Bilingual Family Math Club

School + Families = Success

by

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ABSTRACT

Federal, state, and local entities prioritized addressing these academic deficiencies over the past several decades. An area of concern for teachers and families is multiplication. The two main purposes of this study are to (1) to determine how multiplication achievement and strategy use change from beginning to end of Bilingual Family Math Club, and (2) determine which of the eight components of Bilingual Family Math Club (BFMC) contribute to student learning outcomes. The components of BFMC are (1) Concrete Representational Abstract (CRA) modeling, (2) explicit vocabulary instruction, (3) word problems, (4) homework, (5) math games, (6) adult/child pairs as family engagement, (7) bilingual instruction, and (8) workshop series. Quantitative data includes pre-and post-intervention student math assessments. Qualitative data includes analysis of the scratch work artifacts students produced solving those assessments, as well as post-intervention from adults and students enrolled in the club. Findings from this study support previous research. Families said six of the components of the club helped them the most: adult-child pairs, series workshops, games during class, the CRA method, homework as games, and having a bilingual club. Two of the eight BFMC components families felt did not support them in learning multiplication were word problems and explicit vocabulary instruction. Quantitative results from a paired sample t-test showed a statistically significant change and large effect sizes in post-assessment scores in all four areas of the assessment: fluency, word problems, single-digit facts, and multi-digit multiplication. This study provided critical information for school leaders and district personnel attempting to implement more effective after school support programs for families in mathematics.

DEDICATION

To my inspiring husband, Edward Schroeder. Watching you earn your doctorate degree ignited a passion for me to pursue higher education. I am always amazed at how you make the world a little better every single day. You are the love of my life and I am forever grateful for your support and encouragement you gave me over the last three years. Thank you for your endless patience, understanding, and "de-fluffing" me when I felt overwhelmed. You are my favorite person in the world.

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CHAPTER 1

INTRODUCTION

For decades educators and policymakers have voiced the same concerns about students: the majority of our students are exiting public education systems non-proficient in mathematics.

During Ronald Reagan's presidency, a landmark report on America's education system resulted in the infamous title, *A Nation At Risk* (National Commission on Excellence in Education [NCEE], 1983). The report illustrated how poorly the United States education systems were preparing students for their futures in the workforce. In the opening of the report, the authors admitted, "We have allowed this to happen to ourselves," (NCEE, 1983, p. 469). This reflection became a catalyst for education improvement across America. The report called for an upgrade and overhaul of education in the United States (NCEE, 1983).

The following decades were driven by more educational initiatives designed to support American students in academics. In April of 1988, The United States Congress passed an amendment to the 1965 Elementary and Secondary Education Act (ESEA). This amendment called for additional funding and support for students in "at-risk" populations such as students with special needs, families with low incomes, and Native American students. A year later, The Excellence in Education Act was enacted which rewarded schools for increasing achievement testing and attendance goals. Then, in 1994, former president Bill Clinton enacted the Improving America's Schools Act (IASA) which reauthorized the ESEA and called for an increase in funding for bilingual students, high school drop-out prevention, and educational technology for schools. The most drastic reform measure happened in 2001 when former president George W. Bush called for mandatory high stakes testing and adequate yearly progress with No Child Left Behind (NCLB). The next decade of school reform centered around NCLB. During his presidency, Barack Obama enacted Race To The Top which awarded grants to states who enacted several policies such as more rigorous standards and performance evaluations for educators. In 2015, Every Student Succeeds Act called for detailed and specific plans to support students in subgroups who were falling behind their peers. These numerous acts in legislation centered around the idea that schools needed to support their most "at-risk" student populations, (Sass, 2020).

Despite multiple federal initiatives and decades of laws and calls to action, Arizona academic data shows that every student is not succeeding. Arizona has fallen towards the bottom of education rankings in multiple areas. Arizona's students have continued to remain at risk of not being prepared for their future colleges or careers according to national assessments in reading, math, and high school graduation rankings (National Association of Education Progress, U.S. News and World Report, 2018).

Mathematics, in particular, has caused deep concern for Arizona's school children and their families. To increase rigor for students and accountability for schools, Arizona's Board of Education adopted new standards in 2010 called the Arizona College and Career Readiness Standards (ACCRS). These standards have been a complex topic discussed among schools and families. In the last decade, panicked parents sought support over social media. They desperately asked their friends, co-workers, and anybody who would listen, "How do you do my child's math homework?" ("Common Core Math

Problems Go Viral," 2015). Parents with a variety of education levels were stumped by elementary mathematics problems from the new ACCRS.

Despite a decade of instruction and curriculum tied to the ACCRS, Arizona has ranked poorly in comparison to other states in national education rankings and ties for the last place in high school graduation rates at 72% (U.S. World News & World Report, 2020).

The National Assessment of Educational Progress (NAEP) is referred to as The Nation's Report Card. Since 2000, Arizona scores in fourth grade on the NAEP assessment have been below the national averages. The 2019 data revealed that Arizona fourth-grade averages continued to sit below the national average again (National Association of Education Progress, 2018, 2019; National Center for Educational Statistics, 2019). Within the NAEP data, only 37% of Arizona students scored at or above proficiency levels, with 63% of students not meeting the proficiency scores in mathematics.

It is important to note that the NAEP assessment does not test every student in the country, and is used to get a broad understanding of student achievement. Arizona has its own assessment used to assess all students in third-grade through high school in mathematics that gives data on each student in a public school within the state. The assessment used for the past five years is called AzMERIT. For 2021 the assessment has been renamed AZM2. AzMERIT mathematics data revealed similar trends to the NAEP: the majority of Arizona students (58%) are not proficient in mathematics (Arizona Department of Education, 2019). Out of all students, 91% of students who identify as English Language Learners (ELLs) and 68% of Hispanic students were not proficient in the AzMERIT assessment for mathematics in 2019 (Arizona Department of Education, 2019). Note that the 2020 assessment did not take place due as scheduled. See Table A for a more detailed breakdown of the scores.

Table 1

Student Assessment Results for 2019 Math AzMERIT

Student Group	Students Passing	Score 1 Falls Far Below	Score 2 Approaching	Score 3 Proficient	Score 4 Above Proficient
All Arizona Students	42%	36%	22%	27%	15%
Arizona ELL Students	9%	73%	18%	8%	<2%
Arizona Hispanic Students	32%	45%	24%	23%	9%

In 2009, Arizona implemented a strict 4-hour block of structured English Immersion (SEI). "Arizona law requires English language learners to be grouped together in a structured English immersion setting," where they do reading, writing, oral conversation, and vocabulary, along with grammar for four hours a day (15-751. n.d). Most school days have less than seven hours of instructional time. This means most of the ELL students' school day is spent working on language skills. Six years prior to the AzMERIT assessment, ELL students were not spending as much time in mathematics instruction as they were with language. From 2009-2019 the SEI requirements remained at four hours. One positive change is that Arizona amended their SEI time requirements in 2019 down to two instructional hours reducing this barrier for students (Arizona

Department of Education 2020). The AzMERIT assessment has not been given since this change (Arizona Department of Education 2020).

Mathematics Foundations

Mathematics is a broad subject with five major domains in elementary school: numbers and operations, algebraic thinking, geometry, measurement and data, and fractions. A growing concern in mathematics classrooms has been that students have not had a strong foundation in the four operations: addition, subtraction, multiplication, and division (Rave & Golightly, 2011). The National Center for Education Statistics (2010) reported U.S. students were performing at a "mediocre" level when compared with their international counterparts in mathematics. Furthermore, fifth-grade students who have not mastered their multiplication facts with fluency and automaticity likely would not master these concepts in future years due to the different structure of upper-grade mathematics as compared to elementary mathematics (Lemonidis, 2016). Students who only memorize their facts are left without self-selected strategic support when they encounter a problem they had not memorized (Agrawal & Morin, 2016). In Arizona fifth-grade mathematics standards, 74% (20/27) of standards require mastery of basic multiplication facts in order to solve the higher-level mathematics problems (Arizona Department of Education, 2020).

Since 1965 research has demonstrated the need for conceptual understanding in mathematics, especially multiplication (Agrawal & Morin, 2016; Bruner & Kenny, 1965; Muir, 2012). According to Bruner and Kenny (1965) the way for people to build a strong foundational understanding of a mathematics topic is to gradually progress through the knowledge phases of concrete, representational, and finally abstract mathematics. We call this the CRA model. First, people physically build models of mathematics using concrete objects. This allows them to manipulate physical objects to model their math problems. Next, they transition into representations of those objects after they fully understand what the modeling means. Here they can draw models of the math problems. Finally, once fluency in the two previous phases occurs, people can then begin to master abstract mathematics with a full understanding of the concept. This looks more like traditional math with numbers and operation signs without the supports of a physical object or drawing. The CRA model is new to most families which can cause frustration when supporting their children at home (Muir, 2012).

Parental Engagement in Schools

Building partnerships with families has been a standing tradition in schools. The term “parental involvement” has held multiple definitions over time. Initially, in one-way systems, schools gave parents information. Over time, a dynamic and dual interaction between families and schools has become the norm (Ferrara, 2017). Recently, some researchers conducting work on parent involvement have made a shift from using the term parent involvement to using family engagement in response to the National Standards for Family-School Partnerships created in 2012 (Ferrara, 2017).

Bringing families into school partnerships has positive academic outcomes for students. Successful students are typically supported by their families (Epstein, 1995). For years, states have been advocating for more parental involvement (Ferrara, 2017). Numerous studies have shown when parents take an active role in their children’s education, academic achievement increases. Under The Every Student Succeeds Act (ESSA) school districts receiving Title I funding must have a parent involvement plan

(Every Student Succeeds Act, 2015). Paat (2013) suggested family partnerships are essential to schooling when he stated, “Family is a social institution that provides a foundation in which children learn how to navigate and fit into society,” p. 956. The interaction between two of the strongest systems, school, and home, has the potential to create the strongest possible change for students. When it comes to supporting children in math, family engagement matters.

Local Context

This study was situated within a K-8 elementary district located in the heart of Tempe, Arizona. Our district is 35 square miles including the Town of Guadalupe, as well as some areas of Phoenix just west of the I-10 Freeway. With 22 schools, our population includes 12,156 preschool, elementary, and middle school students. 51% of students are Hispanic, and 33% are English Language Learners (ELLs).

I am a fifth-grade teacher at a Title I elementary school in Tempe, Arizona. This is my eighth-year teaching at this school. For the past decade, our school has been underperforming in state and district assessments in mathematics. The latest data demonstrated only 28% of our fifth-grade students attained the level of being proficient or higher in grade-level mathematics as measured by the 2018-2019 AzMERIT Assessment. Our associated mathematics assessment scores based on the Northwest Evaluation Association MAP showed similar results, with only 35% of students achieving the targeted score ranges for fifth-grade (J. Wilson, personal communication, August 2020).

The AzMERIT data for fifth-grade shows a need for more students to demonstrate proficiency. The assessment tests the AzCCRS for fifth-grade students.

These standards are composed of 27 standards and 20 (74%) of them require basic multiplication fluency for students to accomplish the objective (Arizona Department of Education 2019). Multiplication skills are essential for students to have when solving upper elementary mathematics problems for that reason. In order to support students in upper elementary math, multiplication strategies can be taught to teach the foundational skills missing for students to become successful. Since multiplication is integrated into the majority of the mathematics standards it is logical to support students in becoming fluent in basic multiplication so they can use that foundational skill when solving more complex problems at grade level.

Previous Cycles of Research

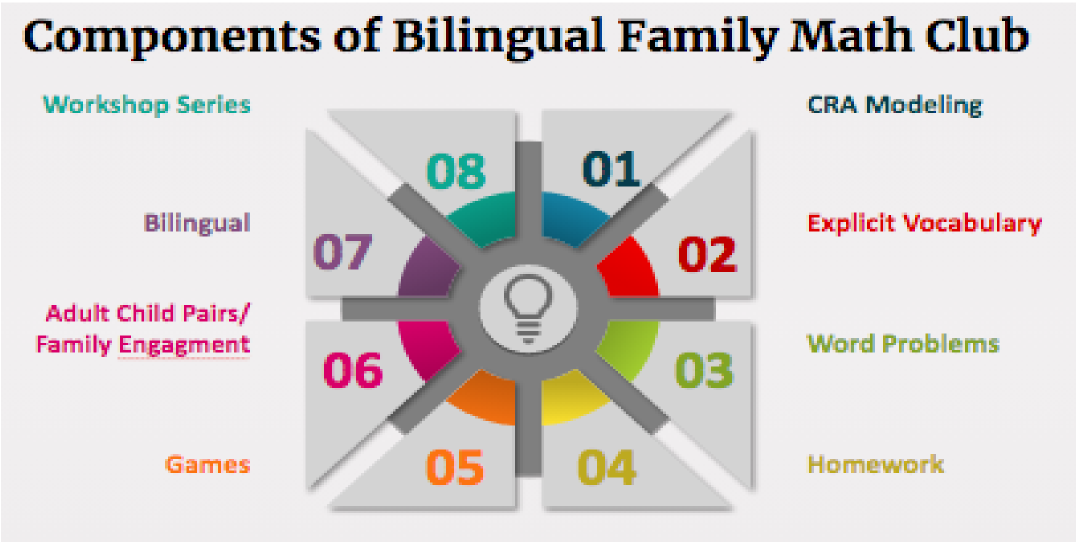
In Fall of 2018 I began my research to understand how to support our students in mathematics. Our school letter grade was released as a D, and our district put our school in corrective action due to our history of inadequate assessment scores. Families were concerned and wanted to know ways they could support their children. During my Cycle 0 research I interviewed families in fifth-grade and asked them what support they were looking for. Through these interviews I found that families wanted to be a part of the solution for catching up their children. However, many of them did not feel confident in supporting their child in academics. Many expressed their worry they would not know the content, couldn’t understand English teaching resources, wouldn't be able to attend morning trainings, and wouldn’t have childcare for their younger children. Through these conversations, Bilingual Family Math Club (BFMC) emerged.

The design of the club was based on educational research supporting the following eight components: (1) Concrete Representational Abstract (CRA) modeling,

(2) explicit vocabulary instruction, (3) word problems, (4) homework, (5) math games, (6) family engagement, (7) bilingual instruction, and (8) learning in a workshop series. See Figure 1 for a visual representation.

Figure 1

Visual Display Showing Components of Bilingual Family Math Club



Component 1: CRA Modeling.

The foundation of this club lies within the Concrete, Representational and Abstract (CRA) continuum of mathematics. Students were brought back to the basics of multiplication and given opportunities to build a strong conceptual understanding. The goal was to give students ample time in each phase so they could transition into the next phase when they were ready.

Component 2: Explicit Vocabulary.

Academic math vocabulary is essential for students to learn math. Explicit instruction would give students and families firm definitions of words and practice with using and solving problems with the vocabulary. Families used the vocabulary words in context during discussions and when solving word problems.

Component 3: Word Problems.

Word problems allowed participants to conceptualize abstract math in a real-world scenario. They could pair word problems with concrete objects to “see” the math they were solving. Solving word problems allowed families to experience academic vocabulary in an authentic setting.

Component 4: Homework.

Homework allowed families to practice the mathematics strategies beyond class time. Fluency within multiplication requires repetition, and families could practice at home. The homework was versions of the games played during the club to familiarize families before sending the homework home.

Component 5: Mathematics Games.

