ALASKA PACIFIC UNIVERSITY

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THE EFFECTS OF IMPLEMENTING MATH STATIONS IN A FIRST GRADE CLASSROOM

This thesis is submitted as partial fulfillment for the Master of Arts in Teaching at Alaska Pacific University. The work has been supervised, examined, and accepted by the thesis committee including one or more members of the Education Department Faculty.

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THE EFFECTS OF IMPLEMENTING MATH STATIONS

IN A FIRST GRADE CLASSROOM

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Melodie S. Smith

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Abstract

Teaching math to primary age students with different knowledge levels and attentiveness can be challenging. I wanted to determine if Math Stations could be a logical way of teaching math concepts to primary students with a greater success rate than whole group instruction. The purpose of this study was to discover if the implementation of Math Stations into the curriculum would increase student achievement and engagement in Math. The research was based on a first grade classroom in Alaska. Students participated in one day of Math Stations each week through two math units, totaling three days of Math Stations. Five data collection tools were used to evaluate if students had an increase in achievement and engagement in math: student questionnaire on attitudes, Pre- and Post-Tests, researcher journal, observational checklist on engagement, and student work samples. Mean percentages from Unit 8 and Unit 9 Post-Test scores (89% and 73%, respectively) were highly significant ($p<.001$) from their respective Pre-Test scores (66% for Unit 8; 48% for Unit 9). Researcher journal entries and video observations reflected that the majority of students liked math stations and were engaged throughout the project. Based on the results from each of the data collection tools, the research suggested students had increased in both achievement and engagement. This researcher believes Math Stations can: 1) support an increase in students' overall competencies in math, and 2) be an effective teaching alternative to whole group instruction.

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Chapter 1: Introduction

There are two areas that I feel can always be improved upon and refined in my teaching practice: 1) student achievement, and 2) student engagement. Fostering student achievement became my primary goal during my student teaching experience. I wanted to identify the best way to increase student knowledge by providing a safe environment, a fun, positive classroom, and an active learning atmosphere. Student engagement is another vital factor for the success of learners. As teachers we need to continuously find ways that keep our students engaged with content and maintain excitement about learning.

I believe by combining multiple strategies such as active and student-centered learning, I will ensure that my students have a broader scope of knowledge available, and ultimately, a greater chance for comprehension. To accomplish this goal, I chose to design Math Stations as a procedure that I hoped would work best for me as a teacher.

My motivation as an educator has always been to discover new, exciting material and engaging teaching methods such as active learning and student-centered methods. By implementing multiple strategies in Math Stations for each student, I may greatly increase the chances of making student-specific connections.

Focus of Inquiry

During student teaching, I was still eager to find the teaching strategies that would best fit my teaching style. There were several students at various developmental levels in math and it was difficult to continue to do whole group instruction each day. Some students did not grasp the math concepts and were not ready to progress while others became proficient. I incorporated Math Stations (Diller, 2011) one day a week to help students focus on certain skills. This also gave them the opportunity to delve deeper into their prior knowledge with different Math Stations. This helped mitigate frustration by allowing me to differentiate instruction and work with individual students and/or small groups. Math Stations appeared to be a more effective method to deliver content to specific students. By implementing the teachings from Diller's (2011), *Math Work Stations: Independent Learning You Can Count On, K-2*, I enabled the students to delve deeper into their mathematical understanding of certain concepts before I continued introducing more concepts.

I built upon my experiences with Math Stations in the classroom by incorporating them into my research study while focusing on active learning and student-centered teaching techniques. The Math Stations followed the district's math curriculum during the period of my study and honored fidelity to the published series then in use, *Everyday Mathematics*: Unit 8 *Mental Arithmetic, Money and Fractions* and Unit 9 *Place Value and Fractions*. This resource guided my research on what techniques work best in engaging students to become lifelong learners of math.

The conceptual understanding of mathematics has become a significant goal for the United States. Our nation has undergone two decades of mathematics reform and is still in the process of changing to increase our knowledge of math at competitive levels with other countries. In 2000, the National Council of Teachers of Mathematics (NCTM, 2000) published a report that stated,

> In this changing world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their

> futures. Mathematical competence opens doors to productive futures. A lack of mathematical competence keeps those doors closed. All students should have the opportunity and the support necessary to learn significant mathematics with depth and understanding. (p. 50)

It is important for us as educators, to determine the best instructional methods to increase a diverse student population's understanding of mathematics. The literature review in Chapter 2 discusses the history of mathematics, and where we are today at finding and implementing better methods to teach mathematics.

Type of Research

I chose to do an action research study, also known as practitioner research, a form of self-reflective inquiry to help develop an understanding of my teaching practice and philosophy with the goal of improving my overall teaching (Anderson, Herr & Nihlen, 2005). I conducted a continuous rotation of "action, observation, and reflection" (p. 3), which resulted in an improvement of my research objectives and methods, and ultimately, the transformations in the students and myself. I increased the trustworthiness and authority of my study by using peer review, member checks, and triangulation. Action research allowed me to better refine my research questions and led me in the direction of developing best practices that are conducive to my teaching style and techniques.

Purpose of the Study

The main purpose of this action research study was to find out if the implementation of Math Stations into the mathematics curriculum increased student engagement and learning through active learning and student-centered techniques. The guiding questions were:

- Can the implementation of Math Stations effectively increase student achievement?
- Does the use of Math Stations increase student engagement?
- Do students have a positive outlook on using Math Stations to learn math concepts?

I included a more comprehensive discussion of the specifics of the study and the guiding questions in Chapter 3 Methodology.

Conceptual Framework

Current action-based research that specifically focuses on Math Stations is very limited. Consequently, this study was designed using research focusing upon mathematics education, theory, and historical context. Data collected from various sources such as *National Assessment of Educational Progress* (NAEP, 2011) and *Trends in International Mathematics and Science Study* (TIMSS, 2007) have shown that U.S. students are failing at learning the necessary mathematical concepts needed to excel in a vast number of careers in the United States. TIMSS (2007) reported that math problems in the U.S. emphasized multiple connections to various mathematical concepts only 17% of the time, while Japan used connections in their problems 54% of the time (para. 3). The research also discovered that the average amount of time spent on a problem in the United States was five minutes compared with that of fifteen minutes in Japan (Zemelman, Daniels & Hyde, et al., 2005). This literature and a more detailed review of the related math pedagogical literature in Chapter 2 suggests that the U.S. is perhaps not using optimal instructional methods to teach mathematical concepts with the big ideas in mind. The United States traditional method of teaching primary students through direct instruction does not allow for active student engagement. There is a need to further investigate active teaching approaches and determine if, in fact, students in the U.S. respond to different teaching mechanisms that may boost mathematical competency. It could very well be, for example, that Japanese students thrive on a different mathematical approach that is different from the one U.S. students experience. Environment, culture, and economic status may all contribute to suitable teaching strategies for students. The use of Math Stations and the current math curriculum in the classroom will allow students to receive multiple instructional methods. More literature supporting the use of Math Stations to increase student achievement and engagement can be found in the Chapter 2 Literature Review.

Definitions of Terms

Definitions are provided to increase awareness and understanding of content. The following words will be used in this study:

Math Stations. A period of time for the students to practice problem solving while reasoning, representing, communicating, and making connections among mathematical concepts while the teacher meets with individuals or small group for differentiated instruction (Diller, 2011).

Active Learning. A method of learning when the students are engaged in activities such as reading, writing, problem solving, or discussion which promotes analysis, synthesis and/or evaluation of content (Center of Research on Learning and Teaching, 2011).

Student-Centered Learning. A teaching method concentrating on the student's needs, abilities, interests, and learning styles with the teacher as a facilitator of learning (*K12Academics*, 2014).

Constructivism Theory. A theory that students learn by constructing their own understanding and knowledge of concepts through experiencing and reflecting on those experiences (Walle, Karp, and Bay-Williams, 2010).

Sociocultural Theory. A theory that social learning settings such as adult and peer interaction, cultural beliefs, and attitudes impact individual student learning (Walle, Karp, & Bay-Williams, 2010).

Study Assumptions, Limitations and Scope

The major assumption of this study was that the implementation of Math Stations would affect student achievement and engagement in mathematics in a positive way. Another assumption was that most pre-primary teachers use a center/station approach to learning and students will be familiar with this type of learning. Expected limitations in the study were the duration of the study—only covering less than a one-month period of Math Stations—and the small sample size (n=13) of a specific classroom in a geographically isolated area. Students in the study were at a first grade developmental level. Methods of data collection were developed for that level of understanding.

The objective for this study was to discover if Math Stations are an appropriate teaching method to help students develop a conceptual understanding of math. To achieve this objective and encourage my students to learn, I investigated the use of Math Stations and tested my students based on small group instruction. I hoped to discover how to help students increase their grasp of basic math concepts in order to increase their success in mathematics throughout life. Additionally, I desired to gain insight into teaching techniques that would benefit students and offer direction to other educators who are looking for ways to "light that fire" in their students.

Conclusion

This action research study showed the efficacy of Math Stations in developing student math achievement and engagement in a primary classroom. Implementing different learning methods such as active and student-centered learning helped solidify students' prior knowledge of math concepts. This, in turn, led to greater understanding of mathematical concepts at an earlier age.

Chapter 2: Literature Review

Introduction

The intention of this study was to determine if the implementation of Math Stations into the mathematics curriculum would help students increased their engagement and grasp of math concepts through active learning and student-centered techniques. Math Stations were held once a week with a direct correlation to the lessons taught using the required district curriculum *Everyday Mathematics* (EDM). For each lesson plan, the district pacing guide served as a design element while implementing the EDM curriculum throughout the study.

I compiled the review using current research written for teacher preparation programs, NCTM publications, EBSCO, Academic Premier, Google Scholar and websites pertaining to math curriculum and standards. The literature review highlights an in-depth overview of mathematics education, which includes the history of mathematics instruction, the regulation of mathematics education, theories used in mathematics instruction, best practices, emotions and education, movement in the classroom, learning centers, Math Stations, and manipulatives. This review helped me develop a deeper understanding about past, current, and future mathematical teaching practices and future directions.

History of Mathematics Instruction

Mathematics education originated in the mid-1800s as an academic discipline. In that era, the textbook was the teacher's manual and the students' guide to learning mathematics. Teachers were introduced and trained by a one-page introduction to the textbook (Ray, 1850). Furr (1996) stated that in the nineteenth century, mathematics was considered a tool for reasoning faculties. Teaching, as a result, was focused on drill and discipline. Between the 1840s and 1950s the U.S. viewed mathematics only as a use for social utility. It was not until the 1920s that the semblance of a mathematical curriculum emerged.

The National Council of Teachers of Mathematics (NCTM) was founded in 1920 with the intention to "keep the values and interests of mathematics before the educational world and advised the curriculum studies and reforms to come from the teachers of mathematics rather than education reformers" (as cited in Klein, 2003, p. 4). Klein found that throughout the 1930s to the 1950s, in an era devoted to WWII efforts, progressivism was advocated for teaching math and curriculum was designed based upon the needs and interests of the students. Math comprehension for enlisted soldiers, who represented a large age demographic, was considerably low, thus requiring the U.S. Army to implement arithmetic into their trainings.

