between the first and second semesters of the Algebra I course. Memory problems can make it difficult for students with disabilities to remember mathematics facts (Thompson & Sproule, 2005). Although the scores for the control group were not statistically significant, the scores were practically significant indicating an improvement from the beginning of the second semester of the Algebra I course to the end of the course.

The student participants of the study who used the TI Nspire performed better on the post-test than the first pre-test which is consistent with the findings from Penuel et al. (2011). The participants in the intervention group showed a 14.5% increase in the post-test scores from the pre-test scores, a 3.055 points difference. The standard deviation decreased by 26.1% from 8.941 to 6.606. Confidence intervals for the first pre-test and post-test variables indicated no statistical significance (refer to Figure 6). The effect size of the pre- and post-test scores was Cohen's d = 0.389 indicating practical significance.

Thompson and Sproule (2005) determined students with disabilities who have memory problems have difficulty remembering mathematics facts. One conclusion from the meta-analysis conducted by Hembree and Dessart (1986) was students' retention skills improved with the use of the calculator. The student participants in the intervention group were administered the second pre-test after a two-month summer break to determine retention. The small differences between the pre-test means (an increase of 4.5% with effect size of Cohen's d = 0.121) and between the second pre-test mean to the post-test mean (a decrease of 8.8% with effect size of Cohen's d = 0.324

favoring the post-test) may suggest the students were able to retain some of the information they learned during the first semester. The results suggest the use of the TI Nspire could help students who have difficulty remembering mathematics facts.

Both the control group scores and the intervention group scores indicated improvement from the time the pre-test was administrated to the time the post-test was administered. Both groups had access to and used a graphing calculator during the course. These improvements suggest the use of a graphing calculator in a mathematics course boosts mathematics achievement which supports findings of previous studies (Heller et al., 2005; Noraini, 2006; Penuel et al., 2011; Rivera, 2007).

To determine if the TI Nspire has an effect on mathematic achievement, the scores of the control group were compared to the scores of the intervention group. Confidence intervals for the control group pre-test mean and the first intervention group pre-test mean showed no statistical significance (refer to Figure 11); however, the effect size was Cohen's $d = 0.352$ indicating a level of practical significance. Comparing the control group's post-test mean and the intervention group's post-test mean also indicated no statistical significance (refer to Figure 12); however, the effect size was Cohen's $d = 0.482$ indicating a level of practical significance. No statistical significance was also found with the comparison of the control group's pre-test scores with the intervention group's second pre-test scores. Again, there was practical significance with an effect size of Cohen's $d = 0.541$.

The hypothesis for the first research question stated the TI Nspire will increase mathematics achievement for students in a resource Algebra I course. The researcher failed to accept the alternative hypothesis that the population mean of the control group is less than the population mean of the intervention group (H_A: $\mu_C < \mu_I$). While not statistically significant, effect sizes indicated a level of practical significance. The practical significance is important because the intervention group post-test was administered after one semester of the Algebra I curriculum and the control group post-test was administered after the students completed the full Algebra I curriculum. Additional research is recommended with larger sample sizes to conclusively deduce the effectiveness of the TI Nspire as a tool to help increase students' mathematical achievement.

Student Attitude

One advantage to having students use a calculator for mathematics class is the students' attitude. Hattie et al. (2016) stated "The attitude students have toward mathematics is important and can impact their willingness to try" (p. 73). A widely-cited advantage for using a calculator in mathematics class is the students' interest, motivation, and confidence in doing mathematics (Center for Technology in Learning, 2009; Ellington, 2003; Hembree & Dessart, 1986; Noraini, 2004). To determine whether the students in a Resource Algebra I class possessed a positive attitude toward mathematical learning while using the TI Nspire calculator, six students were interviewed from the intervention group and four students were interviewed from the control group. The same interview protocol was used for both groups which included two mathematical tasks. Task 1 was completed without the use of a calculator while Task 2 was completed with the use of a calculator. The students from the intervention group used the TI Nspire calculator to complete Task 2 and the students from the control group used the TI 84 calculator to complete the task.

The intervention group provided more positive statements than negative statements overall. When the questions dealing with mathematical learning were separated from the questions regarding the calculator, the intervention group's statements continued to be more positive than negative by a difference of 7%. The control group furnished more negative statements than positive statements overall. Statements bestowed by the control group pertaining to mathematical learning were slightly more positive than negative by a difference of 1%. These results could be interpreted to mean the use the TI Nspire does aid in more positive attitudes of the students toward mathematics.