Families needed an engaging way to learn and practice mathematics. There are only 45 multiplication math facts, so embedding practice in a gamified way gave families unique opportunities to cover the same material. Repetition was necessary for fact fluency, but games offered a more entertaining way for families to support each other during and outside of the club.

Component 6: Adult Child Pairs/ Family Engagement

Instead of just tutoring students, BFMC invited families to co-learn the material with their children. The intent was for the adult family member to act as a support at home when children practiced the math games and homework. Parents got support during the club from the instructors.

Component 7: Bilingual Instruction

The majority of participants in this club speak Spanish as their primary language (L1). The interpreter/co-teacher was necessary for families to truly learn all materials. This also allowed students to learn in their L1 language.

Factor 8: Series Workshops.

The nature of learning multiplication happens over time. Students needed adequate time to fully master each step of the CRA model. Offering workshops over five weeks gave families time to practice the concrete and representative stages before moving onto abstract math.

Using that design, I began my next iteration of research. Cycle 1 lasted eight weeks from February 2019-March 2019. The club was offered at two different times after school, and we had 48 members between the two cohorts. The focus on the club was multiplication due to frequency of multiplication as a foundational skill for fifth-grade students. The overarching strategy for teaching multiplication was the CRA method. This in-person club allowed families to work together when supporting their children, and the series allowed us to check in weekly and share our progress. At the close of cycle 1 I gained feedback from participants on how to improve the club and asked them if there was anything else I could be doing to support their families. One major concern was the length of the club. Eight weeks was a lot of time for a busy family to commit to in their busy schedules. Spring was also a busy sports season for our school, so families felt like they were being pulled somewhere every night.

In Cycle 2, I made adjustments to the schedule. I changed the club to Fall 2019 when we did not have extracurricular commitments going on. Additionally, I shortened the meeting times and reduced the club to six weeks in an attempt to increase attendance and curb attrition. One of the biggest struggles was keeping a consistent interpreter/bilingual teacher. The person who signed up for the role had a death in the family, and substitute bilingual teachers filled in each week. The substitute bilingual teachers definitely knew Spanish, but struggled with understanding the mathematics, and it became harder for families to get the support they needed when the interpreter had to get clarification repeatedly. I knew that in my next cycle I would need a consistent interpreter and somebody who understood the content we were learning. For cycle 3, Fall 2020, I had a former club member, a parent, rejoin the club as the bilingual teacher, and it was a perfect fit. She had been through the process, understood the math, and already had a connection with many of the families. Finding the right person for the role was the biggest request from families in Cycle 2.

Purpose of the Study and Research Questions

The purpose of this study was to determine which of the eight components of Bilingual Family Math Club (BFMC) contribute to student learning outcomes. The components of BFMC are (1) Concrete Representational Abstract (CRA) modeling, (2) explicit vocabulary instruction (3) word problems, (4) homework, (5) math games, (6) adult/child pairs as family engagement, (7) bilingual instruction, and (8) workshop series. This study addressed the following research questions:

RQ 1: How does student multiplication achievement change from the beginning to the end of BFMC?

RQ 2: How does student multiplication strategy use change over the course of BFMC?

RQ 3: Which of the 8 components of BFMC did parents and students feel supported them most when learning multiplication together?

CHAPTER 2

THEORETICAL PERSPECTIVES AND RESEARCH GUIDING THE PROJECT

Chapter one outlined the deep roots of poor mathematics proficiency among students within the United States and initiated the argument that parents are important partners in their child's education. Chapter two will provide a conceptual framework for teaching mathematics using the components of BFMC: (1) Concrete Representational Abstract (CRA) modeling, (2) explicit vocabulary instruction, (3) word problems, (4) homework, (5) math games, (6) adult/child pairs as family engagement, (7) bilingual instruction, and (8) workshop series.

Component 1: Concrete Representational Abstract

The Concrete, Representational, Abstract (CRA) model for mathematics can be used in any mathematics domain. Through this model students first learn a mathematical concept conceptually using real objects. Once students gain mastery in a conceptual understanding, students move towards a representational stage where they draw models of their mathematics in pictorial form. The next progression is the abstract phase when students no longer rely on the physical or pictorial scaffolds in order to solve mathematics problems. Here, students only use numbers when solving the problems.

Concrete Phase

In the concrete phase of mathematics, students have been able to kinesthetically build their mathematics understanding as they solve problems (Bruner & Kenny, 1965). Researchers have studied the use of mathematics manipulatives when supporting students in computation and place value (Peterson, Mercer, and O'Shea, 1988), word problems (Marsh and Cooke, 1996), and fractions (Jordan, Miller, and Mercer, 1998).

Mathematics manipulatives are objects students use to build math problems such as cubes, pattern blocks, base-ten blocks, and playdough. All of these studies showed students working with manipulatives made positive gains in mathematics from the support of the concrete objects (Cass, Cates, and Smith, 2003). Additionally, there is evidence that students who choose to solve math problems with concrete objects score higher than students who do not use them (Sowell, 1989). Using concrete manipulatives to build foundational understanding before transitioning into abstract math has shown to lead to positive effects regardless of grade/ability/topic (Sowell, 1989). During this stage, students built the foundation for representational and abstract thinking by building physical models of mathematics (Agrawal & Morin, 2016; Hui, Hoe and Lee, 2017). As Agrawal & Morin (2016) and Hui et al. (2017) found an important aspect of this phase is that students stayed in this phase until they attained consistent mastery of the math concept beyond the algorithm. Rushing students out of the concrete phase in an effort to "save time" or "keep up" with other students is detrimental to future student progress (Lampinen & McClelland, 2018).

Examples of the concrete stage for multiplication include students using two-color counters to create equal groups, unifix counting cubes to snap groups together, base-ten blocks for numbers larger than ten, and common household items as manipulatives, like beans (Agrawal & Morin, 2016). Providing students with the opportunity to use a physical item gives students "external representations" to support their learning (Hui et al. 2017).

Representational Phase

In the representational phase, students transition from using concrete items and use their drawing abilities to make their own visual pictures to show their understanding of mathematics (Agrawal & Morin, 2016; Hui et al., 2017). Students in this phase use various modes of pencil-paper tasks, whiteboards, or virtual drawing tools (Agrawal & Morin, 2016; Hui et al., 2017).

Examples of the representational stage for multiplication include students using circles and dots to create equal groups, drawings of base-ten blocks for numbers larger than ten, and various pictorial representations to match key ideas in word problems (Agrawal & Morin, 2016). Providing students with the choice to use a picture afforded opportunity for students to create “internal representations” to support their learning (Hui et al. 2017). Internal representations were based on their concrete understanding but were generated by the learner.

Abstract Phase

In the abstract phase, students have completed mastery of the two previous stages (concrete and representational) and have built fluency and automaticity. They no longer needed physical, or pictorial supports when solving problems. Examples of the types of processes used by students in this stage included numerical-based strategies like decomposing numbers, algorithms, formulas, and procedural steps. Further, with respect to multiplication, students would build their fact fluency through memorization using the two previous stages as a rationale and foundation for their answers (Agrawal & Morin, 2016).

More on CRA

An important note about the CRA model is these phases are not unidirectional. That is, a person could transition into a previous phase. For example, a student working in the abstract phase could use their foundational knowledge of the concrete and representational phases to comprehend and justify their work (Lampinen & McClelland, 2018). Additionally, retention of information changes over time. It is possible for learners to move back and forth between phases as their learning progresses and as time goes on.

The CRA model has been used with students demonstrating a variety of mathematical ability levels. Notably, as early as the 1960s, research has demonstrated the CRA model works with advanced learners as well (Bruner & Kenny, 1965). The CRA model timeline needs to be entirely dependent on the learner. This tenet of the model has been ignored sometimes, and the CRA model was misused as a strategy to support students. Educators might try to introduce the representation phase too soon because students demonstrated they can do it in class once or twice, but not consistently. Further, this consideration was extended by Lampinen & McClelland (2018) who suggested instead of looking for students to get problems right, there should be an emphasis on students no longer getting problems wrong.

Elementary mathematics is the foundation upon which more advanced mathematics is built. Learning using the CRA approach provides opportunities for all kinds of learners to master the skills with scaffolds used until the individual is ready to move on (Kenny & Bruner, 1965). In BFMC families learn strategies for each level of the CRA model.

Component 2: Explicit Vocabulary Instruction

The second component of BFMC was explicit vocabulary instruction. Academic vocabulary is one of the building blocks for the comprehension of academic texts (Harris, Schumaker, & Deshler, 2011). Academic vocabulary is used cross-curricularly, and when it occurs across the curriculum (a) is seen with high frequency, (b) is not content-specific, and (c) is critical to comprehension (Beck & McKeown, 2007). Math examples include *factor*, *product*, *divisor,* and *dividend*. Academic vocabulary should be explicitly taught in all subject areas including mathematics in a way that goes beyond basic definition recitation.

Students should be able to use the words in context, understand questions using the words, and speak about a topic using accurate academic vocabulary words. Pierce & Fontaine (2009) found the following:

"Language skills have become increasingly important in mathematics classrooms. The National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics now includes Communication as a process strand (NCTM, 2000). Students need to be able to explain their problem-solving methods orally and in written form, both in the classroom and on high-stakes tests" (p. 239).

Mathematics academic vocabulary acquisition has been studied from kindergarten to high school (Hassinger-Das, Jordan, & Dyson, 2015; Spies, & Dema, 2014). One study showed that kindergarten students' academic vocabularies increased when they were reading storybooks using the same academic vocabulary math words their teacher was teaching in class, (Hassinger-Das, Jordan, & Dyson, 2015). Academic math vocabulary should be taught contextually and engage students to put the terms in their own words, (Spies, & Dema, 2014). Students who start math lessons without explicit vocab knowledge cannot comprehend the topic and get confused (Bay-Williams & Livers, 2009). For students to acquire new vocabulary, they need repeated exposure to words in meaningful contexts, connection to prior knowledge and experiences, and an active role in the learning process (Hassinger-Das, Jordan, & Dyson, 2015).

This literature shows the importance of building academic vocabulary alongside content knowledge. Teaching these academic vocabulary words in context will help support students' abilities in mathematics. Having an intervention that ignores vocabulary instruction would do a disservice to students and their families. Mathematics and language are deeply connected, and students should not learn either in isolation. In BFMC families will be learning and practicing academic vocabulary words during each session.

Component 3: Contextualized Math / Word Problems

The third component of BFMC was contextualizing math through word problems. Connecting mathematics learning to real-life applications has become a common instructional practice in mathematics classrooms (Degrande, Van Hoof, Verschaffel, & Van Dooren, 2018). Solving multiplication word problems is a part of the Arizona College and Career Readiness Standards in grades 3, 4, and 5 (Arizona Department of Education, 2020). The National Council of Teachers of Mathematics has recommended this practice for several decades (1989, 2000, 2005). Word problems are a way of contextualizing abstract operations. Internationally, word problems are a part of the mathematics curriculum as well. Equally as abundant is data showing students struggle to solve them (Savard & Polotskaia, 2017). In 2004, in the United States, only 36% of fourth-grade students were proficient and able to solve word problems at grade level

(Perie, Grigg, & Dion, 2005). When it comes to solving word problems, students need to create a mathematical model and do not always have the skills necessary to carry out that task (Degrande et al, 2018). In BFMC families were solving and creating their own word problems.

Component 4: Homework

The fourth component of BFMC was the use of family homework outside the club. Homework is one of the most studied attributes of education (Rosário, Núñez, Vallejo, Cunha, Nunes, Mourão, & Pinto, 2015). It is said to "cause friction" among parents and their children (Patall, Cooper, & Robinson, 2008). There is a great divide among students, teachers, parents, and researchers on whether or not homework is actually beneficial for students (Patell et al., 2008). Attitudes towards homework have ping-ponged from positive to negative over the last century, (Patall, Cooper, & Robinson, 2006). In Cooper et al.'s (2006) overview, they share how in the early 20th-century homework was seen as a positive educational practice. Then, in the 1940s, families felt that homework was taking away from family time. After the Russian space program launched Sputnik, the 1950s had an era of pro-homework as a response to getting American students more internationally competitive. Then, during the 1960s homework was seen as oppressive. After educational data in the 1980s called for a reform of the education system, homework was back in the spotlight. Then, in the 2000s, homework became the black sheep again. Current educational policies differ among schools and individual educators. Not all homework is created equal, and research shows that some homework is more beneficial than others (Rosario et al., 2015). When it comes to homework, assignments that extend learning rather than offer drill/practice style opportunities showed positive results for students (Rosario et al., 2015). In BFMC families were assigned homework each week to practice.

Component 5: Practice through Games

The fifth component of BFMC was the use of math games, both at home and in the club. Low student math achievement is often due to low engagement in class (Zhang, 2015). Math games gave students an opportunity to engage in mathematics in a new way. Math games offered meaningful context to work on skills (Burton, 2010). Multiplication math games and traditional drill fact practice were studied, and results show that both drill and games yield similar results, but games were more enjoyable for students (Koran & Mclaughlin, 1990). Wadlington and Wadlington (2008) found that student attitudes about math increased when they played math games. Shaftel, Pass, and Schabel (2005) warned teachers against overusing math games but said that games increased student motivation to engage in math and real-life games helped students apply math concepts. When math games come home, families have mixed attitudes about them (Kiliman, 2006). Some families enjoy playing, and others are overwhelmed at the directions. When families build math games into their routines, they are more likely to play them, because games that are unused are not effective (Kiliman, 2006). However, families were more likely to actually play the games if they had the opportunity to practice them at school before they were brought home (Kiliman, 2006). In BFMC families were playing games during the club and as homework.

Component 6: Adult-Child Pairs and Family Engagement

The sixth component of BFMC was incorporating family engagement through adult-child pairing. Parent involvement has been studied for decades, and many researchers have created the ideal model of involvement for families. The parental involvement framework developed by Epstein included six different ways that schools supported families with involvement in children's education. Those include: (a) parenting, (b) communicating, (c) volunteering, (d) learning at home, (e) decision making, and (f) collaborating with the community (Epstein, 1995). The spheres of influence affecting student learning are the school, family, and community (Epstein,1995). Bringing them together would help support the child.

Epstein, Galindo, and Sheldon (2011) found parent involvement programs were more successful among all demographics, including "at-risk" populations, when district and school-level officials supported the program. Administrative collaboration was essential for successful programs.

Involving families is important, but can be challenging (Schueler, McIntyre, & Gehlbach, 2017). Two dominant issues have affected family-school partnerships: low program participant enrollment and retention of participants (Lopez & Donovan, 2009). By low enrollment the authors meant low rates of participation; whereas, retention had its usual meaning. Barriers influencing these issues were language, transportation, childcare and time (Jacobson, Huffman, Rositas & Corredor, 1997). In response to these issues, researchers have taken a problem-solving approach to determine how to strengthen parent involvement programs to maximize academic gains for students.

Many times schools communicate unidirectionally with families about student progress. Fantuzzo, David, and Ginsburg (1995) found that sharing positive updates with families about their children's math progress contributed to confidence gains as well as a positive increase in home-school communication. They had parents take the role of a cheerleader/supporter and not a math teacher. Instead, the families would celebrate the specific academic growth, and all tutoring would happen within the school with a teacher and other students. Their suggestion for future tutoring suggests involving parents within the tutoring process in combination with the cheerleader/supporter role. In the BFMC, parents were active participants in supporting their child. They take the field, not just cheer from the sidelines.