By the 1950s, progressive education was transitionally phased out and considered inadequate because of the decrease of enrollment in advanced math courses (Klein, 2003). A "new math" concept was adopted in the 1950s focusing on skilled instruction and understanding with logical explanations of mathematical procedures. As the former Soviet Union began pushing the envelope in aeronautical engineering with the likes of Sputnik in 1957, the U.S. Government invested heavily into the quality of mathematics and science education (Klein, 2003). Klein stated that America was humiliated by the launching of Sputnik and Congress reacted by passing the 1958 National Defense

Education Act, which was intended to increase the number of students majoring in math, science and foreign languages. By the 1970s, however, “new math” became obsolete, like its predecessors, and consequently funding ceased for the program. The shift in educational strategy was a “back to the basics” program, which emphasized the three R’s, reading, writing and arithmetic (Walle, Karp, & Bay-Williams, 2010).

“Back to the Basics” lasted well into the mid-to-late ‘80s, but in 1989, the National Council of Teachers of Mathematics (NCTM) published their landmark document *Curriculum and Evaluation Standards for School Mathematics*. This established the standards movement for mathematics, a strategy that continues to be modified today. Subsequent publications followed including, *Professional Standards in Teaching Mathematics* (1991), *Assessment Standards for School Mathematics* (1995) and twenty-two addenda booklets that address math topics at different grade levels—all of which were influenced by NCTM’s seminal work (as citied in Zemelman, Daniels, and Hyde, 2005). In 2000, NCTM published the *Principles and Standards for School Mathematics*, which was a revised set of standards that included the initial documents developed previously by NCTM (as citied in Zemelman et al., 2005).

The 2000 NCTM Standards are based on six major principles:

1. Equity
2. Curriculum
3. Teaching
4. Learning
5. Assessment

6. Technology

(Zemelman et al., 2005, p. 110 -111)

These principles were created by NCTM in 2000 to provide guidance and direction for educators in mathematics education. The principles were applied to the ten math standards for grades K-12. Each of the five "content" standards address mathematical content throughout the grade levels. They describe the processes through which students should acquire and use mathematical knowledge to build understanding of the concepts. These include:

*Content Standards

*Process Standards

*Number & Operations

*Problem Solving

*Algebra

*Reasoning & Proof

*Geometry

*Communication

*Measurement

*Connections

*Data Analysis & Probability

*Representation

(Zemelman et al., 2005, p. 110 -111)

Regulation of Mathematics Education

In the late 1960s, the United States developed a program to monitor and assess American students' knowledge in multiple subject areas. The program, called the National Assessment of Educational Progress (NAEP, 2012), provided progress reports through the Nation's Report Card. In its most recent assessment (2011), the average math assessment score was one point higher than the 2009 assessment for fourth and eighth graders. In the 2009 assessment, only 39% of fourth graders and 34% of eighth graders performed at desirable levels of proficiency or advanced (NAEP, 2012).

The United States was also compared to other countries in the Trends in International Mathematics and Science Study (TIMSS, 2007), a study that various nations have participated in every fourth consecutive year since 1995. Data are collected on 4th and 8th grade students' mathematics and science achievement for each country, drawing a comparison of aptitude performance. Results are still pending for the most recent study conducted in 2011, but in 2007, data suggested that the U.S. 4th and 8th grade students were above the international average, but were outperformed by eight countries (TIMSS, 2007).

> The average mathematics score of U.S. eighth-graders was higher than those in 37 of the 47 other countries, lower than in 5 countries (all of them in Asia), and not measurably different from the average scores of students in the remaining 5 countries. The average mathematics score of U.S. fourth-graders was higher than those in 23 of the 35 other countries, lower than in 8 countries (all 8 were in Asia or Europe), and not measurably

> different from the average scores of students in the remaining 4 countries. (para. 2-3)

These data, although compiled from 2007 findings, suggest an alarming concern for our country. In another report by TIMSS, similar findings revealed that "ten percent of fourth grade students and six percent of eighth grade students performed at or above the advanced international benchmark" (para. 3). Based upon these evaluations, the TIMSS curriculum analysis concluded that the United States mathematics curriculum was, "a mile wide and an inch deep" (Schmidt, McKnight, and Raizen, 1996, p.63). This quote metaphorically implies that the U.S. curriculum tried to do everything but consequently never provided an in-depth study of math.

In 2010, the Council of Chief State School Officers (CCSSO), a nationwide, nonpartisan, and nonprofit membership organization, stated it "is committed to creating a public education system that prepares every child for lifelong learning, work and citizenship," (CCSSO, 2012, Who We Are section, para. 1) and it presented the Common Core State Standards. Forty-three states, the District of Columbia, and four territories formally adopted these standards. One effect has been that CCSSO has reformed mathematics such that broad mathematical topics are introduced rather than conventional spiral lessons.

TIMSS, NAEP, CCSSO and NCTM were all integral components in the shaping of mathematics education reform. In less than 25 years, the standards movement has revolutionized the way we view teaching mathematics. In the 1980s, the United States had no national foresight on how or what mathematical concepts should be taught at each grade level. Now, the U.S. has a widely- shared vision of what students should know and what they should be taught at each grade level (Walle et al., 2010).

Multiple studies over the past 25 years have found that the mathematics curriculum in the United States is narrowly focused on procedures and produces facts that are highly repetitive in nature with numerous overlap and review each year (Zemelman et al., 2005). Teachers have continued to believe that knowledge was something that was transmitted to the students, which lead them to use teaching methods that treated students as passive learners (Sloane, 1999). Teachers instructional methods were “didactic, top-down, do-as-I-show-you” instruction (Walle and Lovin, 2006, p. 10). While in some instances passive learning may be an effective teaching practice, such as in post-secondary classroom environments, Walle and Lovin demonstrated that the use of this instructional method alone was not effective for elementary students.

As described by the *Principles and Standards* (2000), the National Council of Teacher of Mathematic’s (NCTM) vision is to instill change into the curriculum such that mathematical reasoning, representation, problem solving, communication, and connections are to be the focal point of learning and teaching mathematics in active learning settings. Research from Neyland and Tepp (as cited in Hatfield, Edwards, Gary & Morrow, 2000) in the 1990s showed that students learn better when they are actively engaged and when learning is connected with previous knowledge. More teachers are treating students as active learners and creating environments that support meaningful, hands-on learning (Sloane, 1999). Instead of teaching every student the same material the same way, teachers are now looking at what is developmentally appropriate for each student. This encourages teachers to become facilitators of learning the concepts rather than just transmitters of knowledge (Sloane, 1999).

Theories used in Mathematics Instruction

Constructivism and sociocultural theory are two concepts that researchers of mathematics education use to describe how students learn math. Walle (2010) stated that Piaget's research in the 1930s led to the constructivism theory, suggesting that "learners are not blank slates but creators of their own learning" (p.19). This means that we cannot teach students by telling, but by helping them construct and build upon their prior knowledge (Walle et al., 2010). One way of applying the constructivism theory is through reflective thought. Students modify existing schema to combine new ideas (Fosnot, 1996).

Another theory developed at approximately the same time as constructivism was the sociocultural theory. This theory was influenced by Vygotsky's research (as discussed in Walle et al., 2010) in the 1920s and 1930s. Sociocultural theory shared the same concept about how the learner must be "active meaning-seeking" for the learning process to be successful. These two theories are reflected in student-centered mathematics education.

According to Walle and Lovin (2006), three factors influence learning:

- Student reflective thinking
- Social interaction with other students in the classroom
- Use of models or tools for learning (manipulatives, symbolisim, computer tools, drawings, and even oral language). (p. 4)

Action Research Studies

A recent study by Jasmine (2011) incorporated action research by focusing on learning centers in a third grade classroom. Her objective was to enhance and motivate student comprehension with multiplication. Her findings revealed that most students believed learning multiplication in a center helped them understand their facts and increased their interest in learning multiplication. The data also suggested that the majority of students enjoyed working in learning centers and felt that it improved their understanding (Jasmine, 2011). Although the literature includes few action research studies of this type, Jasmine's study provides useful examples of how incorporating learning centers in a classroom benefits students.

Best Practices

According to Daniels and Bizar (2005), authors of *Teaching the Best Practice Way*, for teachers to embrace best practices the strategies must be viewed as a good approach, current and mainstream. They also suggested that the definition, theory, and research for best teaching practices are derived from mainstream professional associations, subject-matter organizations, research centers, and curriculum groups. These include, but are not limited to, the National Board for Professional Teaching Standards, International Reading Association, and Center for Civic Education (Daniels & Bizar, 2005).

Educators have a significant task of setting up functional classrooms where all students can learn and succeed. An educator's mindset toward best educational practice develops from years of experience, colleagues, professional reading, schooling, the school district, and environmental considerations. It can be a confusing endeavor to determine what works best for the students and the educators. However, delving deeper into specific best practices, one uncovers the multidisciplinary connections best practices have with educational concepts and theories. These include, but are not limited to student-centered learning, differentiation, and learning centers.

Learning Centers

King-Sears (2007), professor of Special Education at George Mason University, wrote that one way for teachers to effectively respond to diversity in the classroom was to design and implement learning centers that provided instructional extensions for all types of learners. Simplified, there are four groupings of students in diverse classrooms:

- Learners who "got" the content and are ready to move on to much higher level of the content.
- Learners for whom the presentation, pace, and practice that the teacher is using is "just right".
- Learners who need a little more practice with the new content.
- Learners who need a lot more practice with the new content.

(King-Sears, 2007, p. 138)

Centers are areas in the classroom that have authentic materials for the students to learn about specific subject matter in greater detail. For example, a center in a first grade classroom during math may have a variety of materials, such as unifix cubes – plastic cubes that can be connected together to use for addition, subtraction, patterning, etc. – that help students understand math concepts. Centers can produce increased achievement by allowing the students to discover, practice and master specific skills and content (Sloane, 1999). They can be planned to individualize practice for varied readiness levels, and specific centers can be designed for individual or group work. Centers can help students be more actively engaged in their learning, provide time to practice new skills, and increase proficiency in multiple skills (King-Sears, 2007). Some believe that Center-Based Classrooms are the ideal approach for implementing developmentally appropriate practice with primary classrooms (Sloane, 1999).

Math Stations

Math Stations are a center-based teaching approach that can benefit primary students (K-2) in developing an in-depth knowledge of basic math concepts. During Math Stations, students spend time in a variety of activities that can extend prior background knowledge and reinforce classroom instruction. These activities allow the students to develop a deeper mathematical understanding. Math Stations allocate time for students to practice problem solving through reasoning, representing, communicating, and making connections among mathematical topics while the teacher helps individual students or meets with a small group for differentiated math instruction (Diller, 2011).

