EFFECTS OF VIRTUAL MATH MENTORSHIPS ON ELEMENTARY STUDENT MATH SCORES

by

Tammy T. May

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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APPROVED BY:

Alan D. Wimberley, Ed.D., Committee Chair

Amy G. Jones, Ed.D., Committee Member

Todd A. Johnson, Ed.D., Committee Member
ABSTRACT

The purpose of this quantitative, quasi-experimental study was to examine the relationship between college students’ virtual math mentorships and instruction on third grade students’ math academic success. College students in teacher preparation programs investigated deficiencies in third grade students’ competency of math concepts as specified by state standards, and they designed lessons to address these challenges through weekly virtual meetings. Third grade teachers wanted to provide additional math supports for their struggling students, and this partnership between the college students and the third graders was the foundation of this study at four Title 1 rural elementary schools. This research is an extension of a previous investigation where only students’ attitudes towards math were documented, showing improvements after receiving targeted interventions from college mentors. For this study, an analysis of covariance (ANCOVA) was used, comparing six third grade classes, three with virtual math mentoring interventions and three without interventions. Pre and post standardized tests were used in the control and experimental groups, and from the data, it was determined that there was a slight difference in students’ math achievement scores as a result of the interventions by college students. Future research on elementary students’ math success should include: (a) the influence of parents, guardians, and teachers on students’ engagement in and focus on math skills, (b) the attitudes and instructional style of teachers, (c) the experience level of the teachers, (d) the gender and socio-economic status of students, (e) the strength of the relationship between a preservice teacher and elementary students, and (f) the social and emotional status of the students being tested in a non-pandemic year.

Keywords: attitude, deficiency, intervention, mentorship, virtual, elementary mathematics
Dedication

My career in public education began in 1995 when I accepted my first job with Rockingham County Public Schools. Having taught kindergarten, 2nd grade, 3rd grade, 4th grade, and Title 1 Reading, I understand what it means to be on the frontlines of teaching students. Working with students from all walks of life gave my life purpose and meaning as I focused on helping students to achieve academic, social, and emotional growth.

In 2010, I moved from classroom teaching to an administrative role as assistant principal. Although I was not involved with the actual instruction in the classroom, I was still able to provide leadership and guidance in best practice for student learning. Working with teachers, parents, and the community in helping our students and the school to thrive as an educational institution was fulfilling and enjoyable for me.

My current position as the principal of a small rural school in Rockingham County Public Schools began in 2018. As the leader of this high needs school, I am reminded of why I chose to enter the work of education as I navigate the waters of curriculum, policies, and most recently, uncertainty. In this, I am referring to the world of education as it has been impacted by the most recent pandemic. I have discovered that my role as a school leader has been challenged and transformed as I have had to become more flexible than ever before.

As my career has evolved from classroom teacher to principal, I have been blessed to know and collaborate with a multitude of stakeholders in our school division. From educators to parents to community members, the influence of all persons, both positive and negative, have shaped me into the leader that I am today. I dedicate this dissertation to Rockingham County Public Schools’ division leadership and to the individuals who I have had the privilege of sharing with in my twenty-six year educational journey.
Acknowledgments

Knowing that the work of a dissertation would require a vast amount of time, patience, and dedication, I continued to rely on my faith and relationship with God. At the core of my decisions and journey therein were my prayers and dedication to His leading. I also anticipated that my familial and professional support system would be set into motion. Without a doubt, my superintendent and assistant superintendents were checking in on me and cheering me on. My lifelong friend and director of Federal grants, Dr. David Burchfield also provided guidance and direction as I moved into each aspect of my doctoral journey.

I started my doctorate while still working as an assistant principal, and the balancing of work and writing was challenging but doable. Then, when I was appointed principal of my new school, although the workload of leading a new school was intense, I did not abandon my doctoral work. My husband, Keith reminded me of this recently as he praised me for not giving up. He indicated that despite the additional responsibilities of being a new school leader, I stayed the course and became that much more determined to pursue and finish my degree.

With all of the aforementioned being said, I am grateful for my support systems as I know that they had confidence in me to move forward with achieving both my professional and personal goal of earning my Ed.D. Without their continuous monitoring of my emotional and physical well-being, I would have found the journey to be less enjoyable and achievable.

As I close out this acknowledgement section, I again must give the glory and honor of this work to God. My reliance upon him in every aspect of my life cannot be ignored. From providing me with an inner calm to opening my eyes to what He needed me to do as his servant, I could not have entered this journey without Him.
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Academic Self-Concept (ASC)

Adequate Yearly Progress (AYP)

Instructional Technology Resource Team (ITRT)

National Assessment of Education Progress (NAEP)

No Child Left Behind (NCLB)

National Council of Teachers of Mathematics (NCTM)

Student Growth Assessment (SGA)

Standards of Learning (SOL)

Virtual Math Mentorships (VMM)
CHAPTER ONE: INTRODUCTION

Overview

The purpose of this quantitative, quasi-experimental study was to determine if third grade students who participated in specialized virtual mentoring programs with college students in teacher preparation programs demonstrated increased gains on standardized math assessments due to the specialized interventions provided by the college students. Chapter One provides a background for the topics of (1) declining math abilities and academic achievement based on the Nation’s Report Card, (2) the strict regulations of No Child Left Behind (NCLB), (3) more student engagement in and motivation for math, and (4) virtual, creative opportunities for students to better understand math. Included in the background is an overview of the theoretical framework for this study. The problem statement examines the scope of the recent literature on this topic. The purpose of this study is followed by the significance of the current study. Finally, the research questions are introduced, and definitions pertinent to this study are provided.

To determine if well-constructed, intentional math interventions can help third grade students to improve in their math achievement, this study focused on a virtual math mentoring program. Teacher candidates at a local college are paired with third grade students who struggle with math skills, and they virtually mentor and tutor them in math with lessons that are interactive and related to students’ interests.

Background

As reading and math scores for elementary students continue to decline across the nation, educators are faced with the need to research instructional practices that will target and improve students’ engagement in and academic success with these foundational subjects. Most of the
educational focus in recent years has been on the decline of students’ ability to read literature and academic texts (Green & Goldstein, 2019). However, across all demographics, math is emerging as a major concern especially since the lowest performing students are actually doing worse on math achievement (Camera, 2019).

The National Assessment of Education Progress (NAEP), or the Nation’s Report Card, confirms that elementary and middle school students in both public and private schools are underperforming in overall math achievement (Camera, 2019). The problem is not with the teachers; it is in the way that math must be taught due to the expectations of standardized tests which presents unreasonable expectations for teachers therein (Venezky, 2018). The pass rates on end-of-the-year standardized tests for third grade students specifically in Virginia align with the aforementioned poor performance ratings as reported by the NAEP. According to the Virginia Department of Education Standards of Learning (SOL) test scores, the three-year report indicates the following pass rates for third grade students: 2016-2017, 75%; 2017-2018, 73%; and 2018-2019, 82% (SOL Test Results, 2019).

Although the 2018-2019 scores show a slight increase (9%) from the previous year, achievement in math still remains as a national concern (Bodovski, Byun, Chykina, & Chung, 2017). Accordingly, Virginia’s Mathematics Standards of Learning address the need to raise achievement with standards and curriculum that “challenge students to maximize their academic potential and provide consistent monitoring, support, and encouragement to ensure success for all” (Mathematics Standards of Learning, p. vii). The SOLs provide an organized framework for teachers so they can raise academic achievement for all students to prepare them for college and future careers (Mathematics Standards of Learning, p. iii).
To address the poor achievement in math, educators are re-evaluating their current ways of thinking to devise innovative, research based instructional practices that will help students to better understand math content and computation skills (Bachman, Votruba-Drzal, El Nokali, & Heatly, 2015). Besides educators’ efforts, The NCLB initiatives and policies of 2001 focused on student engagement and academic success. States were required to test every student annually to raise achievement in reading and math, and in turn, schools would receive federal funding. Schools were expected to set annual achievement goals so that 100% of students would reach proficiency by 2014, and the results of these tests pushed educators to set high academic standards to meet Adequate Yearly Progress (AYP) (Ladd, 2017). However, over time, the academic rigor and high stakes testing decreased student motivation to learn (Markowitz, 2018).