A book called, *Partnerships in Math: The IMPACT Project* (Merttens, 1993) outlines the efforts to increase parent involvement with mathematics across the grades. In 1985, the IMPACT project took off in London, England. This project aimed to get parents involved in mathematics education by way of extracurricular math activities and worksheets sent home by teachers. One chapter highlighted a parent's perspective after five years and four children involved in the project. Her criticisms of the project ranged from lack of time when trying to do four "optional," but heavily suggested, activities with her four children, lack of consistency between teachers, and low practicality when it came to some activities. This large-scale parent involvement project was unidirectional and gave families input. It was not expected that the parents become tutors, but just follow assignment directions for practice and review of skills. Random and purposeless assignments are a waste of resources for families. BFMC had a specific purpose and specialized material to support learners all experiencing the same struggles in math. These were core standards and skills needed, not an extension or extracurricular math activity.

Another common practice that schools have to involve families in mathematics is to host an annual Family Math Night (Freiberg, 2004). On these nights families engage in games and activities using math in fun and engaging ways. Part of many schools' parent involvement plans with Title I funding is to host two academic nights open to the families. These one-shot nights are not meant to tutor families but give them access to easy activities they could replicate at home (Mcintyre & Moore 2001). Although these nights have math in the title, their purpose is more geared towards building community and relationships with families.

Component 7: Bilingual Learning

The seventh component of BFMC was the bilingual instruction format presented through two teachers: English and Spanish speaking. Over the past thirty years, Hispanic student enrollment in public schools in the United States has tripled, and predictions show that by 2030 at least 25% of all K-12 students will be Hispanic (Gibson, 2002). Spanish-speaking English Language Learners have consistently scored lower than other ELL subgroups and English-speaking students on the NAEP (2004, 2017). Research has shown that students who are unable to learn in their home language exhaust their working memory. Working memory is related to computation speed and accuracy (Swanson, Kong, & Petcu, 2018). Bilingual education has shown to increase mathematics academic achievement in minority language students (Marian, Schook & Schroeder, 2013). Despite data that shows positive results, there are still large debates on whether bilingual education belongs in schools (Marian et al., 2013). In general, life-long bilinguals have shown to outperform monolinguals and process information faster (Christoffels, Hann, Steenbergen, Van den Wildenberg, & Colzato, 2014). Additionally, when students have the opportunity to learn in their L1, their self-esteem increases. Families who are monolingual Spanish speakers note that language is a barrier when trying to support their children with homework and request that bilingual options were available for their families (Smith, 2005). In BFMC all content was taught in English and Spanish.

Component 8: Workshops as a Series

The final component of BFMC was the series workshop design. This stemmed from needing an out-of-school time program that fit the needs of including adult family members. A tutoring series alone would not have been complete without parents. The club was designed as a way to support students and families over time, versus a one-shot training,

In 1994, a provocative report from the National Education Commission of Time and Learning, called "Prisoners of Time," described how student learning is negatively affected by an outdated school system. The authors called into question the 180-day calendar, the length of the school day, and the congruent minutes allocated for classes regardless of the subject. The report resurfaced in 2005 from The Education Commission of the States. The purpose of reprinting this piece was to remind federal policymakers that the previous decade had provided limited educational change to solve the problems discussed. The call to action was to give students more time in schools in order for them to be adequately prepared for college or careers. When it comes to supporting students academically, there are a variety of ways to give students more opportunities to learn. Extended school years (ESY) and extended school day (ESD) are commonly discussed and implemented within the United States.

The modern American school day calendar has 180 days which is less than the average European (190-210 days) or Japanese (240 days) school year (Patal, Cooper, & Bates-Allen, 2010). Between the years 1991-2007, the United States saw 300 initiatives to extend the school day among 30 different states focused on supporting students coming from high poverty areas. Additionally, there were 50 state-level initiatives supporting extended school day efforts from 2000-2008 (Patal et al., 2010). Despite these initiatives, American students still rank below international students on the 2018 PISA assessment in the mathematics subject area (PISA 2018). According to the 2018 PISA assessment, the United States ranked at a level two out of six, with six being the highest and had a below-average score in comparison to all countries tested (PISA, 2018).

A popular solution to get students to grow academically has been to have struggling students participate in after-school tutoring programs for students only. This allows schools to support ELL students who are below grade level without reducing their mandated SEI time. Tutoring models range from 1:1 individual support, drop-in assignment assistance, study skills/strategic tutoring, and peer tutoring (Hock, Pulvers, Deshler, and Schumaker, 2001). Tutoring from teachers also increases the opportunities to ask questions by providing more social comfort and time to ask questions and get support (Graesser & Person, 1994). Not anybody can tutor and get positive results. Tutoring with properly trained tutors gives the greatest effect for students (Bloom, 1984). Strong tutors are necessary, but insufficient because the greatest positive effect on student achievement change comes from tutoring attendance (Bloom, 1984). Students who consistently get the help they need outperform students who have inconsistent tutoring support (Bloom, 1984). Getting students the necessary help is the key to closing the achievement gap. Instead of just tutoring students, the club aims to support students and parents.

Learning mathematics today is different than it was a few decades ago (Burns, Nelson, Ysseldyke, & Kanive, 2015). Families do not always know how to support their children in mathematics (Whiteford, 1998). Using tutoring workshops to teach families elementary skills has become a one way for schools to address growing concerns about student mathematics achievement (Xiao, Namukasa, Zhang, 2015). It is more common for there to be reading workshops than mathematics workshops offered (Xiao et al, 2015). However, once families take part in mathematics workshops they report enjoying the workshops (Xiao et al., 2015) and find them helpful. It is common for workshops to be a single topic/session and stand-alone (Cavanaugh, 2009; Whiteford, 1998; Xaio et al, 2015). When it comes to learning multiplication, students who struggle with computation need more time to learn the skill than peers who are at grade level (Burns et al., 2015). Having a workshop where families get an opportunity to go into depth on a subject versus a wide variety of topics gives participants an opportunity to learn the material at a conceptual level. Using the CRA model, families need multiple opportunities and time to fully develop an understanding of multiplication (Bruner & Kenny, 1965). BFMC was a four-week series workshop design where the instructors are tutoring families after school.

Chapter Conclusion

Bilingual Family Math Club was designed with eight components taken from the literature. Looking at the components together, the literature suggested that it may be beneficial to create a family-school partnership that would teach mathematics to students and their families, after school. In the partnership, we capitalized on developing mastery experiences by building on a conceptual understanding of mathematics using the CRA approach.

CHAPTER 3

METHODS

Introduction

In this chapter, I will introduce my methodology and research design, including the setting, participants, and sampling for the study. Then I will introduce the roles of the researcher and participants. I will discuss the intervention, outline the timeline for data collection, and describe the BFMC sessions. Next, I will introduce the research style and instruments and procedure. The chapter concludes with possible validity threats to this study.

Setting

BFMC took place at a Title I elementary school in Tempe, Arizona in Fall 2020. The K-8 elementary school district for which I work is located in the heart of Tempe. Our district is 35 square miles including the Town of Guadalupe as well as some areas of Phoenix just west of the I-10 Freeway. With 22 schools, our population includes 12,156 preschool, elementary, and middle school students. 51% of students are Hispanic, and 33% of the students are ELLs.

This will be my eighth-year teaching at my school. For the past decade, our school has been underperforming in state and district assessments in mathematics (J. Wilson, personal communication, August 2020). The latest data demonstrated only 31% of our fifth-grade students attained the level of being proficient or higher in grade-level mathematics as measured by the 2018-2019 AzMERIT Assessment (Arizona Department of Education 2019) Our district mathematics assessment scores from the Northwest Evaluation Association MAP showed similar results with only 35% of students achieving the targeted score ranges for fifth-grade (J. Wilson, personal communication, August 2020).

In Spring 2020, a world-wide pandemic spread with a virus called COVID-19. Schools across the US shut physical buildings down and switched to remote learning. For safety reasons, BFMC was transferred to an online club in Fall 2020. Since our district issued Chromebooks and used Google Classroom as a learning management system, students joined the club using a Google Meet. Students and their families logged into the meetings each week from their homes. This was a major switch from the previous two iterations when families came to the school in-person and shared supplies together. In an effort to support families, but not overwhelm them, the club was shortened to four sessions with a week off for Thanksgiving break. Families were given a bag of supplies to last the entire duration of the club instead of checking items and out each week. Families all had their own set of writing materials and mathematics manipulatives to keep as well.

Participants

This study uses purposive sampling. Purposeful sampling uses a subset of a total population and is a non-representative grouping (Creswell & Guetterman, 2019). The participants are chosen based on their relationship to the context. In this case, I chose students who needed the same type of math support and had families able to attend the club virtually. Participants had to speak English or Spanish in order to access the club materials.

At the beginning of the school year, all students took a district math assessment. The results from this assessment targeted specific students at being at-risk for needing support in mathematics if they fall below the 25th percentile. These students were then given a multiplication assessment which showed the students lacking foundational multiplication skills. There are only 45 unique multiplication facts between 1x1-10x10. If students missed more than 50% of the facts (23 or more) on the assessment, they were referred to the BFMC by their teachers at the end of quarter 1 in September 2020.

The club was offered once a week from 5:30-6:30 pm. The dates and times were chosen based on parent availability discussions in the recruitment process. Once families chose to join, they were enrolled in the club and given assent and consent paperwork. Follow-up and confirmation of times were done after families enrolled in the club. A weekly reminder was sent home reminding families of the club, and the parent liaison personally called families to ask if they needed support with technology due to the club being virtual. Some families received a Hotspot device for internet connection.

The participants in this study include third, fourth-, and fifth-grade students, as well as at least one consistent adult family member. Twenty students joined the club. Five families were from third-grade. Four families were from fourth-grade. Eleven families were from fifth-grade. Each student was required to have an adult family member join them in the club who attended all four sessions and would practice the homework with them outside of the club. The adult family member needed to speak English or Spanish in order to access the club material. Table 2 shows a breakdown of participant information including pseudonyms, grade level, primary language spoken at home, and whether they participated in interviews.

Table 2

Participant Information

Family Number	Pseudonyms	Grade Level	Primary Language	Interview Status
1	Mom: Maria Son: Esteban	3	Spanish	No No
2	Mom: Viola Son: Jose	5	Spanish	Yes Yes
3	Grandma: Joe Granddaughter: Sarah	3	Spanish	No No
4	Mom: Jackie Daughter: Mimi	5	Spanish	No No
5	Dad: Rob Son: Devin	5	Spanish	No Yes
6	Mom: Valeria Son: Micky	5	Spanish	Yes Yes
7	Mom: Tonya Daughter: Keisha	5	English	No Yes
8	Dad: Bill Daughter: Sam	5	English	Yes Yes
9	Mom: Carla Daughter: Briana	5	Spanish	No No
10	Mom: Ofelia Daughter: Martha	5	Spanish	No No
11	Mom: Susie Son: Romeo	4	Spanish	No No
12	Mom: Monica Son: Jake	5	Spanish	Yes Yes
13	Mom: Lisa Daughter: Lauren	5	Spanish	No No

14	Mom: Amanda Son: Kyle	3	Spanish	No No
15	Mom: Betsy Son: Derek	3	Spanish	No No
16	Mom: Simone Son: Ed	4	Spanish	No No
17	Mom: Jessica Son: Karter	3	Spanish	No No
18	Dad: Paul Son: Andrew	4	Spanish	No No
19	Dad: Tim Son:Ken	4	English	No No
20	Mom: Maddie Daughter: Claudia	5	Spanish	No No

Role of the Researcher

My role as a researcher was an interventionist and observer. I taught students and their families mathematics facts strategies during BFMC. I was also an insider in the community as a fifth-grade teacher. Five of twenty families had me as a teacher for the 2020-2021 school year. I had a relationship with families ten weeks prior to the club beginning and had already discussed their children's academic needs with them prior to the club beginning. Families knew participation in the club was optional and would not impact their children's grades or relationship in the classroom. I offered support for families, facilitated discussions, and modeled how to play math games. Additionally, I collected and analyzed the data.

Roles of the Participants

The role of the adult family member in the club was to co-learn the material and support the child during the club and at home as learning support. All strategies were taught with students and parents together, and each person will be given notebooks for notes. The club was an open-dialogue format so family members could ask questions, offer support to each other, and get help before they logged-out. The parent and child worked on all activities together as partners. This allowed for families to practice the homework before they logged out and gave the instructors opportunities to model appropriate questioning and modeling techniques. Parents practiced with their child and the instructors provided feedback to support families within their practice. Members of the same family were always one team together. The adult family member was responsible for facilitating math homework practice for the club.

The role of the student was to work alongside their adult family member to co-learn the material. When there was more than one child per family, they worked with their same parent and shared all materials as a group of three or more.

The role of the interpreter was to help all people communicate so families can have conversions, translate all learning materials and support me during interviews with translation needs.

Intervention

Bilingual Family Math Club was designed to support struggling third, fourth, and fifth-grade (upper elementary) students and their families with building a foundational understanding of multiplication. The Bilingual aspect of this club was intentional. The majority of the families attending the club identified their primary language as Spanish (n=17, 85%), and three (15%) were monolingual English speakers. All materials were created in both English and Spanish for family convenience. All information was presented in both languages, including questions and comments from families during discussions within the club. Families had the opportunity to speak, write, and work in whichever language they preferred. An interpreter co-taught the lessons and was utilized when information needs to be translated between families and staff. The same interpreter was used each week and during data collection. This iteration of the club had a former club member, and parent, join us as the interpreter.

Each week the families worked on building their conceptual understanding of multiplication during a 60-minute BFMC session. The structure of the club was similar each week, but the multiplication strategies taught changed. *Table 3* illustrates the session topic, dates, and events.

Families were also given a bag of mathematics supplies to use for the duration of the club. Inside the bag contained 100 of each of the following math tools: unifix cubes, foam squares, counting bears, double-sided counters, dinosaurs, beads, Playdough containers, and centimeter cubes. There were two sets of writing materials: notebooks, mechanical pencils, Mr. Sketch markers, Expo Dry Erase Markers, red pens, blue pens, and highlighters. Additional mathematics supplies were animal stickers, sticky note pads, and dry erase boards. For math games families also had playing cards, dice with 10 sides, regular six-sided dice, and game mats.

Table 3

Table showing the general timeline for the 2020 BFMC

Session Number	Dates	CRA Phase	Vocabulary Words	Mathematics Strategies
1	Thursday, November 19, 2020	Concrete: 2s, 5s, 10s facts	Factor Product Equal Groups	Modeling equal groups & arrays

			Array	
2	Tuesday, November 24, 2020	Representational: 3 & 4s facts	Skip Counting Repeated Addition	Repeated Addition & Skip Counting
3	Thursday, December 3, 2020	Representational: 6 & 7s facts	Skip Counting Repeated Addition	(All)
4	Thursday, December 10, 2020	Abstract: 8 & 9s facts	(All)	Decomposing Standard Algorithm
Post-Interviews	Week of December 14, 2020			

Session 1: The Concrete Phase

The first session of BFMC began with introductions of participants, the interpreter, and the researcher. After the initial introductions, the regular routine of the club began. Families discussed what multiplication meant to them as their opening question each time. Next, families were introduced to the key vocabulary words for the session. From there, families took notes on the four conceptual models of multiplication: equal groups, repeated addition, an array model, and skip counting on a numberline.