Manipulatives

Manipulatives are a common technique used to teach math concepts in primary grade mathematics. This hands-on approach was viewed by many as the recommended way to teach mathematics (Walle & Lovin, 2006). As Walle & Lovin (2006) state in *Teaching Student-Centered Mathematics: Grades K-3*, “there is no doubt that materials can and should play a significant role in the classroom” (p. 8). Manipulatives, when used correctly, can have a positive effect on students' learning, but they are not the only method that should be used in teaching mathematics. Listed below are additional mathematical ideas that, when coupled with manipulatives, may increase overall student competency. It is difficult for students to talk about and test out abstract relationships using words alone. Models give learners something to think about, explore with, talk about, and reason through. As suggested by Walle and Lovin, some uses of models are:

> - Ideas that students are in the process of developing can be tested to see if they fit or work correctly when applied to a model that the teacher or other students have suggested represents that idea.
> - It is often easier for students to think through a problem or task by use of an appropriate model or tool.
> - Tools are especially helpful in communicating ideas that are otherwise difficult for students to talk about or write about.
> - Simple drawings of counters, base-ten blocks, number lines, or fraction pieces can help students who are trying to record their ideas.
>
> (p. 7-8)

Movement in the Classroom

Movement in the classroom has been viewed as a best practice in education because it increases attention, focus and thinking skills. Active learning helps students recall information better when they are physically, mentally, and emotionally engaged than when they are learning passively (Sporns, Tononi, & Edelman, 2000). According to Sejnowski, the "learn, discuss, take a walk" method of teaching is more strongly recommended because it allows "processing time" for the students after they have learned something new, which aids in recall (as citied in Jensen, 2005). The majority of students like to learn actively not passively, but throughout their educational experience, most students have been trained to be passive learners (i.e., lecture). As a result, active learning can seem strange and foreign (Jensen, 2005). Although my observation is that while classrooms in elementary education foster active learning, where children begin to struggle is during the transition to passive learning. It is a switch from one system to another. Therefore, movement in the classroom seems like a practical strategy to get students motivated, excited to learn, and better able to retain the information being presented.

Emotions and Education

Wolfe's quote (as citied in Sylwester, 1995) "Emotion drives attention, attention drives learning," (p. 119) suggested, if applying the geometric transitive property (A = B, B = C, therefore A = C), that our emotions are key components that drive learning. It is believed that emotions control everything we do on a daily basis (Jensen, 2005). Emotions are needed to establish a lasting connection for students. As teachers, therefore, we need to center content around prior knowledge, teach it in context, and be active and reflective for it to become meaningful to the students (Jensen, 2010). A few emotional strategies that have been researched over the years are: 1) prior knowledge influencing all learning (Altmann, 2002); 2) negative types of stress can cause the "fight or flight" syndrome in students (Wilmes, Harrington, Kohler and Sumpter, 2008) and; 3) the rule of error correction states that the brain rarely produces the right content the first time and making mistakes is vital in developing intelligence (Jensen, 2005). As Jensen describes (2005), "It's not just what we think: it's where, when, with whom, and how we feel about it that matters" (p. 55).

Conclusion

This literature review presents a brief compilation of mathematics history, mathematics research, and implications for education. Since mathematics education reform is ever changing, I have focused on the studies that have remained relevant over time, especially in light of rapid advances in neuroscience research. Since the early 1900s, mathematics education has undergone significant change, and we can be justified in assuming that with advances in science and technology, mathematics will evolve. Research shows movement, best practices, and manipulatives will ultimately play major roles in the successful integration of the action research study focusing on Math Stations. A detailed description of how these components fit into this study are described in Chapter Three.

Chapter 3: Methodology

Purpose

The purpose of this action research project was to answer specific questions regarding primary age students learning Math.

The main research question:

- Does the implementation of Math Stations into the current mathematics curriculum increase student engagement and learning?

The sub-questions are:

- Can I implement Math Stations to effectively increase student achievement?
- Does the use of Math Stations successfully increase student engagement?
- Do students have a positive outlook on using Math Stations in the classroom?

This study was designed to benefit my professional teaching practice as an elementary school teacher. I wanted to discover the best way to implement a successful math program that meets students' needs and increases their achievement.

Math Stations have been implemented into various classrooms around the United States as a learning approach through exploration, differentiation, and individual and group work. Diller, author of *Math Work Stations* (2011), stated: "that by implementing Math Stations, the students are able to reinforce and/or extend prior instruction" (p. 7). Math Stations will help the students develop a deeper mathematical understanding and also support various learning styles in the classroom.

This research was conducted to determine if Math Stations would increase the students' conceptual understanding of mathematics. This would lead to a deeper understanding in mathematics and increase the likelihood of student success throughout the K-12 grade curriculum. Centering Math Stations on the principles of active and student-centered learning, I hoped that math achievement in my first grade classroom would result in my students' collective attainment of math standards. Results from a 2010-11 Alaska Standard Based Assessment Report Card from an undisclosed elementary school in the district, showed that 25.61% of students are not proficient in Math in 3rd grade. To improve this percentage and others like this in the district, we must find ways to increase overall knowledge of math concepts.

Setting/Participants

This action research project was conducted in an urban K-6 school setting in Alaska during the fourth quarter of the 2012-2013 school year. Participants in this study were first graders. According to the school district's ethnicity report, 47% of the student population is Caucasian, 6% African American, 9% Alaska Native or American Indians, 15% Asian or Pacific Islander, 10% Hispanic and 13% Multi-Ethnic ("2010-2011 ethnicity report," 2010). These data illustrate a very diverse school population. If these statistics apply to the entire school district, then one can extrapolate these numbers to reflect individual classroom settings in a general, non-geographically biased assessment. Thus, participants in this study potentially reflected strong ethnic diversity and require teaching strategies to accommodate this. The first grade class consisted of 11 girls and 7 boys who did, indeed, reflect the district's diversity. All of the students participated in the study, but data were only used from thirteen students who had parental consent. A consent form was sent to parents at the beginning of the study. (Refer to Appendices C and D.)

Math Stations Outlook

Prior to the initial onset of the five-week study, there was a two-week period when parents could submit consent forms for participation. In each of the three weeks during the study, Math Stations were implemented one day during the week. Each week, the Math Stations began with an introduction to the specific stations. After the introduction, students were placed into four groups based on student understanding of the math objectives for the current unit. The students' understanding was determined through teacher observation, daily work, and/or student work. There were four stations, and each group had 15 minutes at each station.

Using a math station (center rotation) approach provided the students with various learning activities and gave the teacher the chance to differentiate instruction and focus on skills that have not yet been mastered. Each math station implemented active learning and student-centered teaching strategies.

The stations were broken into four groups:

- Station 1 – Work on specific math concepts with the use of math games.
- Station 2 – Manipulative/Real-life application – a real life application or manipulative station where they can apply their learning in a different way.
- Station 3 – Teacher – to focus on a specific math concept with a focal lesson and direct application using manipulatives or specific problems.

- Station 4 – Computer – to work on various standards that should be mastered by the end of the grade level.

Many schools within the Anchorage School District used *Everyday Mathematics* (EDM) curriculum. EDM was the curriculum used during the study, and it focused on Unit 8: *Mental Arithmetic, Money, and Fractions* and Unit 9: *Place Value and Fraction*s. Math station activities were developed or adapted from various sources such as *EDM 1st grade manuals, Teachers Pay Teachers website, and Math Work Stations* to reinforce and expand prior learning from previous math instruction. During Math Stations, students had the time to problem solve, make connections, and work at their level of understanding.

Methods

This action research project was designed using qualitative and quantitative measures. The methods that were used in the project were chosen to help answer the questions stated at the beginning of Chapter 3. Collected qualitative measures are based on a researcher's journal, observational checklist, visual recordings, and student work. The quantitative measures were collected at the beginning and end of the unit. This involved a Pre- and Post-Tests and a student questionnaire collected at the beginning of the study. A detailed description of each method of collection and why it was developed for this study will follow.

Researcher Journal. The journal was implemented at the beginning of the study to help guide my research questions. I reflected on the general outcome and use of the Math Stations, the content of the station and how the students reacted to that station. The focal questions I used after each period of Math Stations included:

1. Were the stations effective? Why or Why not?
2. Did the students' stay engaged at each station? Why or why not?
3. Were there any issues during Math Stations?
4. What went well during Math Stations?
5. What could be improved upon regarding the math station concept?

The researcher journal was used to answer all of the questions in my study. I chose to use the journal because it was a self-administered tool to guide my instruction and a reflective practice during my research.

Pre-Test. I used the post-test questions as the pre-test for Unit 8 and Unit 9 Everyday Mathematics to gather baseline data on each student's background knowledge of Unit 8 and Unit 9 math concepts. This was used to group students based on readiness during Math Stations, and obtain a formal assessment to inform my instruction. The pre-test was a quantitative measure that analyzed competency prior to implementing Math Stations. I drew comparisons and conclusions from this evaluation and the post-evaluation.

Student Questionnaire on Attitudes. This questionnaire was presented to students at the beginning of the study. It was used to identify the overall attitudes of student opinions on Math Stations and Math. (See Appendix A.)

Observational Checklist. This checklist was used in conjunction with video recording to observe student engagement throughout Math Stations. Each lesson was taped. I reviewed the last 15 minutes of each video and record observations specific to the checklist. (See Appendix B.)

Post-Test. The tests were taken from the Everyday Mathematics Assessment program. The Unit Eight and Unit Nine tests were used to assess students' current knowledge of the math curriculum and the outcome was used to determine if Math Stations were beneficial.

Student Work Samples. The student work samples were used as a guide to help individual students, the parents and the teacher view the overall progress of the students' math abilities for Unit 8 and Unit 9. Various samples were taken over both units to increase awareness of where the student stood on certain math concepts.

Figure 1 displays a distribution timeline for the data collection times for the study. I started collecting preliminary data on March 25, 2013 – April 5, 2013. The study began the week of April 8th and ended the week of May 6th.

Data Collection Instrument	Distribution Timeline
Research Journal	Throughout the Study
Student Questionnaire on Attitudes	April 11th
Pre-Test Unit 8	April 11th
Pre-Test Unit 9	April 24th
Observational Checklist A	Throughout the Study
Post Test Unit 8	April 22nd
Post Test Unit 9	May 9th
Student Work Samples	Throughout the Study

Figure 1. Timeline for Data Collection

Research Design and Analysis

The data were collected during the fourth quarter of the 2012-2013 school year for a seven-week period. The reflective journal, unit tests, and student work samples were analyzed using a constant-comparative approach to determine if students increased their knowledge of Unit 8 and Unit 9 math concepts. The reflective journal was designed to look at the overall success of Math Stations. The unit tests were a quantitative measure to see if the students successfully grasped Unit 8 and Unit 9 math objectives. If the students showed progress in their math objectives for Unit 8 and Unit 9, it was concluded that Math Stations were successful in increasing student achievement. If the scores showed a regression of math skills, I concluded that Math Stations were not beneficial to student achievement. Each conclusion was carefully examined to determine if any external bias may have contributed to the final results. I also examined if Math Stations increase student engagement in math. I used the researcher journal in conjunction with the observational checklist and video to crosscheck if the students were engaged in each math station during the math block. The final analysis of the data I used included the reflective journal and a student questionnaire to consider if students had a positive outlook on using Math Stations to learn math concepts in the classroom.