The excessive regulations and strict expectations of NCLB created unrest and controversy in educators’ perspectives of teaching and learning (Heck & Chang, 2017). The federal influence over teachers’ instructional decisions caused teachers to be less motivated to create and implement engaging and enjoyable lessons (Powell, Higgins, Aram & Freed, 2009). Being held so highly accountable to the policies in order to obtain Title 1 funding caused teachers to feel pressured and resistant to change, and their relationships and connections with the students that they taught were also affected as the focus on achievement was at the forefront of their daily work (Heck & Chang, 2017). Moreover, since states were unable to attain the NCLB proficiency mark of 100%, continued uncertainty and confusion amongst educators and stakeholders about accountability standards and testing emerged (Deming & Figlio, 2016).

Although NCLB is no longer in existence, student engagement in and motivation for math still remains as an area of concern for educators especially since many students’ attitudes towards math are negative, and with these negative attitudes comes anxiety, hopelessness, and
avoidance of work (Larkin & Jorgensen, 2016). Teachers spend too much of their instructional time preparing students for the rigors of the standardized tests, and as a result, students are not retaining and applying necessary math skills for future use (Venezky, 2018). Along with the aforementioned are students’ self-perceptions of themselves as learners. When students are not confident in their abilities, they are less likely to focus on the rigor of academics (Prast et al., 2018). A lack of enjoyment in the process of overall learning affects intrinsic motivation, too. When students are not motivated due to a lack of interest in a non-preferred task or activity, they are less likely to stay engaged in it (Lohbeck, 2016).

Educators emphasize the need for students to be mathematicians and not just memorizing facts and formulas (Martin & Rimm-Kaufman, 2015). Putting math into action while solving real world problems gives meaning to math so that students can gain better insights and connections to the perceived need for mathematics (Metzger, Sonnenschein, & Galindo, 2019). Moreover, math problems that stretch students in their thinking and reasoning skills are needed to expand students’ cognitive capacities (Russo & Hopkins, 2017).

Elementary schools that partner with local middle and high schools, colleges, and universities for mentoring and tutoring are becoming more commonplace as teachers anticipate positive relationships and connections therein (Carr & May, 2019). Creating collaboration beyond the walls of the school is sometimes necessary as teachers recognize the value that these interactions can bring to the educational experience. For example, young, impressionable elementary students who travel to a nearby middle school for one-to-one science experimentation and lab activities with older middle school students gain important science and collaboration skills (Smith, 2019). Also, elementary students who have a one to one mentoring and
instructional partner from a nearby college experience positive relationships and connections to build confidence and motivation towards specialized math projects (Carr & May, 2019).

Beyond traveling to other schools and colleges for partnerships and instructional assistance, virtual opportunities are opening up for both students and teachers. The influx of modern technological advances such as Skype, Google Hangouts, and FaceTime offer experiences that can enhance teaching and learning (Carr & May, 2019). Teachers’ abilities to converse with other teachers and specialists are more readily available, and efficiency of coaching and professional development is increased through these virtual relationships (Leighton, et al., 2018). Through the use of digital tools, additional resources and expertise can be secured from other educators in distant locations.

Not only do teachers benefit from virtual discussions with colleagues but also students who connect with college students in teacher preparation programs. Working with college students is motivating and intriguing for young, impressionable students as they establish trusted and caring relationships with their mentors (Carr & May, 2019). College students gain valuable experiences in building rapport with young students and practicing their teaching skills (Brett, O’Merle & White, 2017). Third and fourth grade students in virtual math mentoring partnerships demonstrate engagement in positive relationships with college student mentors and increased motivation for working and completing math problems (Carr & May, 2019). A winning partnership between a college program and a school evolves as college students who mentor younger students acquire leadership skills and invest in active contributions to future generations (Hastings, Creswell, Griesen, Dlugosh, & Hoover, 2015).

Innovative ways to improve students’ motivation for, engagement in, and academic success with mathematics is imperative. Policies and state mandates for student competencies
have been, and will continue to be implemented as student academic achievement is expected. It is critical that teachers understand not only the instructional guidelines in regard to teaching the local and state math standards but also what is needed to motivate and inspire students for better attitudes and overall success in math (Larkin & Jorgensen, 2016).

**Conceptual Framework**

Many studies have been conducted to explain human motivation, and five contemporary motivation theories remain at the forefront: expectancy-value, attribution, social-cognitive, goal-orientation, and self-determination (Cook & Artino, 2016). Vroom’s Expectancy-value model of motivation is based on the idea that people are more intrinsically motivated to work and achieve if they feel there is value or enjoyment in the work or activities before them (Lunenburg, 2011). Specifically, “motivation is a function of the expectation of success and perceived value” (Cook & Artino, 2016, p. 997). This theoretical framework is most closely aligned with the work in this study since intrinsic motivation is being investigated as a determinant to math achievement. Students’ intrinsic motivation to engage in work and activities is a major factor in their academic achievement and overall school functioning (Weidinger, Steinmayr, & Spinath, 2017). Moreover, students who literally own their learning in a Student Centered Learning (SCL) approach are more engaged in and motivated for work and activities (Lee & Hannafin, 2016). When students have a positive academic self-concept, it influences their scholastic achievement (Schmidt et al., 2017).

Similar to this study, other studies have been built on the expectancy-value model where students’ self-control, awareness of the learning environment, and motivation to learn are the precursors to their academic achievement. Galla, Amemiya, and Wang (2018) surveyed over 2,620 middle and high school students asking them how intrinsic value, utility value, and expectancy beliefs impact their academic success. Their study confirmed that students who
understand the value of the tasks that they need to complete and who are more motivated to learn demonstrate higher academic achievement.

The expectancy-value theory was further examined in another study where test taking motivation and achievement were measured with over 40,000 ninth grade students in Germany. Researchers in this study used Likert scales to design surveys to ascertain students’ perceptions and beliefs of themselves as learners, their motivation to learn, and their understandings of the value of the subjects that they studied. The researchers determined that students performed better on achievement tests when they were motivated to understand the content and believed in their abilities to perform well on tests (Penk & Schipolowski, 2015).

**Problem Statement**

A common problem in elementary schools today is how to best meet students’ academic needs, while at the same time motivating them to want to participate in math especially when they feel they are inadequate or anxious (Prast et al., 2018). Larkin and Jorgensen (2016) reiterate this sentiment when referring to their work with primary students and their literal *checking out* when participating in math classes. Students are "psychologically opting out by distancing themselves emotionally and attitudinally from mathematics" (Larkin and Jorgensen, 2016, p. 926). This is a problem because lack of engagement in and motivation for math leads to lower achievement on standardized tests (Stenlund, Lyren, & Eklof, 2018). Additionally, lower achievement impacts students’ initial and future math successes (Weidinger et al., 2017). Acquired math skills and mathematical competence leads to higher levels of future employment and money management, too (Greene, Tiernan, & Holloway, 2018).

On the front lines of the work that is being done with students, teachers express frustration and confusion as they not only do not know how to effectively motivate students, but
they also fear that their instruction is ineffective for students' comprehension of number sense, computation, and basic math skills (Prast et al., 2018). The problem is gaining more attention as the decrease in mathematical competency is evident through local, state, and national reporting measures. Teachers need to be proactive in addressing the negative attitudes and poor performance of struggling math students. Innovative, creative, and multisensory practices and programs are the first step. Next, teachers can develop partnerships with influential and educational community resources that can give additional support and instruction for students (Carr & May, 2019).