The first facts families practiced building were their 2s facts (2x0-2x10) using clay, beads, dinosaurs, and paint. From there, they applied what they learned into a word problem context. Together families solved, wrote word problems, and modeled their answers with these concrete objects.

At the end of the club, the multiplication strategies were practiced using various math games using playing cards and dice. Families were given homework to practice the specific skills and facts from the lesson. Using Bruner & Kenny (1965) CRA model families worked on modeling multiplication problems using various concrete objects with equal groups, repeated addition, an array, or on a numberline during their first session. Families focused on the foundation facts of 2, 5, 10.

Sessions 2-3: The Representational Phase

In sessions 2 and 3, students and their families worked on modeling various multiplication problems using representational models instead of using concrete objects. Families were allowed to continue using the objects as needed.

Families were introduced to the idea of using drawings and self-created paper and pencil models to represent problems instead of physical objects. Families were shown a variety of representational models to solve problems with (3x0-3x10; 4x0-4x10). Models included base-ten blocks, circles and dots, drawings to match word problem context, numberlines, as well as tally marks.

At the end of the club, the multiplication strategies were practiced using various math games using playing cards and dice. Families were given homework to practice the specific skills and facts from the lesson.

Session 4: The Abstract Phase

In week four families transitioned into the final stage of the CRA model, learning more advanced multiplication strategies, such as decomposing and estimation. At the beginning of class families discussed what multiplication meant to them. Families then were reminded of the key vocabulary words from the past sessions. From there, families discussed the four conceptual models of multiplication: equal groups, an array, skip counting on a numberline, and repeated addition with objects. They were also reminded that these strategies take a lot of time when numbers are larger than ten, and there are more efficient strategies to use once numbers within problems get larger.

Families were introduced to the idea of decomposing factors into smaller numbers to create “easier” multiplication problems. Seven can be broken into groups of five and two. Six can be broken into five and one. Eight can be broken into a group of five, two, and one. Using decomposing makes it easier to do mental math. Families practiced a variety of ways to decompose the numbers. Then, families were given word problems to apply their learning in context. Next, families were given the opportunity to create their own word problems.

At the end of Session four, students were given their post-assessments and scheduled interviews for a week following the end of the intervention. We had a virtual party celebrating their hard work and dedication to learning. The supply bags had juice boxes and microwave popcorn.

Research Style and Instruments

Action Research

Action Research is a cyclical process that empowers people to ignite change within their own communities (Creswell, 2015; Ivankova, 2015). With action research, the researcher is an invested member of the community who uses cycles of action research to help solve a problem within their school or organization (Mertler, 2014). I conducted preliminary cycles of Action Research to better design my BFMC intervention in Spring 2019 and Fall 2019. Each cycle brought more insight and information used to test instruments, change programming, and refine research questions. Due to the strict

SEI requirements from Arizona, an after-school intervention was the only possible short-term solution to give more support to students and their families.

Mixed Methods Research

Mixed Methods Research (MMR) includes qualitative and quantitative data collection methods (Ivankova, 2015). This study is a sequential mixed method action research project because the phases occur after each other (Creswell & Creswell, 2018). The Quan-QUAL sequential data comes from student assessment data from their multiplication scores. They are used to show a change after participating in BFMC. The assessments are analyzed simultaneously for scratch work (qualitative) to determine the level of the CRA continuum the student was at at the end of the club.

In this sequential mixed-methods study there are three instruments used to collect data from students and their adult family members. Data collection began in November 2020 and continued until December 2020.

Table 4

Methods and Research Question Alignment

Research Question	Student Math Assessment	Student Scratch Work	Adult Semi-Structured Interviews	Student Semi-Structured Interviews
1	x			
2	x	X	X	x
3			X	x

Quantitative Data

The quantitative data came from the student math assessment. Pre-and post-multiplication assessments were given to students the week before the club began and on the final day of the club. The assessments were composed of subsections to isolate four different components of multiplication. The first section was made of forty-five items all related to single-digit multiplication fluency. This measured a student's ability to memorize their single-digit facts. An example would be *7x9* and students could only write an answer, no scratch work was allowed. The next section had four items, all multiplication word problems. This section measured a student's ability to solve single-digit multiplication in context. An example was *My garden has seven flowers. Each flower has 5 purple petals. How many purple petals are there in all?* The third section had four items measuring single-digit multiplication (non-memorized). This would show a student's ability to use any strategy to find the product. An example was *8x4* and students would be allowed to use scratch work. The fourth and final section also had four items, multi-digit multiplication. This showed a student’s ability to decompose numbers and find the product using place value relationships or the standard algorithm of multiplication. An example was *67x46***.** See Appendix A for the entire instrument.

Each section of the students mathematics instrument was scored based on the students producing the single-correct product to each multiplication problem. Each student had an unlimited amount of time to answer all 57 assessment questions. Twenty students completed both the pre-and post-tests. There was no attrition in participants for this club. Students were in-person for the pre-assessment because Tempe had “opened” their schools to in-person learning. However, due to COVID-19 metrics getting more severe, our school moved to 100% remote learning and students used a digital tool called PearDeck to respond to the test questions in the post-assessment. PearDeck gave students the ability to draw over Google Slides containing all test questions using their touch-screen Chromebooks with a stylus.

Qualitative Data

Qualitative data came from (1) the scratch work from the student math assessment, (2) student semi-structured interviews, and (3) adult semi-structured interviews.

The student scratch work data worked in combination with the paired sample t-test to show another layer of how students grew their multiplication abilities through strategy use. Interviews quotes were also used to support those findings. Students were taught multiplication using the Concrete, Representational, Abstract (CRA) approach. Their scratch work samples were analyzed in relation to the state of the CRA they were in. In the concrete phase students would have needed physical objects to build the problems. This is the lowest level of understanding and builds the foundation for the other two stages. In the representation stage students use pictorial drawings to represent the problem. These could be equal groups, an array, number line, or any self-created drawing to represent the multiplication problem. This is a middle stage in the CRA Model. The final stage is called abstract. This is when students do not need scaffolds of concrete objects or pictures to solve the problem. They use numbers only to solve the problem. They could solve using place-value methods like decomposing or skip counting, or have it memorized.

The semi-structured interview data came from students participating in the club, as well as adult family members who attended the club with the student. The student interview protocol had twelve questions, nine that directly addressed the components of BFMC and research question 3. Two examples of items are: *Describe how you felt having ADULT come with you to Math Club* and *Each week your family had an opportunity to practice at home with Math Club homework. Describe how you felt about the Math Club homework assignments.* See Appendix B for all interview items. All 20 students were invited to take part in the post-club interview process. Only six students' families signed them up for interviews. All six students were interviewed the week after the club ended. Each interview took less than 10 minutes and took place via Google Meet, as schools went virtual again in November 2020 due to COVID-19. The interviews were digitally recorded and then transcribed.

The interview protocol for adults was similar to the one made for students but framed questions from a caregiver's point of view. It had sixteen items, nine that directly addressed the components of BFMC. Only four students' adult family members signed up for interviews. All four adults were interviewed the week after the club ended. Each interview took less than 15 minutes and took place via phone call through Google Meet, as schools went virtual again in November 2020 due to COVID-19. See Appendix C for all interview items. The interviews were digitally recorded and then transcribed.

The qualitative interview data were analyzed to determine if there were patterns and themes using the constant comparative method (Strauss & Corbin, 2008). Open coding, the first level of analysis, was used to review the data from student and adult interviews. During coding, data were categorized. I listened to the interview questions related to each of the components of BFMC for each interviewee. Systematically, I worked through each component listening to all 10 interviews for the same question. During these listening sessions I highlighted words and phrases that were repeated between the interviews. After listening across interviews by question, I listened to each individual interview to look for any repetition I might have missed before. The second level of analysis was axial coding. At this level, repeated patterns connecting the codes from the student and adult interviews were analyzed. I looked for connections between the repetition of phrases across interviews. At the third level of analysis, I reflected on the two previous levels of analysis by constructing theme-related components and themes.

Procedure

In September 2020, I asked upper elementary teachers to send me a list of students they believed needed the support BFMC was designed for. At the close of quarter 1, all families were invited to have virtual conferences with their child's teachers. At these conferences the club was introduced to the eligible students and families had the opportunity to sign up. The week following conferences, our interpreter for the club called all interested families and answered any questions and concerns they had. Our school district opened for in-person learning the next week and students who signed up were given the student math assessment as a pre-test and were given their bag of BFMC supplies on November 12, 2020. Unfortunately, before the club began families returned to 100% remote learning due to the COVID-19 metrics rapidly changing in Tempe.

The week the club began (November 12, 2020) I enrolled all students in a new Google Classroom and uploaded all digital content. Our interpreter called families to arrange for Hotspots for internet access needs, and double-checked they still planned on being club members. Our first session happened on November 19, 2020 using Google Meet. I shared my screen and the interpreter and I took turns teaching each slide in English and Spanish. Families had all materials physically present with them. They turned on their cameras to show their models, white boards, and use the chat to ask questions. When sharing their questions, concerns, or comments students would use the hand raising tool to speak. After being called on, they would unmute and speak/show. Homework games were introduced at the end of the session for families to practice before the next session. The next club date was November 24, 2020. Families shared their homework progress and the club routine began. The third club date happened more than a week later on December 3, 2020 due to the Thanksgiving holiday break. The final club occurred on December 10th, 2020. Students took their post-test for the student math assessment using PearDeck since they did not have access to printers. The week following the intervention I set up interviews with students and families who volunteered.

I conducted semi-structured interviews with adult and child family members. Semi-structured interviews are appropriate for this research because it allowed flexibility to follow up if needed based on a person's response. The protocol also allows the researcher to ask the same intentional questions to all participants (Brinkmann & Kvale, 2015).

All students were invited to participate in the interview process. Only six families consented to interviews for their children. Interviews for students took place using Google Meet during the school day the week following the last session. The questions asked about the eight components of BFMC and how helpful each component was for the family when learning multiplication. For the complete interview protocol for students see Appendix B.

Interviews for adult family members were scheduled the week following the last session of BFMC. These interviews took place via Google Meet and after school hours. The questions asked about the eight components of BFMC and how helpful each component was for the family when learning multiplication and were parallel to the questions asked of the students. I conducted all interviews using an interpreter as needed for translation purposes. Out of the twenty adults, four parents signed up for the interviews, three mothers and one father. Each of their children also was interviewed as a part of the six student interviews. For the complete interview protocol for adults see Appendix C.

Threats to Validity

All studies have potential threats to validity. The following are the possible validity concerns for this study and how I reduced them.

History validity concerns are when something outside of the study occurs that could cause the changes shown in the data, (Smith & Glass, 1987). For my study, students could have been learning multiplication strategies within their regular classrooms or intervention time. I collected information from teachers on which standards they're teaching over the weeks BFMC took place and determined that multiplication was not being taught.

Testing and pretest sensitization are when scores increase as a result of seeing the test materials and expectations before taking the post-test, (Smith & Glass, 1987). This practice effect gives participants a possible gain because they are familiar with the test items. I used pre-and post- math assessment with students. The tests were given five weeks apart. The time between assessments is not close, so the practice effect won't be as severe. There are a finite number of single-digit multiplication problems, so there is not much else I can do to vary the assessments outside of word problem content.

Mortality/attrition is when participants drop out of the study, (Smith & Glass, 1987). This was my biggest concern. During my Cycle 01, I had just over 50% of my families complete the entire BFMC series. Eight weeks was too much of a commitment. I reduced the club to four weeks with a break in between to try to reduce attrition. By surveying families and determining times that worked for the group, there was no attrition in the club for Fall 2020.

CHAPTER 4

DATA ANALYSIS AND RESULTS

Introducing the Analysis

The first three chapters of this dissertation introduced the problem in context, explained the purpose, introduced the theoretical frameworks, introduced Bilingual Family Math Club, and showed the methodology for this study. In this chapter I will share the data analysis and results.

This mixed-methods study examined the relationship between Bilingual Family Math Club and student achievement as well as strategy use with multiplication. Additionally, families were interviewed after the club ended to determine which of the 8 components of BFMC supported them the most through this process of learning multiplication together. Data analysis will be reviewed by instrument, and then results will be presented by research question.

Data Analysis

Student Math Assessment

After I got back each of the pre-and post- student math assessment data I had to transfer their marks into an excel spreadsheet from their paper or PearDeck slides. I then "cleaned" the data looking for errors or irregularities from the transfer into SPSS. First, I ran descriptive statistics for my data. Next, I analyzed the difference between the pre-and post-assessment using a paired samples t-test to assess whether there were differences in average score across the pre- and post-tests. I was also looking for effect size.

Scratch Work

For the scratch work, I analyzed their responses based on their place on the CRA continuum. Many students had blank responses. For students who responded, students could either have an absence of scratch work with wrong answers, use concrete materials to solve the problem, create a representation, or use decomposition or the standard algorithm to solve the problems. I analyzed these to determine if students' scratch work changed between when the pre-assessment and post-assessment were given. Photographs and screenshots were taken to show the scratch work changes.

Interview Data

Following the last day of the BFMC, participants were interviewed. The data was transcribed by listening repeatedly to the interviews and typing it verbatim. After compiling the data, I looked for codes that emerged from patterns within the speech. From there I grouped these codes into themes. Three coding methods were used to analyze the data: open, axial, and selective coding. Open coding was used first to find the foundational relationships with repetition in words and phrases, (Saldana, 2016). After that, axial coding was conducted next to find connections between ideas. Finally, selective coding was used to build theory.

Results

Research Question 1: How does student multiplication achievement change from the beginning to the end of BFMC?

This research question was addressed through quantitative data collection measures of the student math assessment. Five paired sample t-tests were conducted on the student math assessment: overall test, section1, section 2, section 3, and section 4 independently. See Table 5 for a summary of results.

Table 5

Paired Sample t-test data for student mathematics assessment

	M (pre)	M (post)	SD (pre)	SD (post)	T	p-value	Effect size
Overall	14.30	48.80	18.59	9.04	-9.025	<.001	17.09
Section 1	12.95	38.25	16.48	7.73	-7.381	<.001	15.33
Section 2	0.75	3.75	1.55	0.64	-8.623	<.001	1.56
Section 3	0.40	3.80	1.10	0.52	-13.309	<.001	1.14
Section 4	0.20	2.85	0.62	0.81	-11.994	<.001	0.99

For the overall assessment (57 items), a paired sample t-test was conducted to determine if the post-test score was significantly different from the pretest score. The pretest mean of 14.30 (SD=18.59) was compared to the post-test mean of 48.80 (SD=9.04). The average score of the post-math assessment was significantly higher than the pre-test (t_{19}=-9.025, p <.001), with a large effect size (d=17.09), indicating substantial growth in math achievement from pre to post. The range for the pre-test data was 0-48. There were nine students with a 0/57 (0%) in the pre-assessment causing the SD to be larger than the mean.

For each section a paired sample t-test was conducted to determine if the post-test score was significantly different from the pretest score. For section 1: Multiplication Fluency (45 items) the pretest mean of 12.95 (SD=16.48) was compared to the post-test mean of 38.25 (SD=7.73). The average score of the post-math assessment was significantly higher than the pre-test (t_{19}=-7.381, p <.001), with a large effect size (d=15.33), indicating substantial growth in math achievement from pre to post. The range for the pre-test data was 0-44. There were nine students with a 0/45 (0%) in the pre-assessment causing the SD to be larger than the mean.