Validity and Reliability

The study was designed around multiple qualitative and quantitative data collection methods to make it reliable and valid research. With the use of Guda’s criteria of qualitative research, the research consists of credibility, dependability, conformability and transferability (Mills, 2010). According to Mills (2010), credibility is, “the researcher's ability to take into account the complexities that present themselves in a study… dependability is the stability of the data… conformability is the neutrality or objectivity of the data that has been collected…[and] transferability is the researchers' belief that everything they study is context bound" (pp. 104-105). These criteria were addressed through the use of observation, video, student work, multiple methods of data collection and triangulation. Refer to Figure 2 for a visual representation of how triangulation was met during the research project.

Research Questions	Data Source		
	1	2	3
Math Stations increase student achievement?	Researcher Journal	Unit Tests	Student Work Samples
Math Stations increase student engagement?	Researcher Journal	Observation Checklist A	Video Observation
Do students have a positive outlook on using Math Stations in the classroom?	Researcher Journal	Student Questionnaire	Video Observation

Figure 2. Triangulation Matrix

Conclusion

This study was designed to further my professional knowledge on using Math Stations. As an educator, we are responsible in finding the best methods to teach subject matter. Due to the nature of this action research project, a combination of both qualitative and quantitative assessment tools was necessary to fully answer my research objectives. By using the five data collection tools (Pre- and Post-Test; video observation and checklist; researcher journal; student questionnaire; and student work samples) as outlined in this chapter, I was able to determine if Math Stations were effective at increasing student achievement, engagement, and perspective on math.

Chapter 4: Results

Purpose

The purpose and primary research objective of the study was to discover if the implementation of Math Stations into the mathematics curriculum would increase student engagement and learning. I wanted to determine if math stations were a viable option to use during math block in my first-grade classroom.

Setting/Participants

The participants in this study were from an urban school district in Alaska. According to the school district's ethnicity report, 47% of the student population were Caucasian, 6% African American, 9% Alaska Native or American Indians, 15% Asian or Pacific Islander, 10% Hispanic and 13% Multi-Ethnic (2010-2011 Ethnicity Report, 2010). The study was conducted in one class of first graders. Of the eighteen total students who participated in the study, only seven girls and six boys (n=13) returned signed permission slips to allow for data collection in this study. Each student was assigned a unique identification number used throughout the study to protect their identity.

Measurement Tools

Quantitative and qualitative data were collected through specific measurement tools: 1) a student questionnaire on attitudes, 2) pre- and post-unit exams, 3) a researcher journal, and 4) video observations. The study consisted of two math units. The measurement tools are discussed in detail below.

Student Questionnaire on Attitudes. This questionnaire was presented to the students at the beginning of the study. The questionnaire was designed to identify the students' overall attitudes and opinions on Math Stations and Math. It was also used to gain background knowledge of the students' prior use of stations and how they liked to learn math. All thirteen students in the study completed the student questionnaire (Table 1). One hundred percent of the students responded: a) math was important in their life, b) learning math through the use of computer games was enjoyable, and c) each of them had done some type of math station or center previously. Ninety-two percent of the students liked math stations or centers. One student who did not like math stations or centers also reported not liking math. Over fifty percent of the students had a positive outlook on everything involving math. Six students in the study disliked something in math. Most of the students who disagreed on the questionnaire did not like math worksheets, teaching classmates, using hand signals to remember math skills, and/or the use of visual aids.

Table 1

Student Questionnaire on Attitudes

Question	Agree n	Agree %	Disagree n	Disagree %
1. I like math.	10	77%	3	23%
2. I dislike math.	2	15%	11	85%
3. Learning new things in math is fun.	11	85%	2	15%
4. Math is important in my life.	13	100%	0	0%
5. I like learning math by using computer games.	13	100%	0	0%
6. I like doing math worksheets.	9	69%	4	31%
7. I like playing math games.	11	85%	2	15%
8. I like learning math with movement.	11	85%	2	15%
9. I like using visual aids to learn math.	9	69%	4	31%
10. I like to figure out multiple ways to solve a math problem.	11	85%	2	15%
11. Have you ever used math stations or centers in school?	13	100%	0	0%
12. If yes, did you like math stations/centers?	12	92%	1	8%
13. Do you like using hand signals to remember math skills?	8	62%	5	38%
14. Do you like teaching your classmates about math?	8	62%	5	38%
15. Do you like learning the basics of math through exploration?	10	77%	3	23%

Note. n=13

Pre-Test Results

Before the Pre-Assessment test, each student was given three lessons of Unit 8. These particular lessons reviewed coins along with an introduction to dollars and place value. On April 11, a pre-test was given to the class based on Unit 8: Mental Arithmetic, Money, and Fractions. The test consisted of two parts (A and B) totaling 9 questions worth 25 points. Part A tests concepts and skills that the students should have mastered by the end of the unit. Part B contains formative questions that are used by the classroom teacher to guide future instruction.

Based on each student's performance, a class mean was calculated. Twelve students participated in the pre-test. Student 13 was omitted in all Pre- and Post-Test data analysis because he/she did not participate in the Unit 8 Pre-Test and the Unit 9 Post-Test. Therefore, the student's scores were not included in the results. Mean pre-test results for the students participating in the study (n=12) was 66% (standard deviation 10.82%; Figure 3).

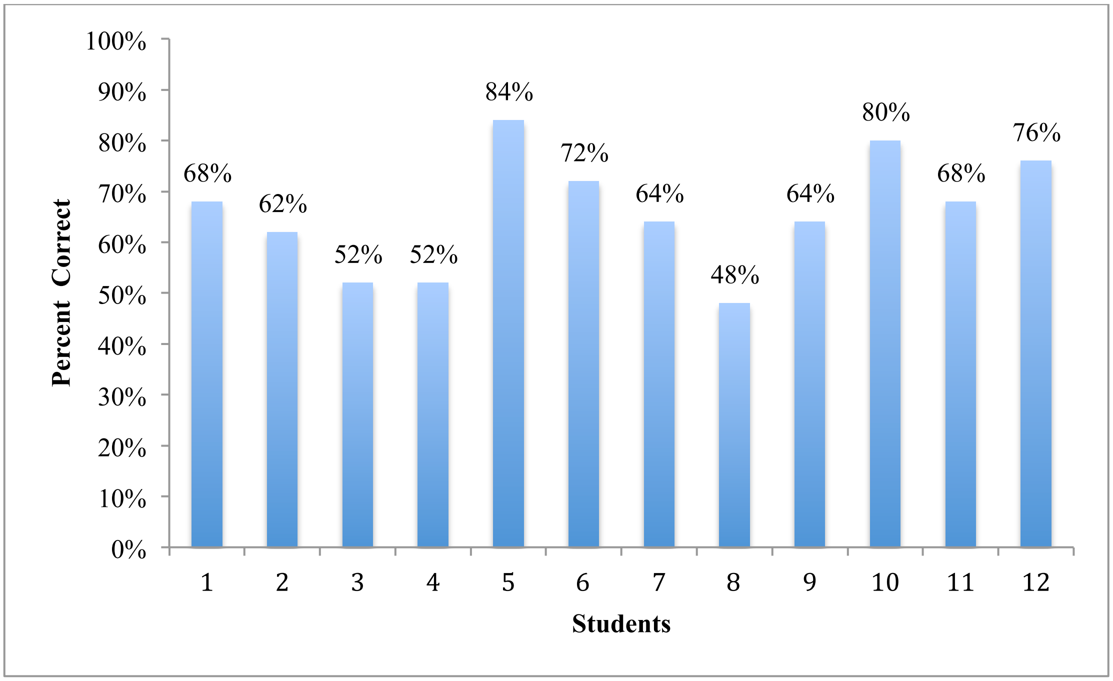


Figure 3. Unit 8 Pre-Test Assessment results for each student.

Everyday Math was designed with the anticipation that students will master a variety of math concepts and skills over time through a process called "distributed practice." The curriculum is intended to regularly revisit topics, concepts and skills (Everyday Mathematics, 2014). For this purpose, the assessment at the end of each unit contains items recently introduced as well as items that assess retention and mastery over time.

Six out of the 12 students who took the Pre-Test scored above the class mean. The majority of the students missed the questions related to money story problems, name collection boxes—a method in which numbers can be expressed in different ways—and labeling equal parts of a shape.

Figure 4 describes the frequency distribution of the students' test scores. A total of 8 students scored below 72%. Four of the students scored 72% or higher; no student scored above an 85%. Results from the Pre-Test suggest that the majority of the students were not proficient at the tested Everyday Mathematics curricula.

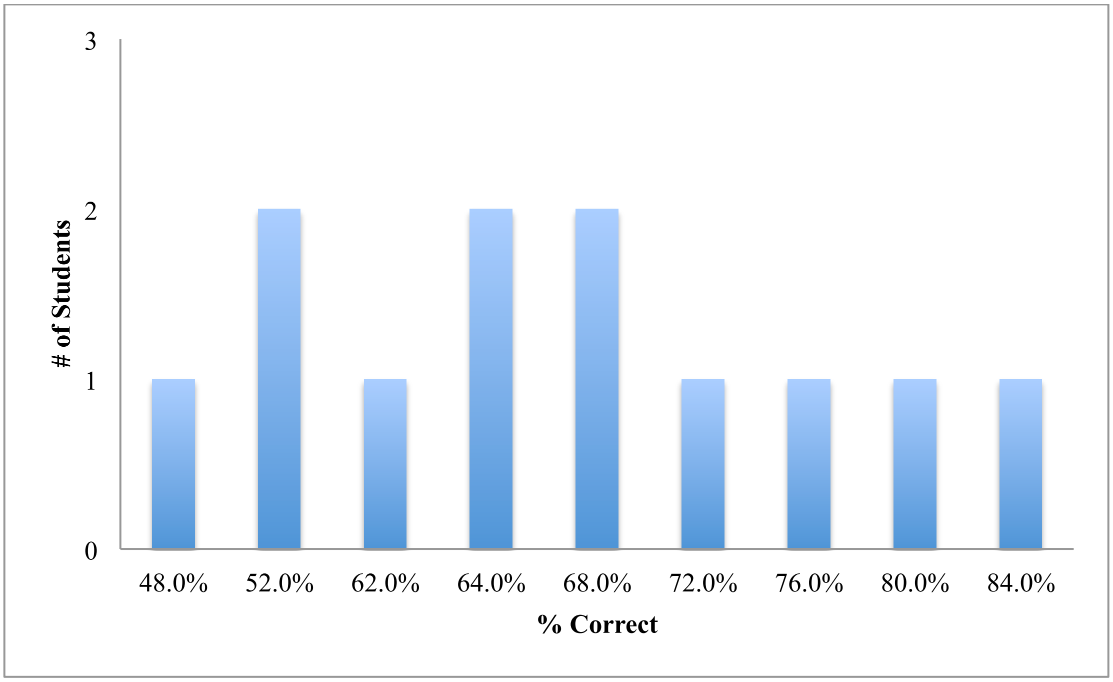


Figure 4. Unit 8 Frequency distribution of students' Pre-Test scores.