One student from the intervention group did not believe that mathematics was important. Two of the six students did not believe that mathematics will be important in their future career. Although StudentEI believed that mathematics is important because it "makes me smart," she did not feel that she will need mathematics in her future career on Broadway or her work with Disney. StudentCI felt that mathematics "would not be that important" to his future career but "it depends on what I do." At the time of the interview he had "no idea" what he would do after high school.

Two of the six students from the intervention group felt mathematics would be somewhat important while the remaining two students believed mathematics would be very important in their future careers. StudentDI did not know what his future career would be but knew he would be using mathematics because "you always use math in everyday life." StudentFI is planning to be a welder and knew mathematics would be important but he stated he "did not know what kind of math" he would use. StudentAI and StudentBI are planning to be a teacher and be a veterinarian, respectively. StudentBI stated that she would be using both mathematics and science in her future career.

All of the students in the control group believe that mathematics is important and would be important in their future careers. StudentAC, who plans to attend college and work in the medical field, stated mathematics was "pretty important" and she would "probably" use mathematics on the job. StudentBC declared in his future job as a construction worker, plumber, or electrician, mathematics would be important as "I will need [to use] math a lot." Mathematics will be "very important" to StudentCC in her future career as a veterinarian, zoologist, or biologist. As a future mechanical engineer, StudentDC finds mathematics to be "extremely important."

The students in both the intervention group and the control group were not able to complete Task 1 successfully. One student in the intervention group and none in the control group were able to solve for the total bill for Task 2. Half of the intervention students felt that Task 1 (the task without the aid of the calculator) was more difficult to complete than Task 2. Three of the four students in the control group found Task 1 to be the more difficult task to complete. Two students in the intervention group and one student in the control group believed that both tasks were equally difficult. Task 2 was more difficult for the remaining student in the intervention group.

All but one of the students who found Task 1 more difficult agreed the difficulty was due to not having the use of the calculator. One student from the control group found Task 1 more difficult because she "forgot" the procedure for finding the percent of a number. Not knowing "how to put percent in [the] calculator" was the reason given by the student from the intervention group who felt Task 2 was more difficult. The students who determined the two tasks were equally difficult commented that the reason was due to "not knowing" how to complete the tasks. StudentBC stated "I was lost" when explaining why both tasks were difficult.

Although the students were not successful in the completion of the tasks, the students in the intervention group provided 49% positive statements while completing Task 1. The statements offered by the control group during Task 1 were more negative than positive. Over half of the statements that both groups imparted for Task 2 were negative (53% from the intervention group; 63% from the control group). While completing Task 2, StudentCI said he "didn't really know how to use the calculator." StudentFI stated he "forgot how to put percent in this thing" meaning he had forgotten where to find the key that will allow the user to calculate with percent without converting percent to decimals. StudentAC and StudentCC both commented on the lack of a percent key on the TI 84.

When the students were asked how they felt when they were completing the tasks, the students in the intervention group said they "felt dumb," "incompetent," "embarrassed," or "frustrated." StudentCI stated he "did not know how to use [the calculator] to get the right answer." StudentEI replied he "did not really know what to do." The students in the control group used words such as "stressed," "anxious," "nervous," "dumb," and "no confidence." StudentBC simply said he "had no clue what [he] was doing." StudentCC commented that she "did not feel pressured, just nervous" because knowing how to complete the tasks "was important."

The intervention group used the TI Nspire while completing Resource Algebra I. The control group used the TI 84 during their completion of Resource Algebra I. All but two of the students in the intervention group stated the TI Nspire was the calculator they preferred over the other calculators they have used or to which they have access. StudentAI, who did not prefer the TI Nspire, replied the TI Nspire was "hard to use" and often "would not work." (The students were using the TI Nspire touchpad handheld calculators which were introduced in 2010.) (https://www.vernier.com/til/2162/) StudentFI preferred to use the calculator on his cell phone instead of the TI Nspire because the calculator on his cell phone "does not have a bunch of numbers" and is "easier" to use. Three students in the control group preferred to use the TI 84. StudentDC preferred the TI Nspire because he "liked working with the latest stuff."

To determine if one group provided more positive statements over the other group, an analysis of the overall statements provided by both the intervention group and the control group was conducted. The overall statements provided by the intervention group contained 6% more positive than the negative statements. The statements regarding mathematical learning, which included both tasks, were 41% positive and 34% negative for the intervention group. The overall statements offered by the control group were more negative than positive by 2% with the mathematical learning statements more positive than negative by 1%. Taking only the tasks into account, the intervention group split the tasks with statements offered during Task 1 being more positive than negative by 13% and statements supplied during Task 2 being more negative than positive by 21%. The control group afforded overwhelmingly negative statements for both tasks with a difference of 40% for Task 1 and a difference of 49% for Task 2. The intervention group providing more positive statements could indicate the use of the TI Nspire contributes to the positive attitudes of students' mathematical learning.