For section 2: Multiplication Word Problems (4 items) the pretest mean of 0.75 (SD=1.55) was compared to the post-test mean of 3.75 (SD=0.64). The average score of the post-math assessment was significantly higher than the pre-test (t_{19}=-8.623, p <.001), with a large effect size (d=1.56), indicating substantial growth in math achievement from pre to post.

For section 3: Single-Digit Multiplication (4 items) the pretest mean of 0.40 (SD=1.10) was compared to the post-test mean of 3.80 (SD=0.523). The average score of the post-math assessment was significantly higher than the pre-test (t_{19}=-13.309, p <.001), with a large effect size (d=1.14), indicating substantial growth in math achievement from pre to post.

For section 4: Multi-Digit Multiplication (4 items) the pretest mean of 0.20 (SD=0.62) was compared to the post-test mean of 2.85 (SD=0.813). The average score of the post-math assessment was significantly higher than the pre-test (t_{19}=-11.994, p <.001), with a large effect size (d=0.99), indicating substantial growth in math achievement from pre to post.

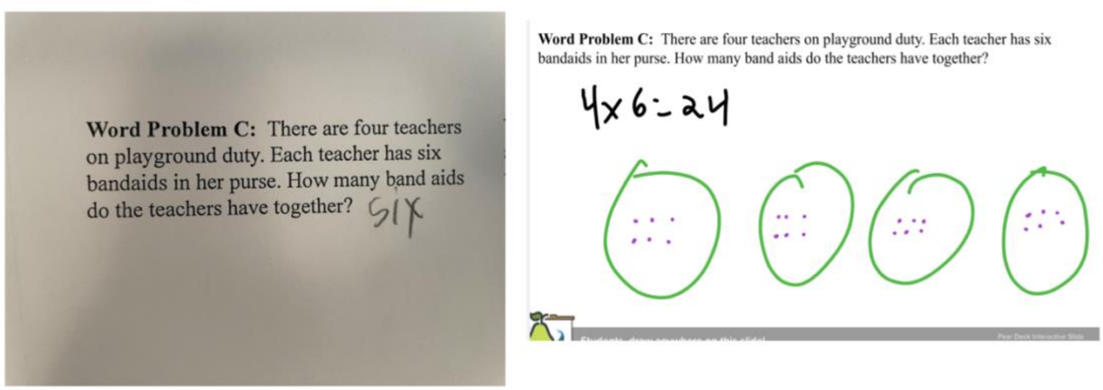
Research Question 2: How does student multiplication strategy use change over the course of BFMC?

I used student scratch work and interview data to answer this research question. Three major themes appeared when looking at their scratch work. First, students came into the club with a limited knowledge of multiplication strategies. Second, students had misconceptions of multiplication strategies in their pre-assessment work. Third, students' multiplication strategy use increased along the CRA continuum between pre-and post-assessment.

Limited Concept of Multiplication prior to the club. Student 1: Esteban is a third-grade male student. He had a limited concept of multiplication during the pre-assessment. His baseline score was 7/57 (12%) and many problems were left entirely blank. When he took the post-assessment most of his responses were in the representational stage and his score was 46/57 (81%). He struggled the most with section 1 (memorization) where he did not have the opportunity to use a strategy. He found the equal groups strategy that worked for him, and he was able to obtain the correct response by using it throughout the assessment. This put him at the representational stage within the CRA continuum. See Figure 2.

Figure 2

Estebans's scratch work

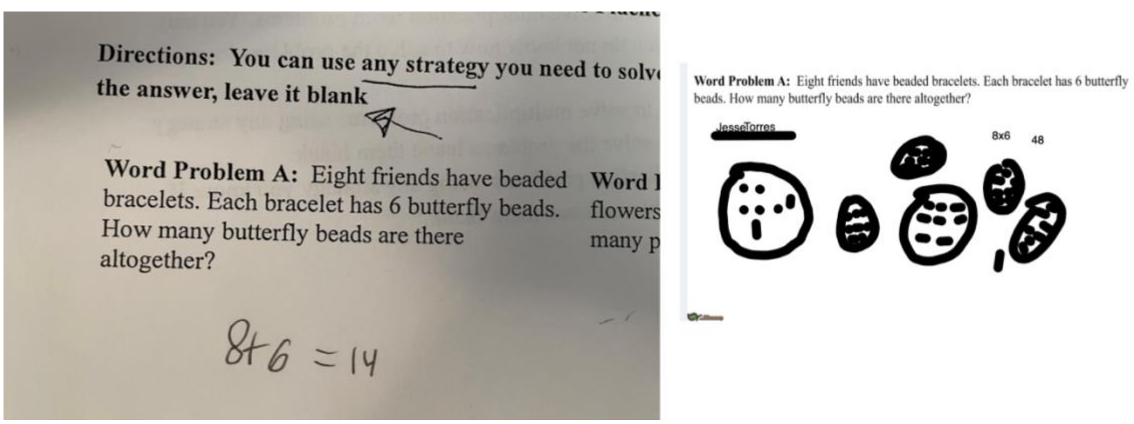


Student 2: Jose is a fifth-grade male student. He had a limited concept of multiplication during the pre-assessment and interpreted multiple problems as addition. His baseline score was 20/57 (35%) with only fluency problems correct from the first section. When he took the post-assessment all of his responses were in the

representational stage and his score was 41/57 (72%). He occasionally had the correct work, but his messy handwriting caused him to miscount his answers on the post-test. He switched between an array model and equal groups which put him in the representational phase. His mother, Viola, was interviewed and said, “My son and I like building with the toys, but it makes more sense to do a drawing together. He likes the drawings because they take less time and we can count each other’s work.” Jose’s interview revealed a knowledge of his misconceptions, “I didn’t know multiplication very much, just the ones I had in my head. I thought it was kind of random and I just copied what my teachers did. Now I know how the numbers work together. The word problems tell me it’s multiplication and the ‘x’ sign means equal groups. I can draw them now” The representational drawings were a strategy reinforced at home during the homework games. This was a typical case. See Figure 3.

Figure 3

Jose’s scratch work

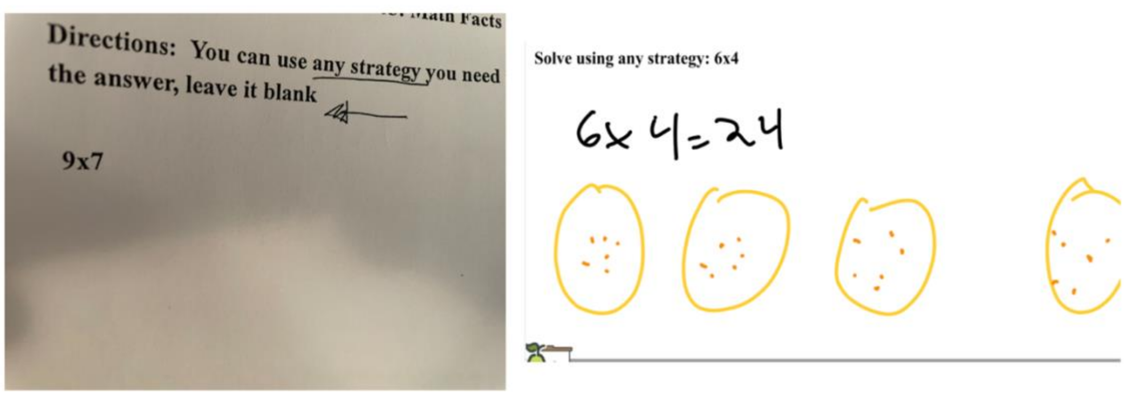


Student 20: Claudia is a fifth-grade female student. She had a limited concept of multiplication during the pre-assessment and left many problems blank. Her baseline score was 0/57 (0%) with no problems correct. She tried to use the math manipulatives to

solve the problems but modeled them as addition instead. When she took the post-assessment most of her responses were in the representational stage, and a few were in the abstract phase. Her score was 37/57 (65%). I was also this child's teacher for the 2020-2021 school year. Having her as a student allowed me to see more details about her multiplication progression. She spent her independent work time using her math manipulatives to practice the facts during class. By week four she was transitioning into drawings. During her assessment she solved all problems representationally and used the physical object to check a few problems. This was a typical case. See Figure 4.

Figure 4

Claudia's scratch work

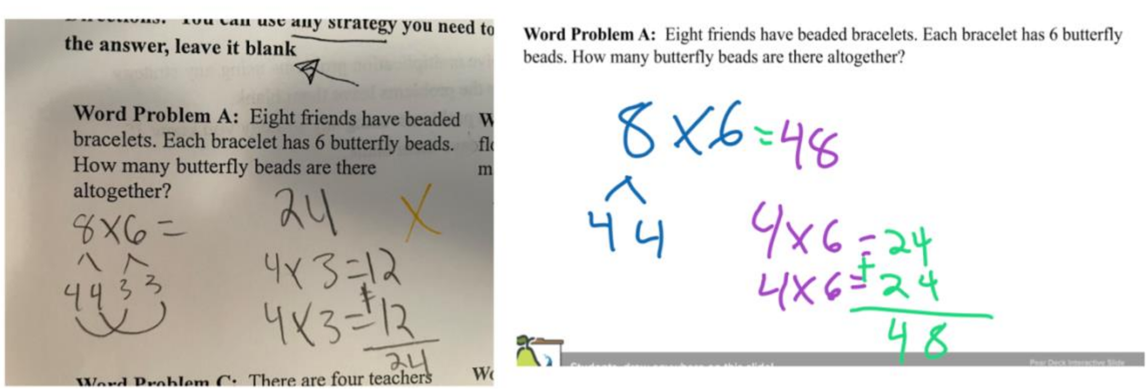


Taken together these examples show the limited knowledge students had prior to joining BFMC. They also show a gain in understanding along the CRA continuum.

Multiplication strategy misconceptions. Student 7: Keisha is a fifth-grade female student. She had misconceptions with the abstract strategies used when solving the problems in the pre-assessment. Her baseline score was 28/57 (49%), and all correct answers came from section 1 where they do not show scratch work. When she took the post-assessment most of her responses were in the abstract stage. Her post-assessment score was 56/57 (98%). I was also this child's teacher for the 2020-2021 school year. Having her as a student allowed me to see more details about her multiplication progression. She had to relearn what she thought were effective strategies. By backing up her progression on the CRA model she was able to regain a conceptual understanding of modeling multiplication. She would try to decompose numbers like her example in Figure 5, but when she built the problem using mathematics manipulatives she would realize her answers did not match. Breaking her bad habits was a struggle. As a fifth-grader she had been making these errors for two school years. In week three of BFMC she stopped using concrete objects to build problems and began the representational stage of drawing. In week four she finally switched back to abstract math, but this time had the correct strategy use. She was interviewed and said, "I was so frustrated at myself for not getting the right answers. I, like, knew what to do, but it wasn't all right. The decompose strategy worked for me, but you guys showed me how to really do it. I was so close. I wish I could go back to fourth-grade and fix my work so my report card would be higher." This was a typical case.

Figure 5

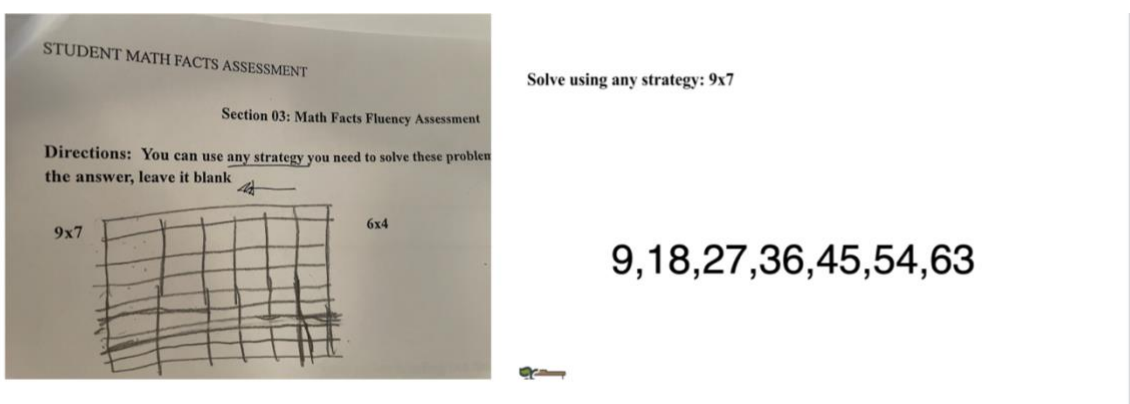
Keisha's scratch work



Student 11: Romeo is a fourth-grade male student. He had misconceptions with the representational strategies used when solving the problems in the pre-assessment. His baseline score was 3/57 (5%) and all correct answers came from section 1 where they do not show scratch work. When he took the post-assessment most of his responses were in the abstract stage. His post-assessment score was 51/57 (89%). This student had misconceptions with an array model in the pre-assessment. He had the correct number of rows, but consistently had the wrong number of columns. After creating his model he also did not write an answer down because he did not know how to use the drawing to find the product. Eventually he moved away from this strategy and found that skip counting was more efficient for him. This put him in the abstract phase for many problems. He did not have to rely on concrete objects or pictures to find his answer. This was a unique case because very few students had any concept of abstract multiplication prior to the club.

Figure 6:

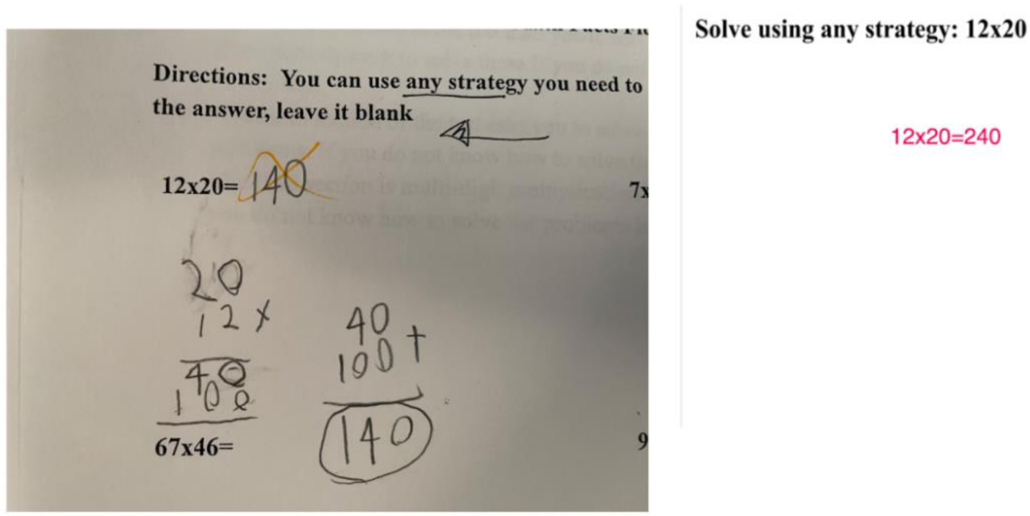
Romeo's scratch work



Student 12: Jake is a fifth-grade male student. He had misconceptions with the standard algorithm, an abstract strategy used when solving the problems in the pre-assessment. His baseline score was 0/57 (0%), and he attempted every single problem. When he took the post-assessment most of his responses were in the abstract stage. His post-assessment score was 56/57 (98%). In this example this student had misconceptions with multiplying multi-digit numbers using the standard algorithm. He had the right set up, but had computational errors related to fluency. He knew he had to multiply across the algorithm, but was not sure which products came from that. He did not attempt to check his work either. This error repeated itself in section 4 of the student mathematics assessment. The other problems he did not use scratch work for and just had the wrong products written down. This student was interviewed. He said, "I am really fast in my head with math. But my mom wants me to slow show and use the strategies you showed. The facts get mixed up in my head, and I get things wrong, even though I am smart. But like you said in class, 'slow down and take your time.' I can check my work now and think, 'does it make sense?'" Jake also said, "I was really mad when I didn't get it right away. Playing games with my mom helped me memorize them better." His mother was also interviewed. "Jake has always had good grades and has always done well in school. I don't know what happened last year. He struggled with math and I know multiplication was hard for him. He just wanted to memorize the facts, but he struggled with his flashcards. Playing the games helped him practice which helped him memorize." This was a typical case.