The first day of Math Stations was on April 18th. The stations were setup as listed below (Figure 5).

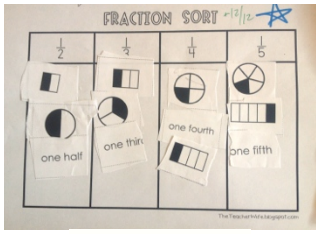
Station	Description
1. Math Game Station Fraction Sort and Math Hands  +	Fraction Sort was a worksheet that was given to help students work through the different visual representations of simple fractions. The students had previously been taught about fractions consisting of quarters, halves and thirds. Math Hands was a two player kinesthetic game that students played by placing a sign in between them and using their fingers as numbers to add. For example, if a student held up two fingers and another student held up five they would have to add the fingers together to get the answer 2+5=7. Whoever got the answer first wins that round. The object of the game is to practice math facts and math fact fluency.
2. Manipulative/Real-Life Station Coin Clothespin Match and Coin Exchange 	Coin Clothespin Match is a game to help students with coin recognition and counting different sets of coins. The coins are different sizes to make sure they are not recognizing them by size but by the president that is on the coin.
3. Teacher Station Lesson 8.8 Sharing Pennies	In this lesson, the students were introduced to pennies and cents notation. We practiced recording numbers of pennies, review comparing numbers, and solving word problems using the "change to less" diagram.
4. Computer Station Everyday Mathematics two person computer games 	The students were able to choose any of the two player first grade math games. Monster Squeeze, Number-Grid Game, Top-It, Memory Match and Number Grid Difference.

Figure 5. Math Stations April 18th

Researcher Journal and Video Observation: Math Station 4/18. The analysis of my researcher journal on April 18 showed that all four stations appeared effective and engaging. All students were involved during Fraction Sort and 10 out of 12 students received a 100% on their work. The other two students confused the wording, e.g., one-fifth, one-fourth. An excerpt from my researcher journal displays the success I was feeling about the incorporation of math stations:

> I felt that Math Stations was very engaging for all my students today. They all participated at the task at hand and I had no behavioral issues during the stations. Clothespin Math seemed to be a big hit. It was supposed to be an independent station, but some of the students decided to play together. I don't know if this really decreased the effectiveness of the center because all the students were still actively engaged. Fraction Sort was a good center. The students were engaged at all times. The noise was high, but it felt productive and excited.

No video observation was conducted for engagement on this day of math stations because of camera malfunction. The computer station was effective. Students played two-player Everyday Math games on our student computers. When I compared the stations subject matter to the test questions that related to fractions and shapes, I noted a 75% decrease in the amount of wrong answers from Pre- to Post-Test. I could not determine if students had a positive outlook on stations because I was unable to view the video for the observation. According to the observations in my researcher journal, the students enjoyed the stations and were actively engaged the whole time.

The issue that arose during math stations was a technology error. I wanted to use the Promethean board as the computer station. My board would not calibrate to allow my students to interact with it. An alternative option was devised utilizing student computers in the classroom. Although I had never taught them how to play two-player games on the computers, they performed well. Logging onto the systems, however, did result in an error in center productivity.

Due to time constraints and a shorter unit than expected, I was only able to do one Math Station session with my students in Unit 8. There were 8 lessons in the Unit and with the time requirement to finish all the units by the end of the year, I was unable to do another station.

Post Test Results. The Post-Test was given on April 22. Twelve students completed the Post-Test and the scores ranged from 68% to 100% (Figure 6).

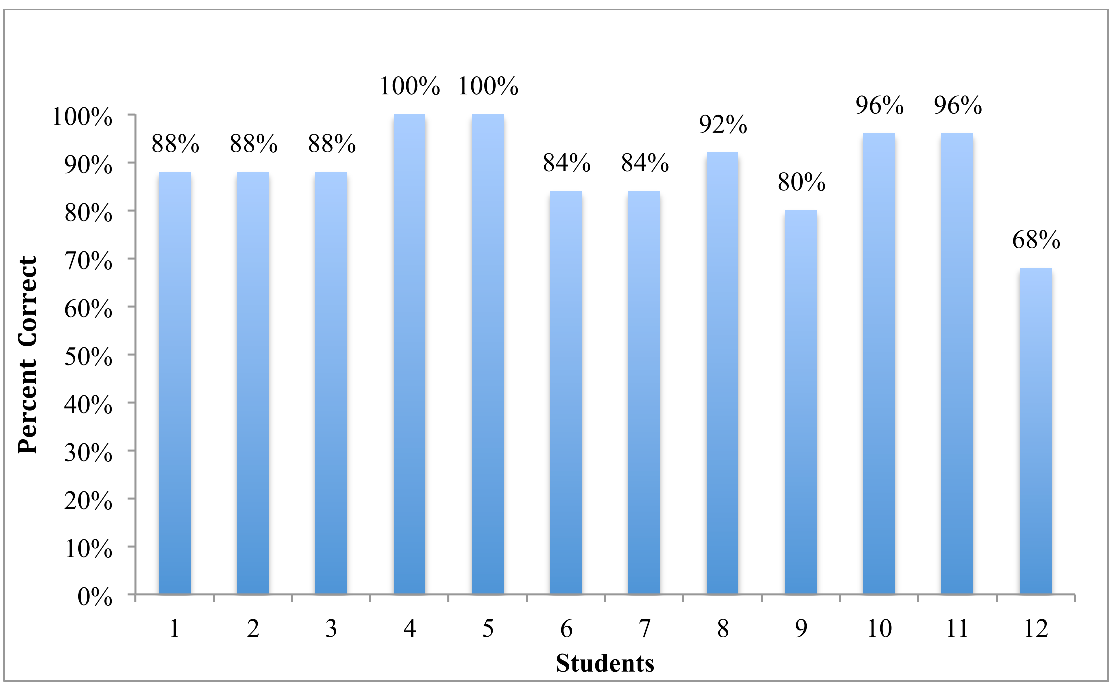


Figure 6. Unit 8 Post-Test Assessment results for each student.

The same number of questions (9) and points (25) as the Pre-Test were administered in the Post-Test Assessment. The class mean for the Unit 8 Post-Test was 89% (standard deviation 8.77%). Eleven students out of 12 scored an 80% or higher on the post assessment. Every student except one showed a positive increase in test scores (Table 2). That individual scored 68% on the Post-Test, which is below a C average. This student was absent on test day and took the test during morning work the next week. He/she also had a decrease on the Post-Test score of 8%. I did not read the questions to the student who was absent unless she/he raised a hand for assistance. This was different than the Pre-Test when I read each question aloud to the students.

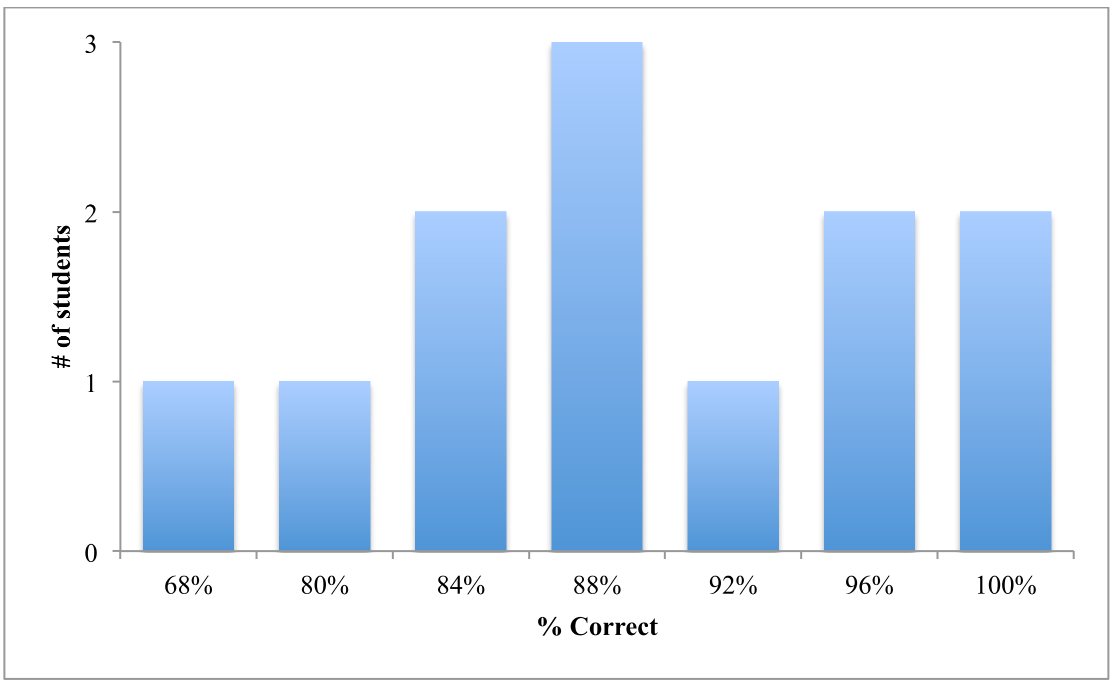


Figure 7. Unit 8 Frequency distribution of students' Post-Test scores.

Figure 7 describes the frequency distribution of the students' Post-Test scores. Only one student fell below proficiency in the Post-Test Assessment; the remaining students scored 80% or higher. Five of the 12 students who were administered the exam scored above 90%, two of which answered all questions correctly. When examining Part-A questions, only one student out of 12 received a score below 80%. Part-A questions are those that the students should have mastered by the end of the unit.

Results from the Post-Test show that 11 students out of twelve achieved proficiency in the tested Everyday Mathematics curriculum.

A paired t-test was conducted between the Pre- and Post-Test assessments to determine if there was any statistical significance. To assess this, I identified a null hypothesis that there was no significant difference between the two tests. Results from the paired test ($p<.001$), indicated that the statistical difference between the results of the two tests was highly significant.

Table 2

Percent Change of Test Scores from Pre- to Post-Test for Unit 8

Student Number Identification	Pre-Test	Post-Test	Change
1	68%	88%	20%
2	62%	88%	26%
3	52%	88%	36%
4	52%	100%	48%
5	84%	100%	16%
6	72%	84%	12%
7	64%	84%	20%
8	48%	92%	44%
9	64%	80%	16%
10	80%	96%	16%
11	68%	96%	28%
12	76%	68%	-8%

Pre-Test Results Unit 9. On April 24th a Pre-Test was given to the class on Unit 9: Place Value and Fractions. The Pre-Test contained the same questions as the Post-Test.