Researchers have studied students with disabilities and their use of calculators. One study by Horton (1985) found students with disabilities showed improvement on computational performance and complex arithmetic problems with the aid of the calculator. Remembering mathematics facts has been found by Thompson and Sproule (2005) to be a disability for certain students. The students in both groups struggled to complete both tasks correctly. One possible reason could be the students simply were nervous as one participant stated. Another reason could have been the students did not remember the correct procedures to complete the tasks. The control group had completed their Algebra I course during the previous school year and most had not had a mathematics class the current school year. Although the intervention group was currently completing their Algebra I course during the time of the interviews, the students had completed the unit on percent the previous school year during their first semester of Algebra I.

Although both groups were unable to complete the tasks correctly, the intervention group provided more positive statements than the control group during the interviews. The hypothesis for research question 2 stated: Students with special needs who use the TI Nspire handheld calculator will develop more positive attitudes toward mathematics. The hypothesis for research question 2 is therefore accepted.

Teacher Attitude

Research literature concerning teachers' attitudes is mixed but generally revolves around students' attitudes and mathematical knowledge plus teachers' training, knowledge of the calculator that is used in the classroom, and time constraints. Teachers were found to be reluctant to use calculators if they considered themselves to have insufficient training on how to use the calculator (Berry et al., 2007; Patterson & Norwood, 2004). In one study, teachers' attendance at a workshop was found to make a difference in how calculators were used (Yoder, 2000). The teacher participating in the current study had informal training on the TI Nspire the summer before the school year in which the calculator was introduced into the Algebra I curriculum.

The teacher felt more positive about the use of the TI Nspire at the end of the semester as was evidenced from the increase in the number of positive statements noted. She stated in the pre-intervention interview that retention was an issue and she was concerned the students would have difficulty learning the functions of the TI Nspire. By the end of the semester, the students were better able to remember which functions to use. The teacher stated, "The students were able to remember numbers better. When they converted to decimals, it was easier for them to remember menu/2/1." (The teacher was referring to the TI Nspire's function of changing a fraction to a decimal. To access the calculator's functions, the user selects the menu and chooses the second option—Numbers—then the first option—Convert to Decimal.) (See Figure 28.)

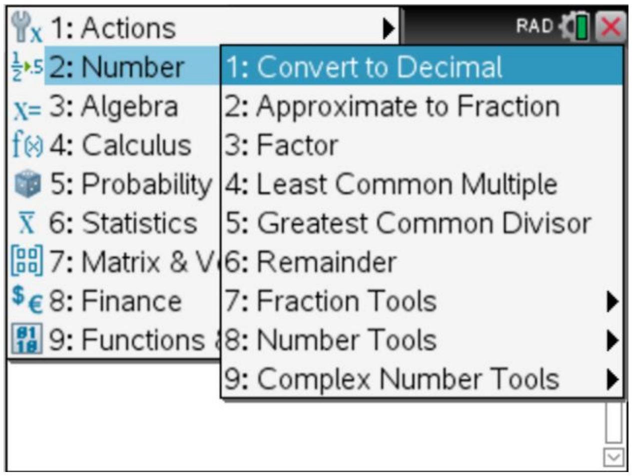

Figure 28. Screenshot of TI Nspire menu function.

The teacher's attitude towards the students' mathematical learning improved from the beginning to the end of the semester. The pre-intervention interview statements made by the teacher regarding mathematical learning can be characterized as approximately 16% negative and approximately 8% positive. Upon completion of one semester, the teacher's statements regarding mathematical learning were then characterized as approximately 9% negative and 9% positive. The teacher conveyed that the students continued to struggle with the concept that the expressions in an equation could be moved from one side of the equal sign to the other side and have the same meaning (i.e. $[c - 3] = 12$ is equivalent of $12 = [c - 3]$). Although the teacher tried to facilitate rather than direct teach more often as the semester progressed, she stated that "with their [students'] levels" she "still did a lot of teaching." The teacher used the TI

Nspire as a motivator to encourage deeper learning as "the students were more motivated to learn" when they used their Nspire calculators during mathematics instruction.