Figure 7

Jake's scratch work



Multiplication is integrated into many standards in upper elementary grades. Students switch from being taught how to multiply numbers to applying multiplication as a foundational strategy to solve more complex math such as volume and area problems. Over time these students forgot the correct strategy use and ended up using inaccurate strategies to solve problems. This was a unique case because most students did not have concepts of multiplication algorithms.

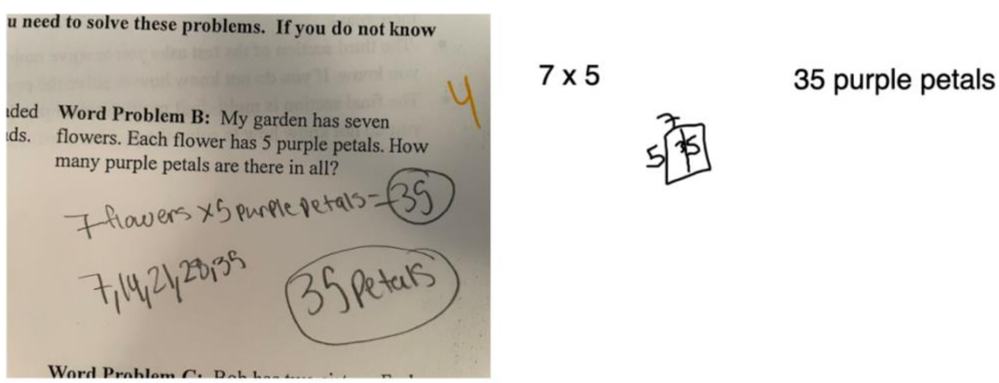
Multiplication strategy use increased along the CRA continuum. Each of the above examples show a shift between a student's initial palace on the CRA continuum and a shift towards a higher sophistication level. The next examples also show a shift. This time the students got the correct answer both times but were able to solve the problem abstractly.

Student 8: Sam is a fifth-grade female student. Her baseline score was 28/57 (49%), and she attempted every single problem. She only missed section one facts with

7s 8s and 9s as a factor. When she took the post-assessment most of her responses were in the abstract stage. Her post-assessment score was 56/57 (98%). Sam came into the club with a strong understanding of basic multiplication strategies, but lacked fluency when it came to the 7s, 8s, and 9s. In an interview she said, “I hate how long it takes me to do, like, one problem with strategies. Before I draw and and draw, but I’m tired after. I never really tried to practice the big facts because I knew I can draw it. But my mom ask me to join the club, and now I see the patterns. I can do the problems easier when I practice each night. I did them so much I have them in my head now.” Her dad, Bill, was also interviewed and he said, “You got no idea how much my kid likes decomposing. She breaks those numbers down and can whip out an answer faster than I can. You really helped her over that bump. She can solve things without the toys or drawings now.” This was a typical case.

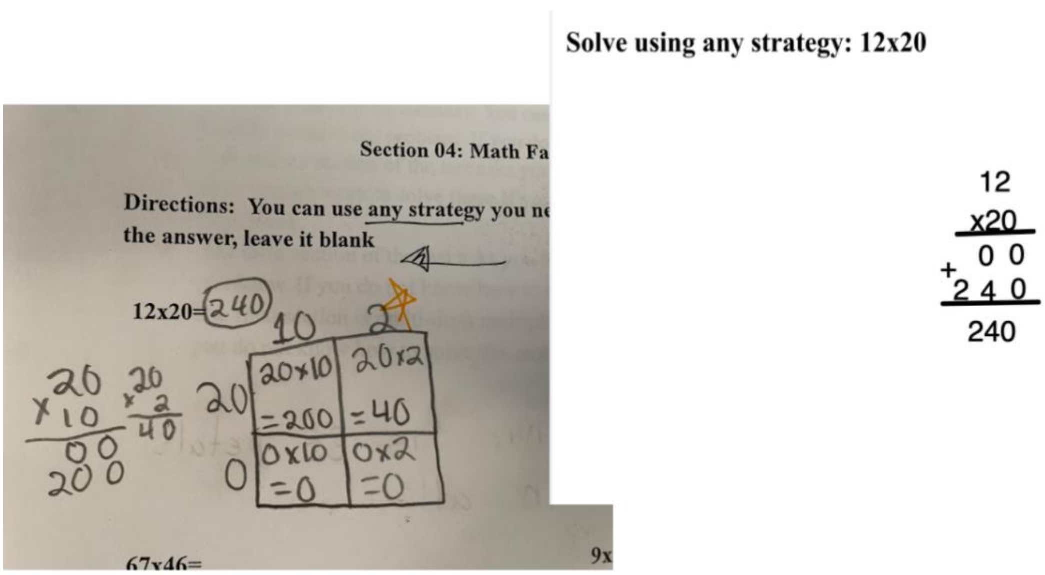
Figure 8

Sam’s scratch work



Student 5: Devin is a fifth-grade male student. His baseline score was 23/57 (40%), and he attempted every single problem. His pre-test showed mostly

representational math. When he took the post-assessment most of his responses were in the abstract stage. Devin's post-assessment score was 57/57 (100%). He came into the club with a strong understanding of basic multiplication strategies, but did not know the standard algorithm for multi-digit multiplication. In his pre-test he got the answer right, but had to decompose the numbers by place value. In his post-assessment he was able to abstractly solve the problem using the standard algorithm. He was interviewed. He said, "I always solved my little multiplication problems with drawings. My teachers always said I had to. But you showed me that I could just solve it with numbers and I like it that way better. I can build and draw the problems, but that sometimes wastes time. I already get it." This was a typical case.



Summary of Results for RQ2. These data worked to answer how their strategy use changed along the CRA continuum. Each of these students came into the club because their teachers and families saw a need to build foundational multiplication skills. These examples show students growth over the BFMC sessions. By adding in interview data for certain students, their changes were explained in their own words. Seeing their understanding of the shift supported the findings.

Research Question 3: Which of the 8 components of BFMC did parents and students feel supported them most when learning multiplication together?

This question was answered using interview data. In interviews with parents and children, I found that families attribute their progress with multiplication to six of the components of BFMC. Two of the components families felt were not as helpful to them. I have presented the themes, theme-related components, and assertions from the interview data in Appendix E. Each theme will be discussed, highlighting relevant participant quotes to support the assertions.

Assertion 1. The family aspect of the club proved to positively benefit student multiplication abilities because students could practice with their families at home. The first theme was composed of three theme-related components: (a) students felt supported by their adult, (b) the adults felt confident in supporting their child after the club, (c) students practiced with their families outside of the club. In post-intervention interviews, 4/4 of the adults provided statements supporting these assertions as well as 5/6 students interviewed.

Parent 02: Viola stated, “And being a team together, that was nice. It was nice to learn together because I did not know it at first either and I was able to learn and help my son.” Echoing her response her son (Student 02: Jose) said, “I mean it was hard to have my mom watch me at first, because I didn’t want to disappoint her. She helped me a lot. We practiced a lot together." These family members both agreed that being together was important for them.

In another family, Parent 08: Bill said, “Any time that I can be a part of my kid’s schooling or their clubs, I am all in. I’m the Gatorade dad at soccer. This was rad. I love field trips, and I am a volunteer guy. COVID is killing me. I want to be there as much as possible.” His daughter, Student 08: Sam, said, “We don’t always get to spend time together because my parents are divorced. It’s nice to have extra time with my dad because I miss him.” This parent expressed his love of being involved in multiple aspects of his daughter’s life, and she shared the struggles of shared custody. This club gave them a change to increase their time together.

Learning together was a positive aspect of BFMC. Students felt supported, and adults were happy to be in a position to help their children.

Assertion 2. A workshop series at night supported families in learning multiplication. The workshop aspect of the club proved to positively benefit student multiplication abilities. However, families wanted more sessions to continue the learning. The second theme was composed of three theme-related components: (a) the length of time was appropriate, (b) families wanted more sessions, and (c) the evening time worked for families. In post-intervention interviews, 4/4 of the adults provided statements supporting these assertions, as well as 4/6 students interviewed.

Parent 06: Valeria said, “Well, I think the hour per week was very good. I would rather have more weeks, though. I feel like we families need more time. We need to catch our children up because of COVID.” This mother attributed COVID-19 as being a factor in wanting this opportunity for her son. She was the only parent to mention the pandemic. Her son, Student 06: Micky, said, “It was good because I wasn’t too tired after. It was like it was faster than regular school."

Parent 02: Viola, said, “The hour was fine with it being online. I want to say if you shorten it, it wouldn’t be enough time. If you made it longer online, too many people would be distracted.” Her son, Student 02: Jose, agreed, “I like the club many days because we can ask for help the next time, but like I’m not bored. It’s short and fun.” Jose mentioned that he was able to ask for help at each session which is important for building fluency in multiplication.

Both students and adults felt like the series model was helpful. The duration and frequency of the club were both highlighted in interviews.

Assertion 3. Playing games during the club supported families in learning multiplication. The games during the club meetings were enjoyable for families and allowed them to transition into homework easier. They were motivated by the competition of “beating” another family. The third theme was composed of three theme-related components: (a) playing together was enjoyable, (b) previewing games made it easier to practice at home, and (c) competition encouraged the family to work together. In post-intervention interviews, 3/4 of the adults provided statements supporting these assertions as well as 5/6 students interviewed.

Parent 12: Monica said, “Yes, we played the card and dice games the most. We practiced each night, as you said, and we had fun together. At first, he was not happy to do more work, but we had his sister play, too. This means we all play together, and we all get to help my son." Her son, Student 12: Jake, said, “Then you get to play games, and it doesn’t even feel like it’s math. It’s nice to spend time with my mom. But the games were fun. Like actual fun, not school fun.” Enjoyment in learning is important. This family liked the games because they had a good time playing them.

Student 02: Jose said, “I played the games at home with my mom after the club. It was, like, fun to beat her in the games. She beat me first during class, so it encouraged me to practice with her later. I wanted to win!” Competitiveness was a repeated factor in the games. Students liked winning. Student 07: Keisha, said, “I like to win. My whole family knows that. Math didn’t change that for me. The games were great, we played them all night long on the weekends.”

Games allowed families to practice the multiplication skills outside of the club. Some families even expanded the players to other family members who did not attend BFMC. The competitiveness of games made it an enjoyable experience. This helped students practice more.

Assertion 4. Using concrete materials supporting families in learning multiplication. Students had a variety of concrete tools to solve math problems. These tools made math more engaging for students and helped students transition into drawings. The fourth theme was composed of three theme-related components: (a) Students built their problems using math toys (b) Drawing facts took less time and (c) The tools made it fun to practice the facts. In post-intervention interviews, 4/4 of the adults provided statements supporting these assertions as well as 5/6 students interviewed.

Parent 02: Viola said, “Yes, Jose was obsessed with building with the little toys. He loved to line the toys up into an array like you show us. I like the new way for math. Before we had to be quiet and think in our head alone. Now we talk, we build, we can draw it. It is nice to show your work and just not be alone.” The CRA model allowed multiple ways for families to practice math together. The model allowed for them to solve the problems together instead of only by memory. Student 02: Jose said, “I liked them, I liked building the stuff with my bag of supplies. Sometimes I got confused but my mom said to pick a strategy that worked for me and not to do them all." He liked the concrete phase of the CRA model.

Student 05: Devin said, "I liked using the toys, once got the hang out I was using the drawings instead. They took less time, plus I know I can use that strategy anywhere without bringing the toys along." He was glad to have a more efficient strategy to use in the CRA model.

Jake's mom, Parent 12: Monica said, "This was all new to me. I did flash cards as a kid. The ways kids can learn math is so helpful. This would have been a game changer for me." In her response she connects the CRA model as something that would have supported her as a student when she was younger.

The math manipulatives were affectionately called toys among families. For students, these tools were ways to play with math. The concrete objects made practicing math enjoyable and offered a scaffold for students not ready for the next phases in the CRA model.

Assertion 5. Word Problems were difficult for most students and families. This component did not support families in learning multiplication. Students and families struggled throughout the club with word problems, especially creation. This component caused stress for families. The fifth theme was composed of three theme-related components: (a) word problems were difficult initially, (b) writing word problems continued to be a challenge, and (c) families were stressed. In post-intervention interviews, 4/4 of the adults provided statements supporting these assertions as well as 3/6 students interviewed.

Parent 02: Viola said, “At first we found it very hard. We speak Spanish and think in Spanish, too. I am practicing my English so I challenge myself to do it in both. Student 02: Jose was mixing up the numbers and I had to bring the little bears to help him see the problem and build it before we wrote it. I am not very creative, but as long as we slowed down and did it in Spanish first I was able to help my son.” Language was a barrier in doing word problems together. Another parent, Parent 08: Bill, said, “Anytime they have to think a little more and get into something, I think it a good challenge. Some of hers was wrong, and it was stressful. She needed help, to do a little extra digging sometimes. I don’t think we really learned how to solve them yet. We need more time.” His daughter said, “These were the worst. Like, I still suck at them. I think more time would help me learn, though. It is just harder than using the numbers.” This family did not feel like they made much progress when it came to solving word problems.

Students did make significant changes between the pre- and post-assessment when it came to solving word problems in section 2, however their families did not think they benefited as much from the word problem integration. Word problems mixed numbers and words and for bilingual families with differing levels of fluency between the languages, they struggled together.

Assertion 6. Using games as homework supported families in learning multiplication. The games aspect of the club proved to positively benefit student multiplication abilities, specifically fluency. Students who practiced often began to memorize their facts. The sixth theme was composed of three theme-related components: (a) games made practice fun, (b) multiple family members played the games together, and (c) the games were easy to play. In post-intervention interviews, 3/4 of the adults provided statements supporting these assertions as well as 5/6 students interviewed.

Parent 12: Monica said, “They were fun. My son loved to play and play. He loves soccer, but he loves math now too.” Her son, Student 12: Jake, said “I liked spending time with my family. It kind of forced us to take off the TV and talk to each other. Like, we are together all of the time, and like with virtual school, we like to separate, because we’re together all day, ya know? But the homework games were easy and fun, and we did them after we had dinner and cleaned up the dishes.” It was enjoyable to practice homework together for this family. They were not just under the same roof together; they were spending time together.

Parent 08: Bill said, “Sam would always initiate the homework. I mean it would be Sunday football and she was like, 'it’s time to play.' I was pausing the game and taking my turn, and dang, I couldn’t pass up the opportunity to see my daughter love learning.” She said, “Anytime I was at my dad’s house we played the games. He even paused football, and he never does that.” These quotes show the power of homework games. Sam’s family practiced together during a major sporting event, and she was glad to use her time with her dad to work on her math goals.