Prior to the Pre-Test Assessment, the students completed one lesson of Unit 9 covering the tens and ones patterns on the number grid. Twelve students participated in the Pre-Test Assessment for Unit 9. The class mean for the Pre-Test was 48% (standard deviation 13%; Figure 8). Five students in the class scored above the class pre-test mean. Only one student performed at proficient level (73%). The majority of the students missed problems on the Pre-Test that were related to story problems, place value, and the number grid puzzle.

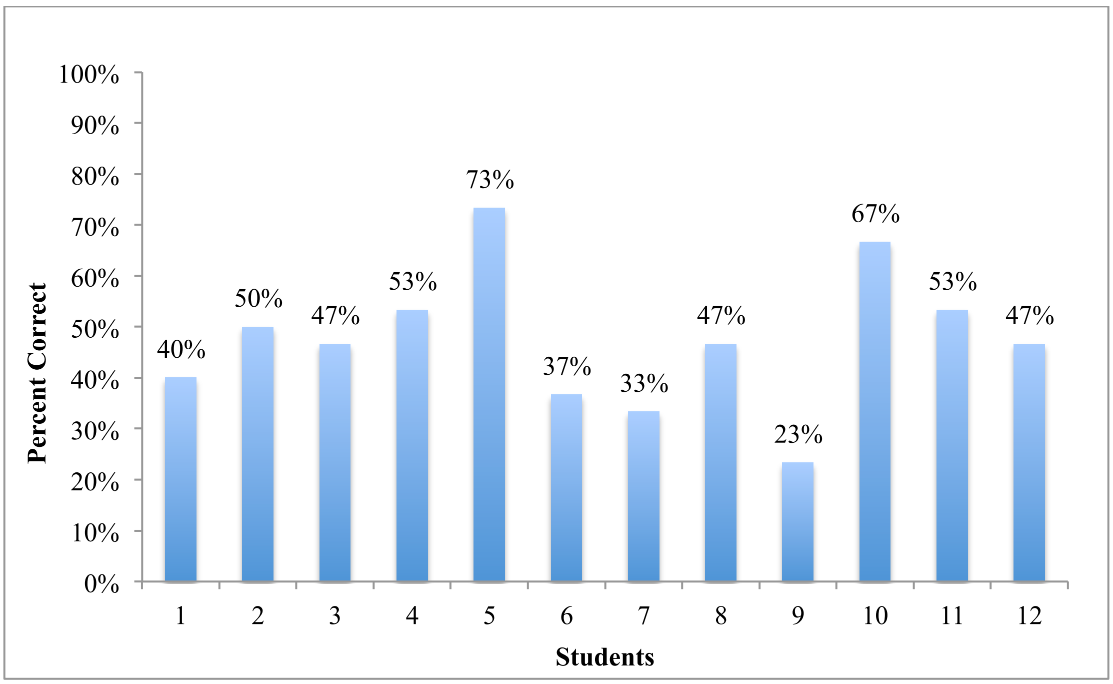


Figure 8. Unit 9 Pre-Test Assessment results for each student.

Based on the frequency distribution (Figure 9), the students' scores showed a large range of results (23%-73%). The students were not clustered in any particular score and were more diversified than Unit 8's Pre-Test scores. The data also reflect the low scores for the entire study. Only one student performed at proficient level.

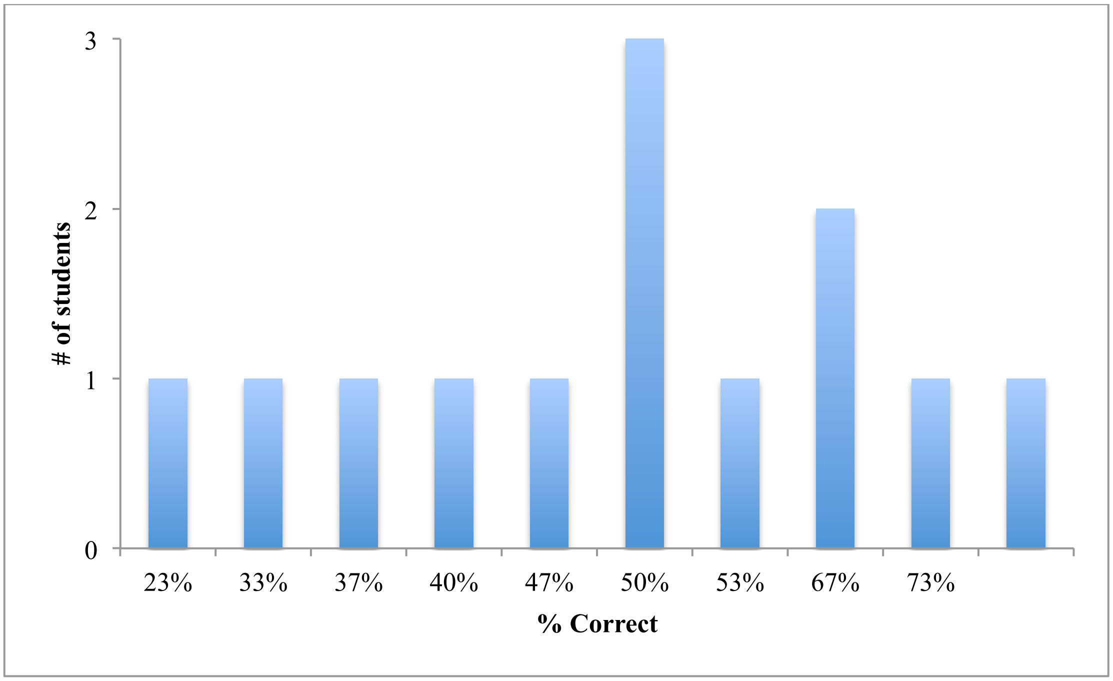


Figure 9. Unit 9 Frequency distribution of students' Pre-Test scores.

Math Stations were organized and executed according to Figure 10 and Figure 11. There were four stations that each student completed. Two sets of math stations were conducted for Unit 9 on different days.

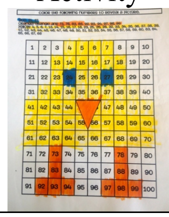
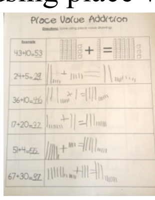
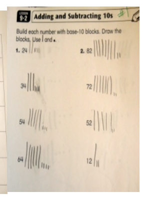
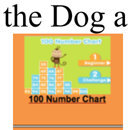
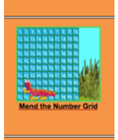
Station	Description
1. Math Game Station Number Grid Color Activity 	The Number Grid Color Activity was a worksheet given to help students practice number recognition and place value concepts. Learning the patterns in the number grid helped with adding numbers and seeing basic relationships in math.
2. Manipulative/Real-Life Station Adding and Subtracting using place value blocks 	The adding and subtracting using place value blocks helped the students start understanding the basics of double-digit addition. It helped the students see the relationship between place value and adding the tens and ones spot.
3. Teacher Station Story Problems and Two-digit Addition	We worked on story problems i.e., Cody and Victoria combined their colored pencils so that they would have more colors to choose from. Cody had 24 pencils and Victoria had 15 pencils. How many pencils do they have to choose from? We also worked on adding two-digit numbers together.
4. Computer Station Mend the Number Grid Monkey 100 Chart Give the Dog a Bone 	http://bgps.sharpschool.net/curriculum/computers/ kid_links/first_grade_kid_links/first_grade_math/

Figure 10. Math Stations April 25th

Researcher Journal & Video Observation Math Station 4/25. The analysis of my researcher journal on April 25 indicated that three out of the four stations appeared effective and engaging. As stated in the journal,

> The hundred chart puzzle, the teacher station and the computer station all seemed highly effective. The kids were engaged with the task at hand and enjoyed doing the work. The computer station was a hit and the number grid puzzle seemed well liked. I also think pulling small groups for instruction is key. It's a great way to review concepts and find the holes that need to be re-taught or explained.

The fourth station appeared to be less effective. From my researcher

journal,

> The manipulative station (Place Value blocks) was the exact opposite. All the students seemed to be just playing with the place value blocks and not concentrating on the task that needed to be completed. It was the hardest concept of all the stations, so that might be why the students were off task. I saw more on task behavior from the 2nd, 3rd, and 4th group than from the 1st group. Building the numbers with place value blocks and adding them to another number seemed to be very difficult concept for my first graders.

The video observation confirmed that three out of the four students observed during the fifteen-minute rotation at the number grid puzzle station were engaged. One student out of the four was moderately engaged. He/she completed the task but during the station talked with another student at the same station. Because of classroom noise level, I was unable to hear what the student was saying. The student may have been asking a question regarding the activity at the station.

Transition time between stations and high voice levels at certain times throughout the stations led to study complications. A few of the students had issues focusing right away. During the video observation a student stated, “I can’t concentrate.” The voice levels calmed down after four minutes into the station. Additionally, we had a fire drill during math stations; however, most of the students commenced work upon our return.

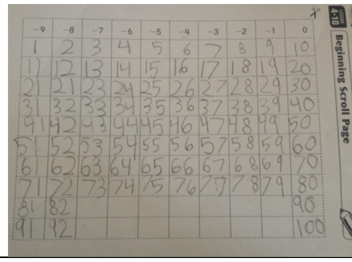
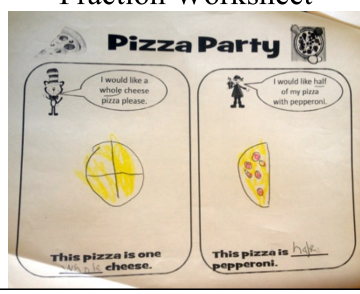
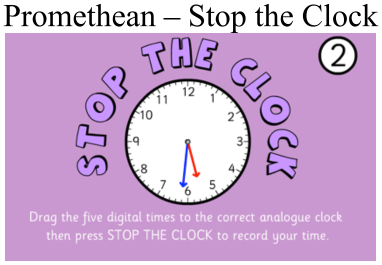
Station	Description
1. Math Game Station Number Grid Scroll 	Number grid scroll was to help students with place value concepts and number patterns. The students enjoy seeing how far they can get.
2. Manipulative/Real-Life Station Fraction Dominos and Pizza Fraction Worksheet 	Pizza Fraction reinforced different types of fractions. Fraction Dominos was a game students played. The objective of the game was to find the matching dominos that represent the same fraction.
3. Teacher Station <,>,= and Place Value Addition	We worked on greater than, less than, and equal to. We also worked on place value addition because I saw in the previous math stations that the students need more practice on place value addition.
4. Computer Station Promethean – Stop the Clock 	Stop the Clock was a game used to help students practice their time skills to the hour, half hour, and quarter of an hour. It had five different clocks that students would need to drag the correct time to. After all the times were in the correct spot they would hit STOP THE CLOCK.