The problem is that the literature has not fully addressed the impact of virtual math mentoring programs by college students on math achievement in elementary school students. Students who do not see the benefits of or who do not enjoy math will be less likely to want to complete math work. Designing and implementing virtual partnerships between college students and elementary students is critical in resolving the problem of poor math achievement.

**Purpose Statement**

The purpose of this quantitative, quasi-experimental study with a pretest/posttest nonequivalent control group design was to determine if third grade students who participated in virtual math mentoring programs with college students in teacher preparation programs demonstrated increased gains on standardized math assessments due to the specialized interventions provided by the college students. Virtual math mentoring includes preservice college teachers virtually connecting with elementary students through Zoom or other school approved virtual platforms. In both face-to-face virtual meetings and independent activities assigned to elementary students through Seesaw, an online educational tool, virtual math mentoring can take place. The independent variable was virtual mentoring, the dependent
variable was student scores from Performance Matters 3rd Grade Math Assessments, and the covariate was the pretest scores on the Performance Matters 3rd Grade Math Assessments. The sample was third grade students from four rural elementary schools in Northwest Virginia.

**Significance of the Study**

Besides the theoretical significance of the Expectancy-value framework as previously discussed, there is also practical and empirical significance to this study. Analyzing students’ motivations to learn guides the researcher in targeting programs, activities, and methods that fuel student interest and engagement in learning. Traditional methods of classroom learning such as memorization of math facts and completion of math worksheets are ineffective in advancing students’ achievement in math. Students need to be connected to their learning and understand the value of what they can and should learn so they can be more invested in it (Prast et al., 2018). This study will contribute to understandings of the importance of elementary students’ connections to their learning and if increased motivation leads to higher achievement.

Opportunities to problem solve with higher levels of cognition and reasoning power fuels students’ engagement in and motivation for math (Russo & Hopkins, 2017). When students communicate with peers, teachers, parents, or others about a mathematical problem and discuss the necessary steps to complete it, they are better focused and intentional with their efforts. Besides establishing positive relationships with younger students, college student mentors can contribute to mentees’ math fluency and computation skills through specialized programs such as “Say All Fast Minute Every Day Shuffled” (Greene et al., 2018). The practical implications of this program are evident as students own their learning while being encouraged to increase their response rates to mathematical facts as presented by their college mentors. Like this study, students’ interaction and communication with college students can potentially yield increased
motivation to complete math tasks, and in turn, achieve math success which is one way my study will add to the current research.

Virtual math lessons are on the rise with the advances in technology, and more public and private school systems are participating in these to better motivate students to learn (Kanna, Gillis, & Culver, 2014). Also, since students are eager to learn in more active and interesting ways, they migrate towards enjoyable math games and activities. With computers and iPads, they are exposed to technology with various game base learning tools (Kim, Ke, & Paek, 2017). Again, these virtual opportunities provide practical means for students to actively focus on math concepts in ways that hold their attention and help them to enjoy the math tasks at hand. The current study will provide additional knowledge on the value of math games and activities that are delivered in a virtual way through the college and elementary students’ partnerships.

From an empirical standpoint, this study correlates motivation to learn with pretest and posttest scores on standardized assessments. Other researchers recognize this need to have more specific data to validate their hypotheses concerning student motivation and academic achievement. Evaluating students’ perceptions of their abilities and motivations to learn has been achieved through surveys and other qualitative measures (Albrecht & Karabenick, 2017). Quantitative studies, such as one by Guo, Marsh, Parker, Morin, and Yeung (2015) reveal data that supports the expectancy value theory that motivation to learn leads to improved scores on standardized tests. Gender and socio-economic status were contributing factors in their study of eighth graders as they examined students’ motivation to learn and their achievement scores on the Trends in International Mathematics and Science Study (TIMSS) global assessments. These scores were shown to increase as a result of students’ desire to engage in math (Guo et al., 2015). Adding to the aforementioned information, the current study will unveil student pretest and
posttest scores that differ as a result of increased motivation to engage in math with help from college students’ virtual lessons.

Another similar study with empirical significance involves the use of video games to motivate students to better engage in math. Despite the arguments that video games consume too much of students’ time, these researchers discovered through their meta-analysis that pertinent math activities in the form of video games not only increased pre-k through 12th grade students’ motivation to engage in math, but also higher learning gains were achieved based on pre and post testing using commercialized and standardized tests (Tokac, Novak, & Thompson, 2019). Other game based learning (GBL) studies revealed positive correlations between “learning by doing” math games to higher levels of motivation for math and increased gains on beginning of and ending of the year learning assessments (Trajkovik et al., 2018). Their end-of-study data shows how a shift in pedagogy and instructional practice with Macedonian elementary students through this “Grandma’s games” project improves student engagement in and motivation for math. This study will add to this information as it will clarify and synthesize ways that the virtual math interventions through a games based approach positively impacts student learning and achievement.

A forward thinking, innovative, and research based methods math program is necessary in elementary schools in order to meet the diverse needs of learners. When teachers actively and quickly address the deficits in and lack of motivation for math, students have a greater opportunity for future achievement (Greene et al., 2018). Across the grade levels, national and state mandates and initiatives should be re-examined and researched so that more reasonable and achievable standards of learning are devised (Weidinger et al., 2017). New knowledge will lead to the “improvement of educational practice” (Gall, Gall, & Borg, 2007, p. 3). Administrators
should also be proactive in focusing on instructional improvement and innovative practices in math (Rigby et al., 2017). Future goals for third grade mathematics instruction are in the hands of lawmakers and policy makers who are not on the frontlines of instruction. Teachers, along with other research based practitioners, can work together to create math standards that develop critical thinking skills and not negative attitudes.

This current study contributes to better understandings of not only how to better engage and motivate students to learn concepts but also how improved motivation and instruction leads to increases in math achievement. In the meantime, reacting with criticism and negativity towards the prescribed educational mandates and standards is futile. Teachers and administrators should respond with thoughts, ideas, and research that moves our educational system towards solutions for better student engagement, competency, and performance (Niklasson, 2017).

Research Question

**RQ:** Is there a difference in math achievement among third grade students who participate in a math mentor program and those who do not when controlling for prior math achievement?

Definitions

1. **Intrinsic motivation**- students are not motivated due to a lack of interest in or lack of enjoyment of a task or activity (Lohbeck, 2016).

2. **Checking out** – students are "psychologically opting out by distancing themselves emotionally and attitudinally from mathematics" (Larkin & Jorgensen, 2016).

3. **Performance Matters** –test used to determine students’ understanding of Standards of Learning content material (PowerSchool, 2020).
4. *Virtual math mentorships (VMM)* – preservice teachers in a college program use interactive digital methods to virtually connect with elementary students to motivate and instruct students in math.
CHAPTER TWO: LITERATURE REVIEW

Overview

Since math achievement scores have been declining, educators who recognize student deficits in math achievement look for ways to improve student engagement in and success with math skills. When teachers diagnose the areas of weakness in math, they seek meaningful, impactful ways to encourage students to be motivated to complete math activities and tasks. They often look for creative and innovative ways to not only guide students’ understandings but to also increase their connections to math. The focus on virtual math mentorships with college students is one method of motivating elementary students to engage in and learn math. This chapter will offer a discussion of the conceptual framework that grounds this study along with an in depth review of related literature that aligns with motivational strategies for elementary students. A summary of the literature will follow that will make connections with the various literature components and gaps therein.