Homework was popular because it was gamified. Students initiated the game play with their family members. Each week families practiced the skills they learned in the BFMC session as games. The games had simple directions and few pieces. This made them accessible to a large group of people.

Assertion 7. Bilingual Teaching supported families in learning multiplication. Having an interpreter co-teach the club in Spanish removed a barrier for families who wanted to support their children. Without an interpreter, families would not have been able to participate. The seventh theme was composed of three theme-related components: (a) families want to support their children, (b) bilingual materials removed a barrier for families, and (c) having an interpreter made it possible for families to participate. In post-intervention interviews, 3/4 of the adults provided statements supporting these assertions as well as 4/6 students interviewed.

Parent 02: Viola said, “I needed it a lot. I do not know as much English. I can understand but not say. Without Nancy, I would not be able to do the work. I would be lost in the meeting. I know she helped me and so many mothers trying to understand the math for their children.” She expressed the essential role the translator played for her in learning math with her child.

Parent 06: Valeria said, “She did a strong job translating, and I am forever grateful for her supporting us. I know a lot of English, but not school words. It was harder for me to learn math if I only had English.” Even a partially bilingual mother was able to appreciate and gain support from our interpreter.

Parent 12: Monica said, "I am so thankful to you. You are the teacher who always knows we speak Spanish. You make sure we all can help our children and I am thankful. We care. We Mexican mothers care, but we cannot always understand what the teachers say, and we have to find somebody to help us translate. Without her help, I would not be able to do this club, and my son would not know his math.” This mom expressed her gratitude for the translator and reminded me that language has been a barrier when trying to support her child in the past.

These interview quotes had the most emotion attached to them. By providing materials in Spanish and having a consistent translator for the club, families were able to participate to the fullest extent. Some families were not as comfortable with academic English words and this club allowed them to learn the academic vocabulary words their children were using in school. This also allowed them to ask questions, gain clarification, and learn in their primary language.

Assertion 8. Explicit Vocabulary Instruction did not support all families in learning multiplication. Despite taking notes on vocabulary terms as a family and knowing some of the phrases prior to the club, students were able to solve problems using strategies but did not know their formal names. The final and eighth theme was composed of three theme-related components: (a) families took notes on vocabulary instruction (b) many students already heard the terms but did not know the strategies aligned and (c) students could solve problems and not know the name of the strategy used. In post-intervention interviews, 3/4 of the adults provided statements supporting these assertions as well as 4/6 students interviewed.

Parent 02: Viola said, “I use that notebook you gave to us and made a dictionary for me to remember all the words. I’m not sure if it helped, but I do have them written down.” Her son, Student 02: Jose said, “Uh, I cannot remember any vocabulary words, but I can do the strategies, I think, without knowing the name of them.” This family wrote the words down but didn’t utilize the academic vocabulary beyond copying the words down.

Student 07: Keisha, said, “I had to take notes with my family. We all had a notebook. I knew the words before, but I don’t think writing it down helped me very much.” She didn’t find much value in the academic vocabulary component of the club.

Due to the club being virtual for this iteration, families were not able to connect as much to each other. Conversations within families were also muted for me, and I couldn’t observe academic language in action over the course of the club. The academic vocabulary was also not a part of the math assessment, so I do not have any growth data available on student academic vocabulary gains.

Summary of Interview Data

Families felt that six out of the eight BFMC components supported them in learning multiplication: adult-child pairs, series workshops, games during class, the CRA method, homework as games, and having a bilingual club. Families felt two of the eight BFMC components did not support them in learning multiplication: word problems and explicit vocabulary instruction. These outcomes were supported by quotes from participants who were interviewed after the club ended.

CHAPTER 5

DISCUSSION

For decades students across the United States have struggled in math (Sass, 2020). Arizona's upper elementary students have historically struggled on statewide assessment in mathematics. The English Language Learner sub-population struggled even more than their counterparts (Arizona Department of Education, 2019). Taking the time to support students in building a strong conceptual understanding of mathematical concepts helps students become more fluent (Bruner & Kenny, 1965). Family engagement has been known to help students academically (Ferrara, 2017) but finding the right plan takes time and is not the same for every community.

Bilingual Family Math Club stemmed from the wants and needs of the school community I work for. Teachers were looking for help and families wanted to play a critical role in getting their students caught up academically. The 2020 COVID-19 pandemic amplified this concern. Over the last three years, the club grew and to meet the needs of the families who participated and shifted to a digital club due to COVID-19. In their homes, students and their families participated in the latest iteration of BFMC in November-December 2020.

This chapter is broken into four sections: discussion of qualitative and quantitative data, discussion of lessons learned, discussion of limitations, and discussion of practical and research implications.

Discussion of Qualitative and Quantitative Data

Action Research is a cyclical process that empowers people to ignite change within their own communities (Creswell, 2015; Ivankova, 2015). Bilingual Family Math

Club 2020 was three years in the making. The club was developed after interviewing families in Fall 2018 about barriers they faced when trying to support their children academically. Overwhelmingly, families stated barriers included English-only programs, the early class times, and lack of childcare for families during the existing parent classes. Additionally, families expressed frustration over the newer math standards and strategies they did not understand. At the time all resources for families were available in English only. This club was developed as a direct response to Fall 2018 parent interviews. I aligned the families' needs with research-based mathematics instructional practices to design the 8 components of BFMC. Mixed Methods Research (MMR) includes qualitative and quantitative data collection methods (Ivankova, 2015). Using both types of data helped me understand my results more comprehensively.

Discussion for Research Question 1: How does student multiplication achievement change from the beginning to the end of BFMC?

Students' multiplication achievement changed significantly over the course of BFMC. The assessment was analyzed as a whole and by individual sections. The results from all sections paralleled each other: students had substantial growth in math achievement from pre to post. This is the type of data I wanted to see as an educator. I wanted to know that this club was supporting students in making gains with foundational multiplication as it is a critical skill used in 74% of our fifth-grade mathematics standards. Each iteration of the BFMC shortened the number of weeks the club took place due to parent feedback and attrition concerns. I was worried that a four-week club with a one-week holiday break would not harness the same effect for student achievement. This time, I had no attrition in the club, and families were engaged in learning despite having to attend the club virtually. My administration was pleased with the quantitative results, but the researcher in me needed to know more. I wanted to know how students' strategy use changed along the CRA continuum since that was the foundational theory guiding my mathematics instruction.

Section 1 on the student mathematics assessment was different than the other three sections for two reasons. First, there were a lot more items. There were 45 items comprised of all single digit multiplication problems 1x1 through 10x10. The other sections had four items each. Secondly, students were unable to show any scratch work. This was a memorized section measuring multiplication fluency. There were no opportunities for students to show the CRA approach.

Discussion for Research Question 2: How does student multiplication strategy use change over the course of BFMC?

A theme I noticed among the pre-assessment data was that most participants came into the club with a limited understanding of multiplication. Many of the problems were left blank and students who did respond had misconceptions when it came to strategy use. No response is still data. This showed me that most students did not know where to begin when solving the different sections of multiplication. When students responded and got the wrong answer, I was able to note their level on the CRA continuum and help correct their errors when introducing the strategies during the club. A few students came in with a high level of multiplication facts memorized but did not know how to find answers to the problems when their memory failed them. For them, teaching strategies supported them in gaining fluency.

The largest theme I noticed was that students transitioned among the CRA continuum over the course of the club. Students initially relied on building concrete models. As they practiced more, they were able to transition into representational and abstract mathematics. Families were given bags of supplies to use in the club and kept afterward to continue practicing multiplication. The different tools aligned with the three stages in the CRA model and offered students multiple ways to practice within each stage. Providing families with these supply bags gave families a peek into what schools are using to support student learning in mathematics. The tools were familiar to students, but new to the adults. Although the club was virtual due to COVID-19, families had their cameras on and shared their models and work during the club. By analyzing their assessment scores alongside their scratch work, I was able to see how students grew in proficiency (quantitative data) and along the CRA continuum (qualitative data).

Some of the interview data also gave insights on how strategy use changed over the course of the club. Without the interview data, I would have been guessing as to why students grew in their strategy use. The interview data helped explain the growth I saw in the percentage score. I was able to learn how the different components played a role in supporting families with understanding multiplication. Students were able to use their concrete toys and representational drawing tools to aid them in learning these facts for homework as well. Using games as a way to practice multiplication skills encouraged students to practice. The easiness of the games and the support from adult family members being in the club helped students create a routine for playing them. Families shared that during the interview process. Practice was an important component of changes in the CRA model. During the interviews, families also expressed the decomposition strategy as the most helpful and new strategy they learned in the program. All correct responses in section four were in abstract form.

Discussion for Research Question 3: Which of the 8 components of BFMC did parents and students feel supported them most when learning multiplication together?

For research question three, I was looking to understand which, if any, of the 8 components of BFMC supported families the most. I interviewed pairs of students and their adult family members to understand the components from different participant lenses. The interviews revealed strong themes supporting six of the components: adult-child pairs, series workshops, games during class, the CRA method, homework as games, and having a bilingual club. Two of the eight BFMC components did not support these families in learning multiplication: word problems and explicit vocabulary instruction.

Interestingly, the two language-based math components were reported as being the least helpful to families. Families discussed the struggle of their child being able to speak Spanish, but not being able to write it. When it came to the written portions of the club, there was a communication gap because students couldn't read the Spanish work their parents did, and families couldn't read the English work their children did. They were able to talk about it, but it was a struggle to write word problems as a team when the team did not share the same literacy abilities. For the vocabulary words, families took notes on them but didn't feel the notetaking on terms really changed the way they supported their children. The words were familiar to students and it was not something they felt made a difference during the club. This makes sense. We were virtual and most of the time they were muted. They were able to speak to each other, but there was limited discussion between families and teachers. With the in-person club families were chatting constantly and would naturally discuss as they sat at tables together. This component wasn't as emphasized in the virtual environment.

For the other six components, families expressed that these were helpful to them. The components worked together and not insolation. Learning together as a family was a critical element to this club. Families were already supporting their children with managing virtual learning but being able to engage in instruction was a game changer. This element would not have been possible with the bilingual component. Our families needed an interpreter/co-teacher who spoke their language in order to access the BFMC materials. Families wanted to be a part of their child's education; they just needed an invite with the right support.

Another component that families attributed to their successes was the workshop series design. Families enjoy being able to learn over time, as well get the opportunities to share and ask questions. The CRA model emphasizes the importance of taking time to master each stage before jumping to the next one. The CRA model tents aligned with family needs of gaining support through multiple sessions. Having a scheduled holiday break also supported students by offering an extra week for them to practice in whatever stage they were currently working at. Families felt both the duration and frequency were effective. They mentioned how it took time to practice the new strategies and were able to ask questions when they returned to the next workshop.

Games were the most commented-on component after bilingual instruction. Students expressed that practicing math did not feel like homework. Parents appreciated the ease and engagement of the games. The game-aspect of the homework resulted in students practicing more. This practice led to a higher fact fluency and helped make meaning of the results from RQ1. Students were playing games with their families because they were fun, competitive and gave them a way to spend time together outside of their normal routine.

Discussion of Lessons Learned

One of the biggest lessons learned was the importance of listening to your school community. In this study, I used action research to solve a problem in my own context. The problems in a school vary depending on the lens used to determine the problem and its priority level. District leaders had been concerned for years about students struggling in math. Families had been asking for ways to help their children. But nobody was linking the two problems together. When interviewing families in 2018 I got a new perspective on what their wants and needs were in regard to supporting their children. The achievement data supported their concerns, and decades of educational research laid the foundation of bringing families into the math equation. Action research is only successful when each cycle of research informs the next. By hosting the club over three school years, I was able to make adjustments based on assessment data, interviews, and feedback from families. Each iteration of the club helped me become one step closer to the goal of supporting struggling math students by involving their families.

Another important lesson I gained from this experience is that kids will work hard towards making a goal when the practice is fun. When multiplication wasn't just worksheets and memorization, students engaged more in the learning process. Students were the ones asking their families to practice homework. Students were the ones taking care of their math supplies and using them throughout the month. Making learning enjoyable supported the mathematics goals I had for them. The concrete materials were novel at first, but quickly became a fun and easy way for students to do something that had been a challenging thing for years.

Discussion of Limitations

Every research study is situated in a specific context. What worked for my school might not work for every school. Action Research is not meant to be a large-scale and reproducible study. That being said, the study was founded, and the components were created on a large body of research that came outside of the AR realm.

Having a small sample size of 20 students, and an even smaller sample size of (4 & 6) interviews is also a limitation. COVID-19 caused a large shift in the club. Families were no longer allowed to share supplies for safety reasons and buying 20 sets of items was expensive. The cost restricted the number of participants which limited the study.

Another limitation was the relationship I had with families coming into the study. I have been teaching at the same place for eight years and running the club for three years. I already knew most of the families enrolled in the club which helped recruitment and retention of participants. Not every club or program will have the coordinator already know the families and start the program comfortable and open for families to ask questions when they need help.

The 8 components of this club were designed from a combination of educational research and the needs of the immediate community. There might be some components that are not relevant to some places, like the bilingual aspect, that schools might not see value in.

Discussion of Implications in Practice and Research

Practice

Supporting students in mathematics is extremely relevant and practical problem schools are having. The CRA approach extends well beyond multiplication. Building a conceptual understanding in all areas of math could be used in classrooms K-12 as teachers plan how to teach math.

Partnering with families can be more meaningful as schools determine how to create two-way partnerships with them. There is a time and a place for annual academic nights but including workshops in topics families at a school request can help support the specific needs of the school. In those partnerships, language, time, and childcare barriers need to be removed if we expect families to be able to attend the events. If we want to work with families, we need to understand their needs and work to create programs that support those needs.

In my school district, we are opening our first dual-language school in August 2021. The importance of bilingual education and the high need in our community has caused this change. Hopefully, the successes of this school spark a district-wide initiative that can support our students and families on a larger scale.

Research

There is a wide body of research about tutoring. There is also a wide body of research about family involvement. This club linked both of those concepts in a new way. Often, we support students and their adult family members separately. If more programs were designed to pair family members together, we could be able to capitalize on the advantages both offer. More research is needed with this structure of adult/child pairs to see the benefits of supporting a variety of academic skills in any subject area at different grade levels.

Closing

I have spent the last three years of my career trying to make my corner of the world better. Through action research, I was able to understand my community's needs and address them by creating a Bilingual Family Math Club. I designed the 8 components of the club using educational research coupled with family needs. Over three years I saw students and their families work together to become better at math. Multiplication is a skill that is needed in almost every fifth-grade math standard in Arizona. By isolating multiplication, we were able to help students who had been struggling for years overcome an academic challenge and repair their relationship with math.

As an educator it is not my job to give families a voice--they already have that; I need to give them an ear. To listen and understand a school community is essential. Family partnerships enrich a school and help us accomplish our mission of educating their children. The math is simple: Schools + Families = Success.

Epilogue

One of the most interesting things about qualitative research interviews are the extra pieces of data that are collected that do not directly answer research questions. One of my biggest struggles coding these data was trying to filter out the interesting pieces of information that weren't connected to my RQs and the BFMC components. My committee suggested I add a short epilogue discussing these findings.