The teacher in this study acknowledged that vocabulary was important to mathematical learning. Researchers have shown that mathematics vocabulary is an important element in mathematical learning (Capraro & Capraro, 2006; Capraro, Capraro, & Rupley, 2010; Dunston & Tyminski, 2013; Riccomini et al., 2015). The teacher recognized the need for better vocabulary with the use of the TI Nspire calculator. During the pre-intervention interview, she mentioned that the calculator would help with the language barrier that is present and that she had to constantly work on vocabulary with her students. For example, when teaching percent of change, the term "original" was difficult for the students to comprehend. During the post-intervention interview, the teacher explained how the students understood the terms "quadratic" and "transformation" while graphing with the TI Nspire. Thus, students' increased mathematical vocabulary enhanced their mathematical learning.

Observing how the students' mathematical learning changed with the TI Nspire calculator as well as their motivation, the teacher's attitude toward the use of the TI Nspire changed from the beginning to the end of the semester. The pre-intervention interview statements made by the teacher regarding the calculator can be characterized as approximately 26% negative and approximately 21% positive. Upon completion of one semester, the teacher's statements regarding the TI Nspire were then characterized as approximately 13% negative and 28% positive. Although the teacher was more familiar with the TI 84, she believed the TI Nspire was more realistic and better for student learning. She believed that having the students see her continuing to learn functions of the calculator was important. The students were better able to explore mathematical concepts with the graphing calculator which improved the students' learning. The teacher's final comment was "I definitely want to continue using them [TI Nspire graphing calculators]."

Teachers need to change their pedagogy and be comfortable with whatever calculator they use (Noraini, 2004). As the teacher progressed through the semester, her attitude toward the use of the TI Nspire became more positive. The teacher's attitude toward using the TI Nspire calculator changed positively when students were able to remember the functions of the calculator more easily. Her attitude became more positive when she observed her students becoming increasingly more motivated to complete their work with the graphing calculator. In addition, as indicated through studies by Noraini (2006) and Simonsen and Dick (1997), the teacher began facilitating her class more often and saw improvement in the students' mathematical vocabulary. The teacher's positive attitude is in opposition to studies by researchers who found teachers had negative attitudes when additional time for learning to use calculators was needed (Berry et al., 2007; Goos & Bennison, 2008; Pierce & Ball, 2009; Simonsen & Dick, 1997).

The third hypotheses stated that the teacher of the Algebra I resource class will develop a more positive attitude toward using the TI Nspire handheld calculator as part of her classroom instruction and that the Algebra I resource teacher will develop a more positive attitude towards students' mathematical learning when using the TI Nspire handheld calculator. The hypotheses for the third research question is accepted.

Teacher and Student Attitudes

Researchers have noted that teachers' attitudes toward the amount of calculator use has been positive when students have shown positive attitudes (Berry et al., 2007; Brown et al., 2007; Tan & Forgasz, 2006). The researcher was interested in determining if the teacher's attitude toward teaching with the TI Nspire handheld aligned with the students' attitudes toward mathematical learning with the TI Nspire handheld calculator. The positive statements the teacher provided during the pre-intervention increased 26% during the post-intervention interviews. The teacher stated she uses a calculator as part of the Resource Algebra I curriculum because her students' "computation skills are low" and the calculator "reduces their stress." The TI Nspire became "more of a resource than a basic calculator." She believed the TI Nspire was "better for student learning."

The statements that the students in the intervention group provided when answering the questions pertaining to mathematical learning were 41% positive and 34% negative. Four students stated that mathematics was important. One student commented that she knew she would need "math and science" in her career choice of a veterinarian. StudentCI did not believe that mathematics would be important in his future career although he did not know what he would be doing after high school.

The students were very complimentary of their teacher. Although StudentDI often felt "exhausted, bored" when he walked into the classroom (because he "knew [he] would be lazy"), he felt "pretty good" about the course and had "learn[ed] a lot." StudentEI stated her teacher was "really good at teaching and explaining." StudentBI commented she "liked the class." StudentFI replied the class was "fun and enjoyable."

According to the statements provided by the students, the teacher has been able to provide a learning environment in which the students' attitudes were positive, the students understood the importance of mathematics, and the students were willing to try which is in accordance with findings of previous researchers (Center for Technology in Learning, 2009; Ellington, 2003; Hattie et al., 2016; Hembree & Dessart, 1986; Noraini, 2004). The positive statements provided by the teacher about teaching with the TI Nspire aligns with the positive statements related to mathematical learning offered by the students in the intervention group. The alignment answers the researchers' fourth and final research question. The hypothesis for the fourth research question is accepted.