Conceptual Framework

Driving this study is the conceptual framework offered by Victor Vroom (1964) who postulated his theory of motivation in conjunction with value that people place in the work that they do. In his Expectancy-value theory, Vroom suggests that if people are motivated to complete a task or work, and if they recognize the value of the work or task they are completing, they will be more successful in completing the task (De Simone, 2015).

Related to Vroom’s framework, the foundation of this study rests on the power of motivation and how it can lead students to increased engagement in math. To achieve the level of motivation needed to complete math tasks, this study examines how virtual mentoring programs with college students in teacher preparatory programs fuel elementary students’
motivational skills to better connect them to math activities. Furthermore, elementary students’ understandings cannot only be increased, but also students can recognize the value of math and eventually, show gains on math achievement tests.

**Related Literature**

Similar expectancy value framework studies have been investigated to guide our understandings on how elementary students best learn math. Poor math achievement can result when students are not motivated to learn or when they feel that math has no value. The combination of poor motivation to learn along with seeing no purpose in learning is a recipe for poor achievement in most students (Putwain, Nicholson, Pekrun, Becker, & Symes, 2019). Moving past strict state guidelines and rigorous standardized tests into a realm of support and encouragement gives students better opportunities for mastery and academic success and less procrastination or avoidance of work (Wu & Fan, 2017). The depth of literature as it relates to this study is expansive as it includes various levels of supports, interventions, and innovative practices that ultimately help students to be motivated and more engaged in math. This literature review will add to the body of background knowledge of how students best learn and under what circumstances they are motivated to pursue difficult subject matter for eventual academic success.

**Motivation to Learn**

To better understand why students engage in learning, a review of various aspects of students’ backgrounds, motives, goals, and mindsets is necessary. From the influence of peers and family to how students perceive themselves as learners, the range of factors is diverse. Not all students come to learning with a desire to learn, and the design of the learning spaces that students enter may not be suitable for everyone (Nolen, Horn, & Ward, 2015). Through
observations, conversations, and data collection, teachers should be aware of the aforementioned social, contextual, and situational aspects when planning lessons for students in order to meet students where they are and motivate them for learning (Nolen et al., 2015).

Lohbeck (2016) emphasizes the difference between students’ intrinsic and extrinsic motivations to learn. When students are intrinsically motivated to learn, they are highly interested in the subject matter and will stay engaged in the work therein. Extrinsically motivated students are less interested in the subject matter but will continue working for an eventual reward such as good grades and peer connections (Lohbeck, 2016). If good grades become the emphasis for learning, students’ connections to the real world and overall project based learning decrease which can lead to a decline in intrinsic motivation (Laur & Ackers, 2017).

Intrinsic motivation and learning-related motivation is not consistently related to good grades; it is more closely connected to students’ enjoyment in the subject matter at hand, especially with students in elementary school (Weidinger et al., 2017). While comparing students’ engagement in learning in other areas of the world, researchers focused on elementary students in grades 4 - 8 in Kenya and Italy. In their study, they determined that school motivation can be revealed through: (1) intrinsic motivation, (2) extrinsic motivation, (3) academic self-concept, (4) causal attribution, and (5) motivation. Kenya’s students ranked higher on intrinsic motivation, extrinsic motivation, and self-concept, and Italian students ranked lower on intrinsic motivation (Sini, Muzzulini, Schmidt, &Tinti, 2017).

Another way that intrinsic motivation can be viewed is through the natural curiosity that students bring to learning (Laur & Ackers, 2017). When students are given a variety of learning opportunities and experiences, their natural curiosity is sparked, their focus on the learning tasks
is deeper, and their involvement in learning can increase. Spending time in play related educational activities that are not only enjoyable but also relevant to the child’s interests activates intrinsic motivation to learn (Laur & Ackers, 2017). Students’ creativity, desire to learn, positive attitudes, and sense of adventure is buoyed by teachers who develop healthy and trusting relationships with them, all of which leads to an increased motivation to learn (Koca, 2016).

Enjoyment in learning is important, and if students do not enjoy the learning process, they are less likely to retain the expected content of the curriculum (Nesloney & Welcome, 2016). Relevancy to the subject matter cannot be overlooked; however, keeping students’ highly interested is critical. Following the ARCS model as described by Souders (2020), students can be more motivated to engage and achieve with the following prescription: (1) arousing interest, (2) creating relevance, (3) developing an expectancy of success, and (4) increasing satisfaction through intrinsic and extrinsic rewards. Mundane tasks need to be brought to life for students to stay focused, alert, and engaged. To optimize and promote intrinsic desires to learn, every moment of instructional time should be devoted to purposeful, content based, and enjoyable lessons (Nesloney & Welcome, 2016).

Parents can also be instrumental in guiding their children in motivational learning opportunities. In a study funded by the Swiss National Science Foundation (SNF), elementary students and their parents were surveyed to determine how their support, or lack thereof, impacted the children’s motivation for and success in mathematics (Dinkelmann & Buff, 2016). The five-year study with 457 students and their parents showed that parental support, warmth, encouragement, and structured help with math increased students’ competence beliefs and their intrinsic motivation for math (Dinkelmann & Buff, 2016).
Individual differences are examined to determine why some students are more motivated to learn than others (Malmberg, Pakarinen, Vasalampi, & Nurmi, 2015). Through Learning Every Lesson (LEL) projects, situation specific motivations can be evaluated with autonomous versus controlled experiences. Examining students’ beliefs about themselves as learners combined with teacher rating scales gives better clarity to what motivates students to learn. Similar to learning intrinsically, autonomously motivated students experience enjoyment and interest in learning. On the other hand, students who seek controlled experiences are extrinsically motivated to learn (Malmberg et al., 2015).

Academic self-concept (ASC) is analyzed for students’ perceptions of their own abilities. This frame of reference guides educators on how to best motivate students in all subject areas (Schmidt et al., 2017). Competence beliefs and task values are related, and motivation for achieving is increased when students feel they are capable (Rosenzweig, Wigfield, Gaspard, & Guthrie, 2018). Emotion awareness helps high school students to detect how they are feeling in various learning situations so they are better able to self-regulate and change their behaviors in response to learning (Arguedas, Daradoumis, & Xhafa, 2016).

The Myself-As-a-Learner Scale (MALS) can be used to assess student academic self-concept to better prepare and guide teachers in their instructional practices for motivating students to learn (Frost & Ottem, 2016). From students’ feedback, teachers can adjust their attitudes, instruction, and feedback to students (Arguedas et al., 2016). University students in a marketing class at a large German university are better motivated to learn and achieve when they see and hear an enthusiastic instructor (Frenzel, Taxer, Schwab, & Kuhbandner (2018). Students read positive cues from their teacher such as emphatic speech, eye-contact, demonstrative gestures with hands and arms, smiles and laughter, and high levels of energy. Displayed
enthusiasm and motivation by the teacher yielded more positive student-to-teacher interactions and student achievement (Frenzel et al., 2018).

**English language learners.** For English Language Learners (ELL), learning English language is also better achieved by highly motivating and engaging teachers (Kurt & Kurt, 2018). Teachers who follow detailed lesson plans along with specialized motivational activities are able to help students to not only acquire language skills but also to make better gains in academics and attendance (Kurt & Kurt, 2018). Closely following students’ individual desires and goals for learning English along with their overall learning patterns and emotional states help teachers to provide enjoyable educational opportunities for ELL students (Saito, Dewaele, Abe, & In‘nami, 2018). Higher levels of language acquisition are attributed to more motivating teachers who are highly tuned in to students’ age, pronunciations of new words, and comfort levels in their natural settings (Saito, 2018).