Figure 11. Math Station May 3rd

Researcher Journal and Video Observation: Math Station 5/3. The analysis of my researcher journal on the May 3 showed a different perspective about math stations. As stated in my researcher journal,

> From my observation, the stations were not as effective today as compared to other days. The Manipulative/Real-life Station seemed to be the most effective because students were on task at a quiet level at that station. I feel that the computer station derailed the effectiveness of our stations. Today I used the Promethean for the computer station so the students could work together. My Promethean setup does not allow my projector to be mounted above it. The current setup of my Promethean and projector displays a shadow of anyone that is working on the board. This creates a problem for students because who doesn't like to play with a shadow? During math stations, I was redirecting at least one student in each group for making shadows on the Promethean. The students are all well aware of the rules with the Promethean but some of them can't resist making shadows when the teacher is working with another group.

From the video observation it seemed that the "Stop the Clock" station had a negative impact on stations today. A few of the students announced their frustrations, "Everyone is talking…I can't concentrate" or, "Stop the Clock is too loud!" Throughout the station work, I did a lot of redirecting for voice level and on task behavior. The video observation confirmed that two out of the three students observed during the fifteen-minute rotation at the number grid scroll station were engaged. One student out of the three was moderately engaged. He/she completed the task, but during the station talked with another student at the same station. He/she also looked around the classroom during the station looking at the stop the clock station and the teacher station. It seemed he/she was trying to solve the problems and was distracted by the Promethean during seat work. The fourth student in the video observation engagement checklist was absent.

Post Test Results Unit 9. The Unit 9 Post Test was given on May 9. Twelve students completed the Post-Test and the scores ranged from 33% to 98%. The class mean for the Unit 9 Post-Test was 73% (standard deviation 18.95%; Figure 12). Five students out of 12 received a score of 80% or higher on the assessment. Four students out of 12 received a score below a 70% on the Post-Test. One student (#13) was omitted from all Pre- and Post-Test results. Test scores, frequency data, and statistics reflect this omission.

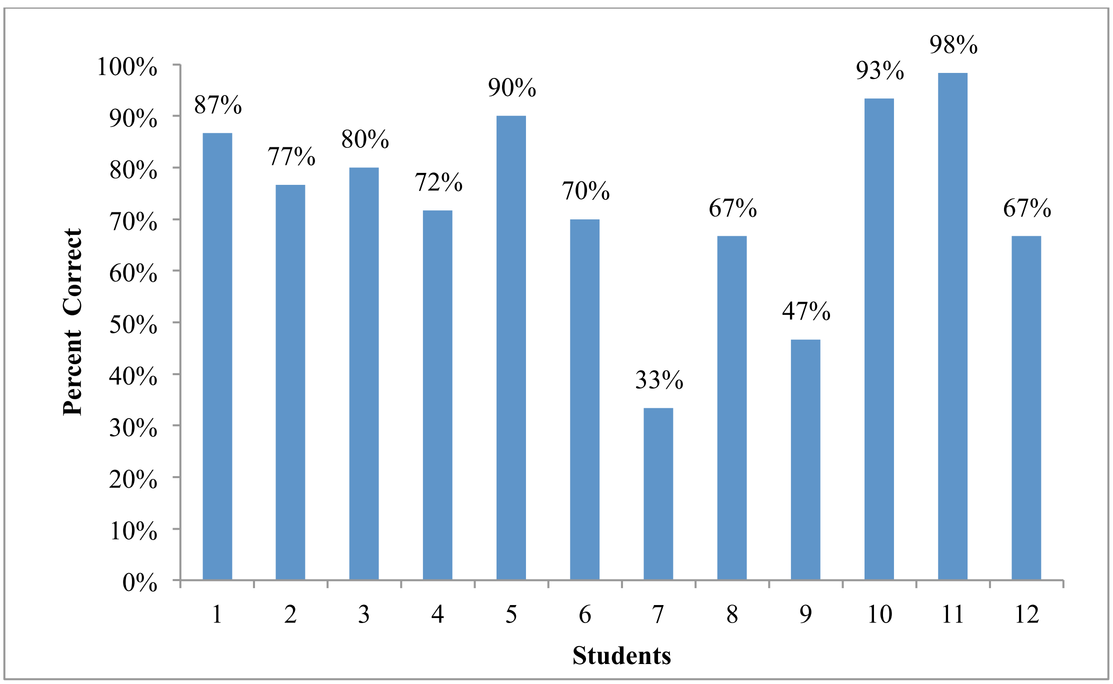


Figure 12. Unit 9 Post-Test Assessment Results for each student.

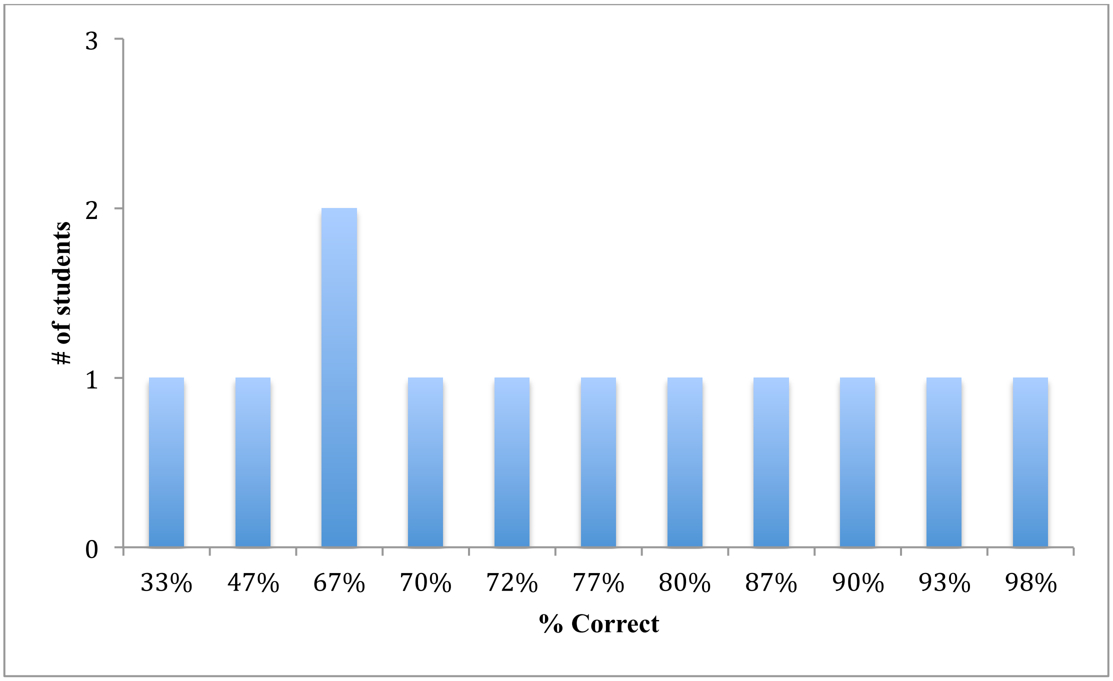


Figure 13. Unit 9 Frequency distribution of students' Post-Test scores.

The frequency distribution of Unit-9 Post-Test scores (Figure 13) reveals a broad distribution of scores but a higher percentage correct than Pre-Test scores. The range between scores was also smaller than the Pre-Test evaluation for Unit-9. Eight students scored at or above proficiency level. Only 4 students did not reach proficiency. All students except one showed a marked change from Pre- to Post-Test for Unit 9. Table 3 illustrates each student's percent change in their test scores.

A paired t-test was conducted between the Pre- and Post-Test assessments for Unit 9 to determine if there is any statistical significance. To assess this, I identified a null hypothesis that there was no significant difference between the Pre- and Post-Tests. Results from the paired test ($p<.001$), indicated that the statistical differences between the results of the two tests were highly significant.

Table 3

Percent Change of Test Scores from Pre- to Post-Test for Unit 9

Student Number Identification	Pre-Test	Post-Test	Change
1	40%	87%	47%
2	50%	77%	27%
3	47%	80%	33%
4	53%	72%	18%
5	73%	90%	17%
6	37%	70%	33%
7	33%	33%	0%
8	47%	67%	20%
9	23%	47%	23%
10	67%	93%	27%
11	53%	98%	45%
12	47%	67%	20%

Conclusion

The purpose of this study was to see if Math Stations increased student achievement and engagement in a primary classroom. Results were analyzed from all five data collection methods outlined in Chapter 3. Mean percentage scores in both Pre-Tests were below proficiency, but both Post-Test mean percentage scores were either at or exceeded proficiency. Mean percentages from Unit 8 and Unit 9 Post-Test scores (89% and 73%, respectively) were highly significant ($p<.001$) from their respective Pre-Test scores (66% for Unit 8; 48% for Unit 9). Researcher journal entries and video observations reflected that the majority of students liked math stations and were engaged throughout the project. A more detailed description of the analysis of the results will be discussed in Chapter 5.

Chapter 5: Conclusion and Implications

Purpose

This study sought to determine if the implementation of Math Stations into the mathematics curriculum increased student engagement and learning. In this chapter, I discuss further details of the results presented in Chapter Four, present my analysis of the findings, and review the key questions in the study. Additionally, I describe my reflections from this study as a teacher researcher, explain the limitations of the study, and provide future research directions.

Discussion

Questionnaire. The data gathered from the student questionnaire were helpful in showing me what ways students in a first-grade class like to learn math. It showed that all thirteen students agreed that learning math by the use of computer games was enjoyable.

The results also displayed what students did not like about math. I was surprised to discover the number of students who did not like teaching their classmates about math or learning with the use of visual aids, hand signals and movement. It would have been interesting to know if this was correlated to the students' learning modalities (e.g. visual, auditory, kinesthetic). The one student who disagreed with the question regarding math stations and if they liked it seemed to have trouble working with others. In future studies, a post-questionnaire on math attitudes or exit ticket questions would be beneficial in determining if attitudes improve throughout the study or for various stations.

Pre-Test Unit 8 and 9. The data gathered from the Unit 8 Pre-Test showed that four students out of twelve had a basic knowledge of the content on the exam before they were taught the concepts. This was noticeably different than Unit 9 where the mean score was much lower than Unit 8. There may have been multiple factors that caused this discrepancy. The prior knowledge from Unit 8 Lessons One through Three—taught before the Pre-Test—may have contributed to students' Pre-Test scores being higher than expected. Additionally, the spiraling of the math content may have also contributed to the higher than expected scores in the Pre-Test for Unit 8. Giving a Pre-Test to first graders before the material was taught proved to be very difficult. Upon reviewing the video tape of one pre-assessment, I could see students getting frustrated with not knowing the answers, frequent bathroom breaks, and multiple raised hands throughout the test. In future studies, I would perform a pre-assessment examination based on unit concepts. For example, there would be one question for each concept. This would provide me guidance in what concepts need to be focused on and if the students have a general understanding of the content before the stations are formed.