We are in a pandemic. It was impossible to escape that reality during this research project. My entire club shifted online and students at the time were not even learning in schools. Yet, these families showed up every week. These students showed up after school hours to learn more despite the screen fatigue they had. I had no attrition for this cycle, and families attributed that to a lack of commute and their fear that COVID-19 would cause their children to fall behind their peers academically. However, not being in person took away some of the social aspects of the club. Families didn't get to meet each other. They didn't get to have small talk and socialize in the ways my previous cycle participants were able to. For me, I noticed a lot less questions being asked from parents. There was a different feel to our online community. Families already felt comfortable in their homes but did not feel that way at our school. If we had held the club in the new space, it would have been a different feeling. Families would have had the chance to build a relationship on school grounds and start to build that connection.

While being a doctoral student I also joined my university's principal preparation graduate program. I was viewing this research from the lens of a future administrator as well. I realized that it is imperative to truly get to know the needs of a school. Some schools have similar concerns for behavior and academics, but do not always have the same cause. Getting to know the students, their families, and the story behind data is essential to truly supporting families. There is a deficient narrative that some educators have about student families and that causes them to not see the value in partnering with families and listening to their concerns and needs. Being in this program reminded me the importance of communities and schools working together towards the same goals of supporting students in their journey in education.

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APPENDIX A

DATA COLLECTED NOVEMBER-DECEMBER 2020

APPENDIX A

STUDENT MATH FACTS ASSESSMENT

Pre/Post

Student Name: ____

Teacher Name: ____

Time Started: _________________

Time Finished: _________________

Procedure: Orally give directions to students before handing out the assessment. Say, "Today you are going to take a pretest on multiplication math facts. This is not for a grade. This test will let me, and your classroom teacher know how to help you improve in math. This is not a timed test. You can take as much time as you need. The test is broken into four sections.

- The first section is by memory. You cannot draw, count on your fingers, or use any other strategy to solve the problem. If you do not know it, leave it blank.
- The second section of the test asks you to solve multiplication word problems. You may show scratch work to solve these. If you do not know how to solve the problems leave them blank.
- The third section of the test asks you to solve multiplication problems using any strategy you know. If you do not know how to solve the problems leave them blank.
- The final section is multi-digit multiplication problems using any strategy you know. If you do not know how to solve the problems leave them blank."

Section 01: Math Facts Fluency Assessment

Directions: Solve each problem in your head. If you do not know the answer, leave it blank.

2x2=	8x1=	3x1=	3x3=	9x2=
4x7=	9x5=	8x7=	2x4=	4x1=
8x3=	5x6=	9x9=	5x7=	2x7=
6x6=	3x10=	2x3=	9x3	7x3=
3x6=	4x5=	9x4=	4x4=	8x5=
7x1=	2x10=	8x6=	8x8=	5x5=
8x2=	6x7=	8x4=	6x9=	2x6=

7x9=	3x5=	7x7=	3x4=	4x6=
5x1=	2x5=	8x9=	8x10=	6x1=

Section 02: Math Facts Fluency Assessment

Directions: You can use any strategy you need to solve these problems. If you do not know the answer, leave it blank

Word Problem A: Eight friends have beaded bracelets. Each bracelet has 6 butterfly beads. How many butterfly beads are there altogether?

Word Problem B: My garden has seven flowers. Each flower has 5 purple petals. How many purple petals are there in all?

Word Problem C: There are four teachers on playground duty. Each teacher has six band aids in her purse. How many band aids do the teachers have together?

Word Problem C: Bob has two sisters. Each sister has ten toes. What is the total amount of toes the sisters have together?

Section 03: Math Facts Fluency Assessment

Directions: You can use any strategy you need to solve these problems. If you do not know the answer, leave it blank

9x7   6x4

8x4   3x9

Section 04: Math Facts Fluency Assessment

Directions: You can use any strategy you need to solve these problems. If you do not know the answer, leave it blank

12x20=   7x15=

67x46=   9x83=

APPENDIX B

DATA COLLECTED DECEMBER 2020

APPENDIX B

STUDENT SEMI-STRUCTURED INTERVIEW FORM

Student Name: ____

Time Started: ________________ Time Finished: ________________

Procedure: This interview is being audio recorded. Your adult gave consent for me to interview you about BFMC. Talking to you will help me understand how to make the club better and how to help students in the future. You will not be graded on this, and you can stop the interview at any time.

Number	Question	Follow Up Prompts	Research Question/ Factor
			RQ 3:
1	Alright, let's get started. What is your name?		
2	Who is your regular classroom teacher?		
3	Who attended Math Club with you?	• How is this person related to you? • Do you live with this person?	
4	Describe how you felt having ADULT come with you to Math Club.	• What made you excited/nervous/worried? • Can you tell me more about why?	Component #6: Adult-Child Pairs
5	Describe how you felt about the amount of time we spent together in Math Club.	• Why did you think it was too short/too long/the right amount of time?	Component #8: Series
6	In Math Club we played many games. Describe how you felt about playing these games.	• Which games did you like to play? • Which games were difficult to play?	Component #5: Games
7	In Math Club we solved multiplication problems in a variety of ways. Describe how you feel about the way we practiced multiplication.	• Can you tell me more about that? • Why did you like/dislike it? • What made it easier/hard?	Component #1: Concrete-Representational-Abstract
8	In math club we solved and created our own word problems. Describe how you	• Why did you like it? • What made it difficult?	Component #3:

	felt about the way we practiced word problems	• What makes using real objects make it easier?	Word Problems, Contextualized Problems
9	Each week your family had an opportunity to practice at home with Math Club homework. Describe how you felt about the Math Club homework assignments.	• How often did you do the homework? • Who did the homework with you?	Component #6: Homework Games
10	Each week there was a Spanish/English interpreter available. Describe how you felt having an interpreter join us as another teacher for Math Club.	• Why did you like/dislike it?	Component #7: Bilingual Club
11	Each week we practiced math vocabulary. Describe how you felt about our vocabulary practice during Math Club.	• Why do you like/dislike it?	Component #2: Explicit Vocabulary Instruction
12	Think back on the entire math club experience. What parts of math club do you think helped you the most?	• Why do you think they helped you?	All Factors

APPENDIX C

DATA COLLECTED DECEMBER 2020

APPENDIX C

ADULT SEMI-STRUCTURED INTERVIEW FORM

CODE Name: ____

Time Started: _________________ Time Finished: _________________

Procedure: This interview is being audio recorded. Talking to you will help me understand how to make the club better and how to help students in the future. Your child will not be graded on this, and you can stop the interview at any time.

Number	Question	Follow Up Prompts	Research Question/ Factor
			RQ 3
1	Alright, let's get started. What is your code name?		
2	Who is your regular child's classroom teacher?		
3	Who attended Math Club with you?	• How is this person related to you? • Do you live with this person?	
4	Describe how you felt joining your child in Math Club.	• What made you excited/nervous/worried? • Can you tell me more about why?	Component #6: Adult-Child Pairs
5	Describe how you felt about the amount of time we spent together in Math Club.	• Why did you think it was too short/too long/the right amount of time?	Component #8: Series
6	In Math Club we played many games. Describe how you felt about playing these games.	• Which games did you like to play? • Which games were difficult to play?	Component #5: Games
7	In Math Club we solved multiplication problems in a variety of ways. Describe how you feel about the way we practiced multiplication.	• Can you tell me more about that? • Why did you like/dislike it? • What made it easier/hard?	Component #1: Concrete-Representational-Abstract
8	In math club we solved and created our own word problems. Describe how you	• Why did you like it? • What made it difficult? • What makes using real objects make it easier?	Component #3: Word Problems, Contextualized Problems

	felt about the way we practiced word problems		
9	Each week your family had an opportunity to practice at home with Math Club homework. Describe how you felt about the Math Club homework assignments.	• How often did you do the homework? • Who did the homework with you?	Component #6: Homework Games
10	Each week there was a Spanish/English interpreter available. Describe how you felt having an interpreter join us as another teacher for Math Club.	• Why did you like/dislike it?	Component #7: Bilingual Club
11	Each week we practiced math vocabulary. Describe how you felt about our vocabulary practice during Math Club.	• Why do you like/dislike it?	Component #2: Explicit Vocabulary Instruction
12	Think back on the entire math club experience. What parts of math club do you think helped you the most?	• Why do you think they helped you?	All Factors

APPENDIX D

THEMATIC CHART

APPENDIX D

THEMATIC CHART

Theme-related components	Theme	Assertions
1. Students felt supported by their adult 2. The adult felt confident in supporting their child 3. Students practiced with their families	Adult-child pairs were a support for families in learning multiplication.	The family aspect of the club proved to positively benefit student multiplication abilities because students could practice with their families at home.
1. The length of time was appropriate 2. Families wanted more sessions 3. The evening time worked for families	A workshop series at night supported families in learning multiplication.	The workshop aspect of the club proved to positively benefit student multiplication abilities. However, families wanted more sessions to continue the learning.
1. Playing together was enjoyable 2. Previewing games made it easier to practice at home 3. The competition encouraged the family to work together	Playing games during the club supported families in learning multiplication.	The games during the club meetings were enjoyable for families and allowed them to transition into homework easier. They were motivated by the competition of "beating" another family.
1. Students built their problems using the math toys 2. Drawing facts took less time	Using concrete materials supported families in learning multiplication	Students had a variety of concrete tools to solve math problems. The tools made math more engaging for students. The tools also helped students transition into drawings.

3. The tools made it fun to practice the facts		
1. Word problems were difficult initially 2. Writing word problems continued to be a challenge 3. Families were stressed when solving the problems together	Word Problems were difficult for most students and families. This component did not support all families in learning multiplication.	Students and families struggled throughout the club with word problems, especially creation. This component caused stress for families.
1. Games made practice fun 4. Multiple family members played the games together 5. The games were easy to play	Using homework as games supported families in learning multiplication	The games aspect of the club proved to positively benefit student multiplication abilities, specifically fluency. Students who practiced often began to memorize their facts.
1. Families want to support their children 2. Bilingual materials removed a barrier for families 3. Having an interpreter made it possible for families to participate	Bilingual teaching supporting families in learning multiplication.	Having an interpreter co-teach the club in Spanish removed a barrier for families who wanted to support their children. Without an interpreter, families would not have been able to participate.

1. Families took notes on vocabulary instruction 2. Many students already heard the terms, but did not know the strategies aligned 3. Students could solve problems and not name the strategy used	Explicit vocabulary instruction did not support all families in learning multiplication.	Despite taking notes on vocabulary terms as a family and knowing some of the phrases prior to the club, students were able to solve problems using strategies but did not know their formal names.

APPENDIX E

BILINGUAL FAMILY MATH CLUB PARENT CONSENT

APPENDIX E

BILINGUAL FAMILY MATH CLUB PARENT CONSENT

PARENTAL LETTER OF PERMISSION

Dear Parent:

I am a student in the Doctoral Program at Arizona State University working under the direction of Dr. Carole Basile. I am also a fifth-grade teacher at Wood Elementary School. I am conducting a research study to examine the effects of the components of Bilingual Family Math Club on mathematics achievement and growth at Wood Elementary School for children in third-fifth grades.

I am inviting your child's participation in a math assessment about multiplication because your child's teacher indicated they need support in mathematics based on their grade level observations in quarter 1 and our benchmark testing. Your child's participation in this math assessment is voluntary. If you choose not to have your child participate, there will be no penalty. Likewise, if your child chooses not to participate in the math assessment there will be no penalty. The results of the math assessment may be published, but your child's name will not be used. This math assessment is a way for me to get to know your child's ability to solve multiplication problems.

In Bilingual Family Math Club, we will learn multiplication strategies each week and play games for practice 30-60 minutes each week. You and your child/ren will work together to solve multiplication problems using mathematics manipulatives, white boards, and markers. The goal is to work through all of the 45 single-digit math facts over the course of four weeks. The class will be taught in English and Spanish simultaneously with an interpreter. Each week you will have an optional homework assignment/game to play to practice the multiplication skills. You will report what you did for homework on a homework reporting sheet. If you or your child chooses not to complete the homework reporting sheet, there will be no penalty. The results of the time spent on homework may be published, but you and your child's name will not be used.

I may also be inviting you and your child's participation in an interview about what they have learned during Bilingual Family Math Club that will take 20-30 minutes. You and your child's participation in this interview is voluntary. If you or your child chooses not to participate in the interview, there will be no penalty. The results of the interview may be published, but you and your child's name will not be used.

The direct benefit from your child participating is they will be introduced to various multiplication strategies that they can use during elementary mathematics classes. There are no foreseeable risks or discomforts to your child's participation.

Responses will be kept confidential and will not be labeled with students' names.
The results of this study may be used in reports, presentations, or publications but
your child's name will not be known/used.

If you have any questions concerning the research study or your child's participation in the survey or interview, please contact me at (480) 338- 5507

Sincerely,
Brittany Barnes

By signing below, you are giving consent for your child __________________ to participate in the above study.

______________________	___________________________	______________
Signature	Printed Name	Date

If you have any questions about you or your child's rights as a participant in this research, or if you feel you or your child have been placed at risk, you can contact Dr. Carole Basile at Arizona State University at (480)965-3463 or the Chair of the Human Subject Institutional Review Board, through the Office of Research Integrity and Assurance at (480) 965-6788.

APPENDIX F

CHILD ASSENT FORM

APPENDIX F

CHILD ASSENT FORM

Bilingual Family Math Club

I have been told that my parents (mom or dad) have given permission (said it's okay) for me to take part in a project about Bilingual Family Math Club.

I will be asked to fill-in a math test that includes items about multiplication and word problems. I will be asked to complete the assessment two times. It will take about 15 minutes each time to do the assessment; that means 30 minutes in all. This will take place during the club in week 1 and week 4.

Each week my family and I will watch videos or attend virtual math clubs for 30-60 minutes. In Bilingual Family Math Club, we will learn multiplication strategies each week and play games for practice. My adult family members and I will work together to solve multiplication problems using mathematics manipulatives, white boards, and markers. The goal is to work through all of the 45 single-digit math facts over the course of four weeks. The class will be taught in English and Spanish simultaneously with an interpreter. Each week we will have an optional homework assignment/game to play to practice the multiplication skills.

When the club is over, I will be asked to answer 10-12 questions in an interview with my teacher. The interview will take 20-30 minutes.

I am taking part because I want to. I know that I can stop at any time if I want to, and it will be okay if I want to stop.

______________________________ __________________________

Sign Your Name Here — Print Your Name Here

____

Date

APPENDIX G

INSTITUTIONAL REVIEW BOARD APPROVAL

APPENDIX G

INSTITUTIONAL REVIEW BOARD APPROVAL

ASU Knowledge Enterprise Development

EXEMPTION GRANTED

Carole Basile
Teachers College, Mary Lou Fulton (MLFTC) - Tempe
480/965-4064
Carole.Basile@asu.edu

Dear Carole Basile:

On 10/26/2020 the ASU IRB reviewed the following protocol:

Type of Review:	Initial Study
Title:	Bilingual Family Math Club
Investigator:	Carole Basile
IRB ID:	STUDY00012724
Funding:	None
Grant Title:	None
Grant ID:	None
Documents Reviewed:	• Barnes IRB Child Assent Form.pdf, Category: Consent Form; • Barnes IRB Parental Consent Letter 010416.pdf, Category: Consent Form; • Brittany Barnes IRB Protocol.pdf, Category: IRB Protocol; • Brittany Barnes IRB Recruitment Letter.pdf, Category: Recruitment Materials; • Instrument 1: Student Math Assessment, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Instrument 2: Student Semi-Structured Interviews, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Instrument 3: Family Form, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions); • Instrument 4: Adult Interviews, Category: Measures (Survey questions/Interview questions /interview guides/focus group questions);