In Rwanda, students’ intrinsic motivation was tapped into by educators to increase their focus and engagement to learn English (Takahasi, 2018). Over 1,200 students participated in a 34 question survey to determine what best motivates them. By far, praise led to more intrinsic levels of motivation and increased success with acquiring English speaking skills (Takahashi, 2018). When teachers welcome students’ perspectives, feelings, and personal experiences, motivation to learn a second language is increased (Sieglova’, 2019).

Czech Republic Schools students’ autonomy and opportunities to make decisions about their learning is maximized, and as a result, they are more motivated to engage in learning (Sieglova’, 2019). When students’ perspectives, feelings, and personal experiences are given priority related to new subject matter, they are more likely to be connected to and enjoy the learning experiences therein (Sieglova’, 2019). Similarly, Chinese students make greater gains
in learning English when both the classroom teachers and English medium instruction (EMI) programs work hand-in-hand, fine tuning their efforts to understand the students’ needs and motivations therein (Jiang, Jun Zhang, & May, 2016).

**Gender.** From the results of a questionnaire in a research study in Israel, 129 ninth grade students (67 males and 62 females) reported gender related differences in motivation to learn. The research showed that girls are more likely to report their teachers as supportive of them in their work and overall emotional experiences (Katz, 2016). Contrary to this study is one conducted by Thomas (2017) where males are recognized as “science-is-males” (Thomas, 2017, p. 35), and these stereotypes and implicit biases can be detrimental to females’ motivation to learn science. Robotics competitions in the United States reveal higher levels of female participation in programming in the early years; however, as students get older, more males are involved in the higher level programming and competitions (Witherspoon, Schunn, Higashi, & Baehr, 2016).

Gender differences in motivation to learn with university students has been investigated in the United Kingdom where academic motivation, performance goals, self-efficacy, and active learning strategies were analyzed for both males and females (Pirmohamed, Debowska, and Boduszek, 2016). Males were shown to rely on and be motivated by all of the aforementioned areas, whereas females’ self-efficacy was the main predictor of achievement and motivation (Pirmohamed et al., 2016).

The attitudes and stereotypes of primary teachers impacts the motivation and competencies of young students as early as preschool (Wolter, Braun, & Hannover, 2015). When preschool teachers adopt the idea that “reading is for girls” (Wolter et al, 2015), this attitude transmits to boys who are perceived as less competent in reading. As a result, by the
time that students reach first grade, male students’ motivation to read was as expected: less than females. (Wolter et al., 2015).

**Socio-economic status.** When students perceive that they are discriminated against or are not privileged due to their lower socio-economic status, they are less likely to be motivated to academically achieve (Banerjee, 2016). From 771 studies conducted using preferred reporting items for systematic reviews and meta-analysis (PRISMA), underprivileged students are shown to be less engaged and motivated to learn due to a lack of positive environment and support (Banajee, 2016). In a study in China with the China Education Panel Study (CEPS), although a family’s socioeconomic status greatly impacts student learning and achievement in school, teachers are the key adults that can make a positive difference through daily motivational interactions in class (Liu & Chiang, 2019).

The IMC Skyhigh! Program involving 7 and 8 year olds in Sydney, Australia considered students’ actions such as looking, doing, listening, and proximity to others. From this, lower socio-economic students were able to better connect to their learning. These closer connections gave students an increased motivation to learn, and in turn, their academic achievement improved (Yoo & Loch, 2016). When educators are highly tuned in to students’ learning styles and needs, they can better plan specialized activities to help less privileged students to be involved in richer, sensory oriented encounters and experiences (Yoo & Loch, 2016).

**Extrinsic motivation to learn**

When students’ motivation to achieve is dependent on earning good grades, receiving money, or gaining praise and recognition, this is an extrinsic motivation to learn (Cherry, 2020). At the onset, extrinsic motivators can spark interest and a high level of engagement; however, over time, endurance and actual enjoyment of the learning process is diminished (Souders,
Ethical concerns arise when students are given cash for grades as coercion and corruption have been examined closely in recent studies (Warnick, 2017). The dilemma between receiving rewards for making progress versus a more personal desire to be highly engaged in meaningful learning remains a topic of controversy (Warnick, 2017).

Reading achievement can be analyzed through students’ curiosity, involvement, and competition, and extrinsic motivators related to outperforming each other’s reading amounts is less impactful on students’ reading success (Stutz, Schaffner, & Schiefele, 2016). The positive correlations between students’ motivation to read and reading comprehension are documented as students make greater gains in reading performance when they are encouraged to read more often (Troyer, Kim, Hale, Wantchekon, & Armstrong, 2018).

**Lessons in Nature for Motivation to Learn**

Beyond the walls of the school, outdoor learning spaces provide new opportunities for primary students to learn in flexible and creative ways at the Forest schools in England and Wales (Harris, 2017). For optimal learning of science concepts such as plants and animal life, students should be outside to experience nature and learning first-hand (Borsos, 2018). Eleven-year-old Serbian students demonstrated better understandings of and engagement in learning when they participated in the “Which plant am I?” game. Through this interactive and enjoyable opportunity, students not only spent a great deal of time outdoors, but they also gained a newfound appreciation for the plants around them (Borsos, 2018). Students who participate in Outdoor Education Programmes (OEP) demonstrate gains in motivation to learn, social and personal development, and physical activity (Becker, Lauterbach, Spengler, Dettweiler, & Mess, 2017).

**Recess and Motivation to Learn**
The 21st century’s social changes and urbanization has given way to students spending less time in outside recreational activities resulting in a more sedentary way of life (San Pedro Veledo et al., 2018). Pre-service teachers at the School of Teacher Training and Education at the University of Oviedo in Spain learn how to create lessons that use physical activity and a focus on the environment for optimal student engagement and learning (San Pedro Valedo et al., 2018).

Playing on the playground or running on the track are part of a regular school day for most students around the world. The concern that too much play can break a student’s concentration for academic tasks has been questioned by educators and parents (Kuo, Browning, & Penner, 2018). Taking learning to the outdoors shows positive results as noted by a study in an environmental magnet school in Midwestern United States (Kuo et al., 2018). Education Outside the Classroom (EOTC) is a method that Danish teachers can use to encourage outside learning, and in turn, physical activity, well-being, social relationships, and motivation to learn are increased (Nielsen et al, 2016).

**Perspectives from Motivational Strategies in Reading**

Even though motivation for and achievement in math is the focus on this study, other interventions, supports, and individual differences in learning styles have been investigated to determine their impact on student engagement and learning (Malmberg et al., 2015). Reviewing these studies is necessary as the strategies and practices that have been implemented are instrumental in guiding our understandings of how to encourage students to be more motivated to do math. Since reading is another core subject, understanding the intrinsic and extrinsic motivations for students to read is helpful as it relates to motivation to learn math (Stutz, Schaffner, & Schiefele, 2016).
Teachers’ roles. Motivation to engage in learning is necessary for students to be academically successful (Vroom, 1964). Attitudes towards subject matter can be improved with a variety of innovative and motivating practices. Beyond working with parents to help their children with early reading and literacy skills, some researchers focus on teachers’ development of students’ self-determination skills. Teachers who are strategically trained on how to motivate students in reading are better able to implement a supportive and structured motivational program.

Differentiating instruction for students is also relevant to student motivation. When students are given more individual attention for the tasks they need to complete, they develop more confidence and competence (Guay, Roy, & Valois, 2017). A more predictable, supportive, classroom environment with individual supports in place builds student autonomy and motivation to work therein (Guay et al., 2017).

Literacy-rich dramatic play has a positive impact on kindergarten students from varying socioeconomic backgrounds in a study of two U.S. public schools. Students received their mandated literacy instruction along with teacher directed play activities in classroom games, recess, or free time. From this individualized specialty program, students are eager to participate in and ultimately be more motivated for literacy and pre-reading skills (Cavanaugh, Clemence, Teale, Rule, & Montgomery, 2016).