The data retrieved from the Unit 9 Pre-Test showed that one student out of twelve who took the pre-assessment scored above a C average, demonstrating that he/she had some knowledge of the content. Comparing the two Pre-Test scores, Unit 8 and Unit 9 Pre-Test scores reflected a 18% difference in the test means—Unit 8 being the higher mean (66%). This suggests that the results were likely due to students' not receiving as many lessons in Unit 9 before taking the Pre-Test as they did in Unit 8. Students were more prepared for Unit 8 than they were for Unit 9.

Post-Test Unit 8 and 9. The results for both Unit 8 and Unit 9 Post-Test were highly significant when compared to their Pre-Tests, respectively. This suggests that Math Stations were an effective method of instruction for those two particular Math Units. Regardless of the level of instruction prior to the Pre-Test, both Post-Test scores reflected a significant positive increase in student scores. Although test results do not necessarily reflect total student comprehension, the overall findings from the study suggest that the Math Stations contributed to the students' learning of the content in a positive, constructive manner.

When examining the Pre- and Post-Test scores independently (i.e., only Unit 8 scores and only Unit 9 scores), I found differences that should be noted. Eleven out of twelve students showed an increase in their scores for Unit 8, the majority of whom achieved proficiency in the subject matter. A negative change for one student from Pre- to Post-Test in Unit 8 was most likely due to the method in which I delivered the test. Each of the other students was given the test recited by the teacher researcher. This student had missed the test-day, and was administered the exam a subsequent day without having the questions read aloud by the teacher researcher. On the other hand, results from Unit 9, showed one student who did not progress from Pre- to Post-Test. It appeared that this one particular student did not have strong number recognition, which was reflected in the poor results.

The stations that were organized for Unit 9 did not center on the main concepts the students needed to master on the Unit 9 exam. Looking back, I would have spent more time on clocks, story problems, and money. This proved to be a difficult unit for most of the students. Some of the content that was taught will not be mastered until second grade, so it is understandable why overall test scores for Unit 9 were lower in both Pre- (18% difference) and Post-test (16% difference) when compared to Unit 8.

Researcher Journal and Video Observation. Upon analyzing video observation data coupled with looking over my notes, I noted that the majority of students liked math stations and were engaged throughout the project. There were a few factors that would need to be addressed in a future study to help support a successful implementation of Math Stations. These include but are not limited to: a) a wall mounted Promethean board; b) a way to handle students' accountability piece (i.e., how to hand in papers, what to do if students don't finish the task within the given time allotted, etc.); c) time to model, explain and practice appropriate station behavior; d) visual must do/may do activities for early finishers; e) a visual rotation schedule and; f) a timer for the students to refer to during stations. Other unforeseen problems that occurred that would have benefited from an improved management piece include the end of the school year behavior, fire drills, training the students, and students who have short attention spans—all of which the teacher researcher experienced during this study and which were not adjusted for prior to the study.

Implications

The objective of my research was to find whether implementing Math Stations into the mathematics curriculum increased student engagement and learning. The sub-questions listed below helped guide me in finding the answers to the main research question.

The sub-questions are:

- Can I implement Math Stations to effectively increase student achievement?
- Does the use of Math Stations successfully increase student engagement?
- Do students have a positive outlook on using Math Stations in the classroom?

Below I have addressed my three sub-questions to determine if Math Stations was an effective intervention in Math to increase student engagement and learning.

Can I implement Math Stations to effectively increase student achievement?

As the teacher researcher, I successfully implemented Math Stations to increase student achievement. Both Post-Test data sets suggest that math stations had a positive effect on student test scores despite additional factors that may have played a role in the achievement on test scores. It appeared that students scored better on the questions that were related to the stations that were implemented. I did not think it necessary to correlate the two, as the relationship was intuitive. For example, in Unit 8 Math Stations, we focused on fractions, coins, and money story problems. The results showed upward progress in math scores with the questions related to the Math Stations conducted. Regarding the Pre-Test question that asked about money, nine out of twelve students got it wrong. On the same Post-Test question, nine out of twelve students obtained the correct answer. Every student missed the Pre-Test question concerning the concept of equal parts and fractions. On the Post Test, however, nine out of twelve students completed the question correctly. Unit 9 seemed to display the same results on the Pre-Test when nine out of twelve students obtained the incorrect answer referring to greater than, less than or equal to. On the Post Test, nine out of twelve students attained the correct answer. Another example of this is the story problem question regarding money. Eight students out of twelve answered it incorrectly on the Pre-Test and only three out of twelve student missed the question on the Post exam.

In a future study, directly correlating the teacher's small group station with the post exam might yield an increase in correct answers. Having small group interventions could be the key to increasing awareness on specific math concepts. Having more time, more students, and a comparison group are additional considerations that might further impact a study such as the one conducted.

There are many factors that could have contributed to this type of upward trend on both Post-Tests. These include the lessons I taught, the practice workbook pages the students completed, math stations, homework, previous knowledge, etc. To be certain that my use of Math Stations was the deciding factor, I would have needed a control group to measure the difference of Math Stations versus no Math Stations. In a future study, using two classes, one as a control group who is only taught math with whole group instruction and the other that uses stations would help to determine if math stations increased student achievement. Coupled with a larger sample size, I suspect these two additions to the study would have increased statistical power and measures to better analyze the results.

Does the use of Math Stations successfully increase student engagement?

This sub question was not intended to be broad, but with further investigation and a longer study I would be able to answer this question with more confidence. From my observations as the teacher and with the use of the videos, I recorded an increase in student engagement in my researcher journal and observational checklist. This, however, should be noted with caution as my study had limited participants, and the study lacked a control group with which to compare. A control group was out of the scope of this particular action research study but could be implemented in future studies.

Do students have a positive outlook on using Math Stations in the classroom?

Through researcher journal notes, video observation, and the student questionnaire, I determined that students overall seemed to have a positive outlook on math stations. They were engaged with the stations and enjoyed doing them. In further studies, I would add a student exit ticket to each station to allow for more student voice and more weight for each station. It would be interesting to discover what station the students enjoyed the most, the least, and what could be improved upon. Also beneficial would be data collected on whether the students retained information and gained the knowledge expected of the station. It would also help gather information pertaining to whether they liked the activity, if it was easy, just right, or hard. I would also include one question related to the station to determine their understanding of the concept taught or reinforced during that station.

Limitations

Several limitations arose during this action research study. The project was conducted with a first grade class. The class size was 19 students, 13 of whom were granted permission to participate. The small sample size plays a role in limiting the generalizability of the results. The length of study was also a factor. The research proposal was submitted to the Institutional Review Board in July and was not granted approval until eight months later. Because the research project was conducted at the end of the school year and required two math units, the length of the study had to be modified from a six-week study to a three-week study. The time constraint with the end of the year assessments played a role in not allowing further investigation.

Triangulation

I believe the study was reliable and valid because it was designed around multiple qualitative and quantitative data collection methods. A few ways the criteria were addressed are the use of observation, video, student work, multiple methods of data collection and triangulation. Refer to Figure 2 (page 30) for a visual representation of how triangulation was met during the research project. With the use of multiple data sources, I answered one of my three sub-questions (Can I implement Math Stations to effectively increase student achievement?) with significance. In future studies, the use of more exact data sources (i.e., exit tickets), a longer study, and a control group would increase the likelihood of my being able to answer all three sub-questions with clarity.

Future Research

In future studies, I would propose a longer data collection period with multiple classrooms and teacher researchers looking at one common question: “What teaching techniques in Math help increase student achievement?” Determining which technique works best in teaching primary students the basics of arithmetic could benefit students later on in Math. Secondly, another question stemmed from this action research study: “Does small group instruction increase the in-depth knowledge of students?” Answering this second question would more accurately determine whether students retained the concepts over a longer period of time.

Conclusion

Since the conclusion of this action research project, I have taught another year of first grade and implemented a new math curriculum the District adopted. Having taught two different math curricula in two years, I still see the need for small group math instruction. I feel differentiation in all subjects is necessary to meet the needs of a diverse student body, especially those in my district with its comprehensive diversity.

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Appendix A

Student Questionnaire on Attitudes

Name: ___________________________ Date: ____________________

Directions: This is a math survey developed to help your teacher understand what you like and dislike about math and math stations. If it is something you like, color in the ☺ or Y; or if it is something you don't like, color in the ☹ or N.

1. I like math.	☺ ☹
2. I dislike math.	☺ ☹
3. Learning new things in math is fun.	☺ ☹
4. Math is important in my life.	☺ ☹
5. I like learning math by using computer games.	☺ ☹
6. I like doing math worksheets.	☺ ☹
7. I like playing math games.	☺ ☹
8. I like learning math with movement.	☺ ☹
9. I like using visual aids to learn math.	☺ ☹
10. I like to figure out multiple ways to solve a math problem.	☺ ☹
11. Have you ever used Math Stations or Centers in school?	Y N
12. If yes, did you like Math Stations/Centers?	Y N
13. Math Stations help me understand math?	Y N
14. Do you like teaching your classmates about math?	Y N
15. Do you like learning the basics of math through exploration?	Y N

Appendix B

Observation Checklist

Learning Center: ____

Date:	Student Name	(3) Engaged	(2) Somewhat Engaged	(1) Not Engaged	Notes

Appendix C

Parental Consent Letter

Date

Dear Parent(s) or Guardians:

I am currently a master's student at Alaska Pacific University obtaining a Master's in Education. I will be conducting an Action Research Study on the Implementation of Math Stations this fall. Action research involves looking closely at a teaching technique or product and examining its effectiveness. This year I will be examining the use of Math Stations within the Math curriculum to see if the use of Math Stations can increase student achievement and overall engagement. The students will not have to do any extra work because of my project. All instruction and data collection will be conducted during the scheduled daily math block. My final report will not include student names or photographs. In the written report, or in charts and bar graphs, the students will be referred to as a letter (student A).

Please take a few minutes to read and complete the Parental Consent Form and return it no later than ______________________________________.

I look forward to working with your child this year.

Sincerely,

Ms. Melodie Sharon

Appendix D

Parental Consent Form

I, ____ (print name of parent or guardian), agree to permit ____(print name of student) to participate in the action research study *The Effects of Implementing Math Stations into a First Grade Classroom* being carried out by Ms. Melodie Sharon. I have been informed by the researcher of the general nature of the study as well as the anonymity for all involved.

I understand the following:

1. My student may withdraw from this study at any time.
2. I may withdraw permission for my student to participate in the study at any time.
3. Even if my student completes the study, I have the right to withhold permission from the researcher to use any data based on my student's participation.
4. Upon my written request, the researcher will provide me with a written summary of the study's findings.

I have received, and agree to the parental consent form for the Action Research Study, *The Effects of Implementing Math Stations into a First Grade Classroom*.

____

Signature of Parent or Guardian Date

____

Relationship to Student