Conclusion

The expected outcomes for the current study included an increase in mathematical achievement and more positive student attitudes toward mathematics with the use of the TI Nspire. In addition, it was expected the teacher would possess a more positive attitude after integrating the TI Nspire into Algebra I mathematics topics. Students who used the TI Nspire would have statistically significant higher post-test scores than students who did not use the TI Nspire during an Algebra I course. Also, students using the TI Nspire would possess beliefs that mathematics is necessary and a subject that is enjoyable to study. The teacher of the Resource Algebra I class would exude more confidence when teaching with the TI Nspire and believe that when students used the calculator there would be positive merits when teaching students with special needs.

The researcher accepted the hypotheses for research questions two through four but failed to accept the hypothesis for the first research question. The first research question dealt with the increase in mathematical achievement of the students who used the TI Nspire. The students who used the TI Nspire took the post-test after one semester of Algebra I. The students using the TI 84 took the post-test upon completion of the Algebra I course. The students who used the TI Nspire had higher post-test scores than those students who used the TI 84; however, the scores were not statistically significant as was expected at the onset of the study which could be due to the small sample size ($n_C = 16$, $n_I = 18$). More research on the effect of the TI Nspire with students with disabilities is recommended.

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APPENDIX A

STUDENT INTERVIEW PROTOCOL

What period do you have math this year? Tell me how it is going so far?

When do you find yourself using math the most?

How important is math to you and to your future career?

How do you feel when you enter your math classroom?

When you are given a math problem, walk me through how you would solve it.

What types of calculators have you used?

Which one do you like the best?

Why do you like that one the best?

In what ways do you use a calculator?

What concepts do you use the calculator for?

How does the calculator make math easier for you?

I have two tasks that I would like for you to complete. One I'd like you to complete without a calculator, and the other task you can use a calculator. You can stop whenever you want. Are you willing to start the tasks?

Task #1 (complete without a calculator): You are shopping at Old Navy for a shirt. You find the perfect shirt on sale! The price of the shirt is $10 with a 20% off tag. At the register, you receive an additional 10% off! How much do you pay for the shirt (excluding tax)?

Task #2 (complete with a calculator): You have just completed eating at Olive Garden. The server hands you the bill. Your meal totaled $14.28 and the tax rate is 9.75%. What was your total bill? How much should you leave as a tip?

Which task did you have more difficulty solving? Why was it more difficult?

Compare how you felt completing the task with a calculator with how you felt completing the task without a calculator.

Thank you for letting me ask you about mathematics!

APPENDIX B

TEACHER INTERVIEW PROTOCOL

Teacher Interview Questions (pre-intervention)

1. What do your students currently use in answering computation and problem-solving questions? How useful and effective is it (or are they) in helping your students solve problems?

2. How do you use calculators in your class (e.g. whole class demonstrations, individual students or pairs, exploration and problem solving)?

3. What portion of class time is spent using calculators?

4. Why do you use calculators in your teaching?

5. What difference has the graphing calculator made in your teaching

In behavior of your classroom

In your teaching style

In your role as a teacher

In the content of what you teach

6. Has your use of calculators changed over time?

7. Has your attitude toward calculators changed as you gained more experience?

8. How has the graphing calculator impacted the students learning?

On student motivation

On student behavior

9. What do you think will be the easiest/hardest part for your students about using the TI Nspire calculator?

10. Do you think using a TI Nspire calculator will be effective in increasing accuracy and efficiency of students' computation and problem-solving work?

11. What do you think you will like about your students' using the TI Nspire calculator?

12. What do you think you will not like about your students' using the TI Nspire calculator?

Teacher Interview Questions (post intervention)

1. How did your students answer computation and problem-solving questions? How useful and effective were those strategies in helping your students solve problems?

2. How did you use calculators in your class (e.g. whole class demonstrations, individual students or pairs, exploration and problem solving)?

3. What portion of class time was spent using calculators?

4. Why do you use calculators in your teaching?

5. What difference has the TI Nspire calculator made in your teaching

    In behavior of your classroom

    In your teaching style

    In your role as a teacher

    In the content of what you teach

6. How did the use of the TI Nspire calculators change during the course of the semester?

7. Has your attitude toward TI Nspire calculators changed as you gained more experience?

8. How has the TI Nspire calculator impacted the students learning?

    On student motivation

    On student behavior

9. What do you think was the easiest/hardest part about using the TI Nspire calculator with your students?

10. Which would prefer to use to teach your students: the TI 84 or the TI Nspire and why?

11. Would you use the TI Nspire calculator in everyday classroom mathematics? Why/Why not?

12. Any other thoughts you would like to share about the use of the TI Nspire calculators by your students?