Fifth grade students who are motivated by their teachers to engage in at-home reading are more likely to not only read more but also have increased gains in self-determination and end-of-year reading growth test scores (De Naeghel, Van Keer, Vansteenkiste, Haerens & Aelterman, 2016). Concept-Oriented Reading Instruction (CORI) can be implemented by classroom
teachers to enhance reading motivation and reading tasks completion through programs like Reading Engagement for Adolescent Learning (Rosenzweig et al., 2018).

Authentic and enjoyable student learning is facilitated by teachers who closely monitor student engagement (Laur & Ackers, 2017). Activities related to reading include literacy centers, round table reading, and story sharing. When teachers observe and record student communications and interactions as a means of gauging student engagement, they can promote future reading activities that motivate students to read (Laur & Ackers, 2017). Students who feel supported in their efforts to read and comprehend are more confident in their abilities when authentic, effective support is in place by teachers (Rosenzweig et al., 2018). Australian teachers who provide opportunities for preschool children to frequently visit the library enhance children’s positive perceptions of reading and increase their reading frequency (Roni & Merga, 2019).

Elementary students who read to Reading Assistance Dogs demonstrate an overall positive change in attitude towards reading (Lenihan, McCobb, Diurba, Linder & Freeman, 2016). With improvements in attitudes and a more determined mindset, students are more likely to be motivated to engage in the work that they need to complete (Lenihan et al., 2016). Teachers who use a variety of classroom projects such as drama, Readers’ Theater, and literacy circles, along with collaborative techniques to immerse students in reading are more successful with motivating reluctant students to read (Capina, & Bryan, 2017).

**Siblings.** The influence of older siblings in encouraging and helping younger students to achieve is also noted by researchers. Knoester & Plikuhn (2016), in their research that focused on Gee’s Theory of Discourses and motivation to read outside of school, found that younger siblings were more likely to engage in and enjoy reading in school when being exposed to older
siblings’ encouragement and modeling of at-home reading practices. Time spent reading and engaging in other literacy based activities at home show positive effects on primary students’ motivation for reading and other emerging literacy skills (Colgate, Ginns & Bagnall, 2016). Interactive reading activities with siblings of all ages such as reading aloud or being read to provides social exchanges, fosters language development, and increases student reading performance. As a result, students are better prepared for reading with essential foundational reading skills and are more motivated to read therein (Merga, 2017).

**Parents.** Parent involvement in at-home literacy tasks is also more likely to occur with better results when teachers guide and support parents in their efforts with their children. Knowing not only what to read but how to effectively encourage, implement, and sustain at-home literacy skills is critical (Crosby, Rasinski, Padak & Yildirim, 2015). Homework for most subjects is often considered daunting for parents (Bergmann, 2017). Even though parents want what is best for their children, homework can seem meaningless and only assigned as busywork which creates anxiety for both students and parents (Bergmann, 2017).

Since homework should have a specific purpose and be meaningful, flipped learning in the form of short at-home instructional videos can be interactive, enjoyable, and viewed before class. In this, students are given information and clarity for the work that they will eventually do during their face-to-face meetings (Bergmann, 2017). When reading homework is too difficult or if the value of it is not recognized, students not only are unmotivated to complete it, but they are also more likely to ignore it (Bergmann, 2017).

**Math Anxiety**

Another aspect of poor motivation to engage in school work of any type revolves around anxiety. Anxiety is prevalent in students, teachers, and parents, and when it is related to math, it
can cause a lack of enjoyment in and focus on word problems, computation skills and other math related tasks (Mutlu, 2019). Math anxiety is a worldwide problem affecting students and adults of all ages (Luttenberger, Wimmer, & Paechter, 2018). Although a variety of other variables contribute to anxiety for math, the psychological impact of feeling concerned about completing math tasks fuels student frustration therein (Luttenberger et al., 2018).

**Students.** Math anxiety can be described as tension and apprehension that interferes with students’ abilities to complete math problems (Yilmaz, 2019). Anxiety towards math is highly prevalent and is related to students’ perceptions of math as useless, senseless, and nonessential (Ramirez, Shaw, & Maloney, 2018). When students, both primary and secondary, are concerned about having to complete math related tasks, they are less likely to be successful with math achievement, especially if they perceive that they fail when it comes to math (Sorvo et al., 2019). As students with math anxiety encounter math problems that are both easy and difficult, their first response is usually resistance and procrastination. This, in turn, contributes to continued postponement of other academic tasks such as homework or exam preparations (Luttenberger et al., 2018).

Although assessing math anxiety in primary students is somewhat new, the *Early Elementary School Students – Abbreviated Math Anxiety Scale* (EES – AMAS) was developed as a scale suitable for assessing math anxiety in young children (Primi’, 2020). Better understanding the obstacles that students encounter and how it leads to math anxiety is the focus of the EES – AMAS scale. From the study, math performance was negatively impacted by math anxiety as determined from the group analysis and new measurement scale (Primi’, 2020). Third graders who completed a math anxiety scale and math achievement test revealed there are no major gender differences when it relates to math anxiety; however, when anxiety is present,
achievement is negatively impacted (Mutlu, 2019). As anxiety is addressed and managed, struggling students are able to increase their working memories and be more fully engaged in math (Yilmaz, 2019).

**Teachers.** When teachers feel inadequate and anxious about teaching math, their negative attitudes are not only easily visible but also contribute to the students’ negative attitudes towards math (Luttenberger et al., 2018). If teachers’ math anxiety is decreased through interventions, student outcomes will be positively impacted (Ganley, Schoen, LaVenia, & Tazaz, 2019).

Similar to assessing students for math anxiety, teachers can also be assessed for their levels of tension related to understanding and teaching math (Ganley et al., 2019). Math Anxiety Scale for Teachers (MAST) was developed to identify educators’ emotions, tensions, thoughts, and nervousness related to the teaching of math. From General Math Anxiety (GMA) to anxiety regarding math instruction, teachers, both pre-service and seasoned, are given the MAST to identify their triggers and better guide their future math instruction (Ganley et al., 2019).

**Parents.** Like their children, parents voice concerns about math especially as it relates to homework (Nesloney & Welcome, 2016). When parents are anxious about math, this negatively impacts their child’s attitudes towards math. This leads to poor math achievement, inability to complete at-home math tasks, and overall math concept development (Luttenberger et al., 2018).

Through surveys, parents convey their concerns about math and other anxiety related issues. They report that they are less likely to help their children with math homework when they are frustrated with math (Maloney, Ramirez, Gunderson, Levine, & Beilock, 2015). Involving parents in math fair preparations at home not only builds rapport with them, but it also
gives them opportunities to authentically connect with math in enjoyable and meaningful ways (Nesloney & Welcome, 2016).

**Collaboration with Others for Interventions and Supports**

The diverse role of teachers and assistants cannot be overlooked when analyzing student engagement in learning. Motivating students to see the value of the subject matter that they need to learn can be challenging for teachers, especially since they are adhering to the prescribed, methodical, and rigorous curriculum (Venezsky, 2018). Reaching out to other sources is often necessary as teachers are on the frontlines of not only teaching the mandated curriculum but also searching for ways to motivate and encourage students to engage in learning (Metzger et al., 2019).

**Community partnerships.** Kolbe, Allensworth, Potts-Datema, and White (2015) suggest that schools and communities should be partnered to benefit students’ health, safety, and educational trajectories. Their Whole School, Whole Community, Whole Child (WSCC) Framework includes ways that community organizations can work together to help schools with improving students’ overall well-being and their academic engagement and total school experiences. From financial assistance to specialized programs at the college or university level and other local educational agencies, specialists in these areas provide health education, youth development, and academic support, all in line with assisting and motivating students (Kolbe et al., 2015).

Similarly, Israel, Goldberger, Vera, and Heineke (2017) studied the benefits of university and school partnerships and collaboration in their work with migrant and refugee children in Chicago, IL. From their meaningful educational opportunities to their encouragement and
support for academics and the future, the high population of the aforementioned students experienced greater success in their acclimation to school and with academics therein.

Another community connection that offers positive adult role mentoring and assistance with engagement in and success with learning is Big Brothers Big Sisters (BBBS). BBBS is the oldest and largest youth mentoring organization in the United States where mentors help mentees to develop academic and social success (Mitchell, 2019). Mentored youth experience fewer behavioral problems and stronger coping skills as they are offered praise, educational opportunities, in-depth communication skills, and pro-social behaviors with a caring and positive adult (DeWit, DuBois, Erdem, Larose, & Lipman, 2016).

Other experts in the community include local businesses and historical societies where students are given opportunities to engage in real world learning (Laur & Ackers, 2017). Authentic ways to engage in project-based learning not only builds rapport with the local community, but it also gives students a feeling of pride as they are learning in the context of community agencies (Laur & Ackers, 2017).

University partnerships. Villa and Thousand (2017) emphasize the need for partnering with resources outside of school to foster and facilitate additional learning opportunities for students. They purport how these partnerships can be mutually beneficial especially with college students working with elementary students in clinical practices with enhanced, differentiated educational interventions (Villa & Thousand, 2017). Moreover, reciprocal benefits for elementary students and the future leadership and generativity of the college students is more likely to occur as college students prepare to be active contributors to the next generation. Mentoring opened the college students’ perspectives and gave the younger students a positive opportunity to communicate with a socially responsible adult (Hastings, et. al, 2015).
Paired peer learning is another avenue for college student and elementary student learning partnerships. Pre-service teachers in a local college who are paired with student engineers not only collaborate and communicate in positive, engaging, and enjoyable ways, but they also develop deeper critical thinking skills as they problem solve and learn more about the multifaceted aspects of engineering (Fogg-Rogers, Lewis & Edmonds, 2017). The active learning inherent in this program is not only more motivating for elementary students, but it also helps them to demonstrate better attitudes towards science and improvements on end of unit assessments (Fogg-Rogers et al., 2017).

Power Hour after school workshops and classroom interns for elementary students are two ways that pre-service teachers from a local university contribute to a collaborative partnership (Elburn, Cooper, & Conners, 2017). Salisbury University and Snow Hill Elementary School’s connections gave elementary students continued exposure to support and motivation for learning, and the pre-service teachers gained valuable and practical knowledge for first-hand teaching experiences. The Power Hour workshops also gave pre-service and experienced teachers a chance to connect and collaborate regarding student engagement and motivation (Elburn et al., 2017).

Other educational partnerships with local universities include research-practice partnerships (RPP) like the University of California Los Angeles (UCLA) Teacher Education Program and the UCLA Community School (Quartz et al., 2017). New school designs combined with innovative practices for instruction and student support are evident in these RPPs as pre-service teachers are exposed to this “teaching school” and the inner workings therein. High systems of accountability, mentoring, and instructional opportunities for teacher candidates is prevalent and beneficial for the elementary student recipients (Quartz et al., 2017).
Benefits of Technology

Beyond teacher, sibling, parent, and community supports and interventions are those that can be offered from technology with both specific programs and other online opportunities. An innovative mindset in devising and implementing creative computer lessons that fuel students’ desires to learn is critical (Couros, 2015). Since high stakes testing and rigorous accountability standards have historically driven curriculum and teaching practices, opportunities to engage in one to one technology has been investigated to determine if it impacts student motivation to learn and achievement. Since 2002, the NCLB Act expected that students would be more technologically literate; however, the impact on motivation to learn and overall academic achievement is still being investigated (Harris, Al-Bataineh & Al-Bataineh, 2016).

Technology can be added to infuse deeper learning opportunities in all subject areas and is used in a variety of ways in classrooms and in students’ homes (Couros, 2015). The use of technology creates a limitless world of learning in our schools (Nesloney & Welcome, 2016). Teachers in the 21st century are becoming more skilled at how to effectively teach while using technology, but they do require more opportunities to learn how to best integrate technology into their lessons (O’Neal, Gibson & Cotton, 2017).

Using technology gives teachers more opportunities to differentiate their lessons to meet the diverse needs of each student. In doing so, students are better engaged with the subject matter as it is designed to meet their individual learning needs (Harris et al., 2016). Students demonstrate a desire to use technology as they have become digitally strong since the onset of computer and iPad use. As these digital natives use technology, they are able to be exposed to a vast array of learning tools that are enjoyable, motivating, and easy to navigate (Cut, 2017).
One-to-one technology allows every student to use their own personal computing device for individualized learning (Lao, Cheng, Huang, Ku, & Chan, 2016). Using computer-supported self-directed learning (CS-SDL), second graders set their own mathematics learning goals based on teacher feedback and pacing of their individual portfolios. This form of technology gave highly motivated learners autonomy and increased motivation for completion of work (Lao et al., 2016).

Computer based learning tools such as PlantingScience (PS) use scientific inquiry, classroom instruction, and online science mentors to motivate students to engage in inquiry skills and to learn about science (Scogin & Stuessy, 2015). Vocational Education and Training (VET) students who have higher self-regulated learning strategies (SRL) and effort regulation demonstrate more involvement and engagement in online learning than classroom instruction, which in turn, increases their motivation to learn (Quesada-Pallares, Sanchez-Marti, Ciraso-Cali, & Pineda-Herrero, 2019).

Since students can easily understand and utilize the various features of computer programs and applications, they not only enjoy the work that they do, but they also perform better on reading, math, and other subject area achievement tests (O’Neal et al., 2017). Primary students in the Community Language Schools in Australia experience self-directed at-home learning with online educational games that help to promote early literacy development and language acquisition (Eisenchlas, Schalley, & Moyes, 2015). A game-based learning activity called SoLoMo that connects the real world to the digital world was developed by researchers in Taiwan where they expected to not only increase student engagement in learning but also to promote and support cultural education (Lin, et al., 2018). Seventh grade students who used a
fun, interactive, and competitive gamified interactive response system (IRS) were more energized and engaged in English language learning (Sun & Hsieh, 2016).

**Virtual Connections**

Beyond the walls of the classroom, teachers can use FaceTime to virtually collaborate to support and encourage each other for professional development opportunities (Leighton et al., 2018). Along with teachers, students can be connected with the outside world through virtual means. With virtual communication through Google Hangouts, elementary students can communicate with college students in a teacher preparatory program to gain needed motivation and encouragement to engage in math computation and number sense (Carr & May, 2019).

In a program called *Science Buddies*, 1st and 7th graders students met face-to-face for science experimentation, communication, and mentoring (Smith, 2019). This program gave students opportunities to hang out during the school day while both sets of students were in their respective schools. They did this though Google Hangouts, and as a result, students were not only able to do specialty projects together, but they also maintained positive relationships which motivated both groups to be more engaged in the science activities at hand. Teachers discovered that through the use inquiry skills, prediction, observations, and reflections through these virtual opportunities, some of the most unmotivated elementary and middle school students were excited to take on these new roles in the virtual partnerships (Smith, 2019).

Primary schools in Finland used virtual methods to teach science to first graders (Hautala et al., 2018). Narrated science presentations and virtual tours gave students deeper understandings of the science concepts being taught, and teachers reported higher levels of engagement and interest in science. Posttest assessments also revealed improvements in end-of-year science scores as a result of this virtual tutoring system (Hautala et al., 2018).
School-based virtual field trips (VFT) help to not only deepen students’ knowledge about other parts of the world but also help to make content learning enjoyable and engaging (Delacruz, 2018). Global opportunities that can be experienced in a virtual way can help to promote authentic learning, motivate students to learn about various aspects of the world, and help to develop them into global, responsible citizens (Delacruz, 2018). Other VFTs include student participation in physical activities such as ones in London primary schools (Norris, Shelton, Dunsmuir, Duke-Williams, & Stamatakas, 2015). Using Google Earth, students were able to virtually explore the London Olympics and events therein. Activity prompts for students to reenact the various sporting events were given, and students moved according to directions given. The VFT not only gave information about Olympics, but it also motivated students to learn in an active and enjoyable way (Norris et al., 2015).

Students ages 7 - 22 in Pamplona, Spain virtually learned about a famous artist, J. Oteiza through educational games and a trip to the museum to view his artwork (Bossavit, Pina, Sanchez-Gil, & Urtasun, 2018). Individual learning was promoted with the specialized and relevant educational games, and the virtual trip enhanced students’ engagement in the learning process while giving them deeper understandings of the abstract art concepts (Bossavit et al., 2018).

**Blended learning.** A combination of face-to-face instruction and a virtual learning environment (VLE) is the practice of blended learning (da Silva Marques Ribeiro, Oliveira, & Mello, 2017). In some Brazilian schools and colleges, blended learning serves as a tool for communication with others, interactive learning, and collaboration from home to school. Although elementary and middle school teachers are not adequately prepared to implement the
blended learning model, the benefits of student engagement and individualized learning are recognized and documented for future research (da Silva Marques Ribeiro et al., 2017).

English language learners benefit from virtual learning when they are given authentic contexts for language acquisition (Hsiao, Lan, Kao, & Li, 2017). Students at Pennsylvania State University were given three virtual world contexts (supermarket, kitchen, and zoo) and clicked on the various objects in each location. Pronunciations of the names of the objects were given along with audio files describing the words. The virtual visualizations and learning log entries showed increases in student motivation for learning a new language (Hsiao et al., 2017).

**Targeted Math Innovations and Interventions**

**Teachers.** On the frontlines of the daily work with students at school are the teachers who follow the expected curriculum and present the material in their own ways to help students to learn. Just as all students do not learn in the same ways, all teachers do not teach in the same ways. Recognizing and understanding the unmotivated students is imperative so that more engaging, enjoyable learning experiences are planned and implemented (Bachman et al., 2015).

According to the Executive Summary from the National Council of Teachers of Mathematics (NCTM), K-12 math teachers should do the following for students:

- hold high expectations and offer strong support
- provide a coherent, well-articulated curriculum
- understand what they know, support, and challenge them
- assess to gain useful information about learning
- help them to build on what they know
- use technology to enhance learning (NCTM Executive Summary).
This baseline knowledge should guide K-12 teachers in their approaches to instruction and potential ways to enhance student motivation for math.

According to Levy (2018), teachers who observe students, collaborate, and investigate innovative practices offer proactive solutions to help with the issue of math motivation:

- build confidence
- encourage questioning
- emphasize conceptual understandings
- provide authentic problems
- share positive attitudes about math

When students from various achievement levels perceive that they are capable mathematicians, they are more likely be successful with math (Prast et al., 2018). Besides students’ perceptions of their abilities with math is how they recognize the value of math and the processes therein. Tapping into opportunities for students to connect their math skills to everyday experiences in life is a precursor to better engagement in and motivation for math (Metzger et al., 2019).

Special education teachers work with students who are often highly unmotivated to start and/or complete their specified math work. Both boys and girls demonstrate greater challenges with understanding math concepts and computation skills. Interventions involving goal setting, explicit timing, immediate feedback, and positive reinforcement has shown positive results with third grade special education students in Germany (Grunke, Karnes, & Hisgen, 2019).

**Parents.** The lack of support from parents and families for math achievement is also noted by researchers. Students’ attitudes and perspectives about math are highly influenced by their parents. When parents project and share negative experiences about math, their children are more likely to share their same sentiments and frustrations (Soni & Kumari, 2017). Negative
attitudes towards math generates less engagement and motivation which in turn, leads to poor math competency and achievement (Soni & Kumari, 2017).

Parental support at home with math activities and skills review is also an effective intervention that improves student achievement in math. Math story time is an intervention that uses short numerical story problems that parents can engage in with their children. At the end of the school year, first graders math achievement markedly increased (Berkowitz et al., 2015). Parental guidance and support has also been shown to decrease students’ anxiety towards math which leads to increased math achievement (Ramirez et al., 2018).

**Pre-service teachers.** To effectively prepare pre-service teachers for the diverse and far reaching job of teaching, colleges and universities should not only give them practical tools and information for instructing students, but they should also motivate and mentor them in being reflective, innovative, and resourceful as motivators for student learning (Loukomies, Lavonen, & Juuti, 2015). Knowing potential ways to educate and encourage students to learn math and experience success is necessary for pre-service teachers as they are preparing to teach in their own classrooms (Carr & May, 2019).

Along with mentoring and support for pre-service teachers, teacher preparatory programs should encourage more experiences with technology as a tool for instructing students such as the Adaptive Learning Programs (Smith, 2018). In this, students are instructed at their individual levels of learning, and it includes assessments, instructional content, and feedback for the math work that is being presented (Smith, 2018). In alignment with the expectations of NCTM, the use of technology is critical in helping to develop our students’ math skills and understandings. Pre-service teachers should not only be focused on these standards, but they should also focus on
ways to use them as a tool for motivating students to engage in math computation and skills enhancement (Smith, 2018).

When education majors in college preparatory teaching programs lack competence and skills in math content areas, they, too, experience anxiety which affects their abilities to effectively teach students (Novak & Tassell, 2017). The negative effects of math anxiety are detrimental to students’ achievement in math (Novak & Tassell, 2017). Pre-service teachers who manage their own anxious feelings towards math are less likely to exhibit and model discomfort when teaching math, which in turn, helps students in their engagement in and enjoyment of math (Gonzalez-DeHass, Furner, Vasquez-Colina, & Morris, 2017). Early childhood teacher preparatory programs should be obligated to address any anxiety that preservice teachers may have and help them to build self-confidence and self-efficacy so that their teaching reflects confidence and competence (Hollingsworth & Knight-McKenna, 2018).

Specialized programs of study for teacher preparatory candidates through academic service learning (ASL) can involve work with the surrounding communities, especially in areas where there is higher poverty and less support for math achievement. The Little Village Tutoring Sessions gave teacher candidates opportunities to work with preschool students and their families where math skills were taught and practiced therein. At the close of these sessions, attitudes towards math from parents and early learners were documented as improved (Hollingsworth & Knight-McKenna, 2018).

Another study involving a differentiated approach to teaching math involved the use of children’s picture books. In this, The Learning Purposes and Teaching Strategies for Integrating Multicultural Mathematics Picturebooks Framework emerged as a way for preservice teachers to integrate math lessons with children’s literature (Harding, Hbaci, Loyd, &
Reading books that incorporate what students already know about math in the context of their cultures and prior knowledge strengthens students’ understandings of and engagement in math concepts (Harding et al., 2017).

**Professional Development**

Teachers, administrators, and school divisions investigate ways to sharpen their skillsets to address the diverse needs and abilities of students. The need to be innovative and specialized in math instruction is imperative. Teachers are expected to learn and practice new methods as instructional, strategic, and creative practices are evolving (Couros, 2015). Building teachers’ repertoire of digital games, specialized activities, and technological resources gives teachers better understandings of the aforementioned tools, and guides them in teaching practices, and helps them to make efficient use of their time (Callaghan, Long, van Es, Reich, & Rutherford, 2017). Teachers can learn how to use and implement new tools and strategies for math integration and instruction by personally participating in professional development workshops as actual hands-on, engaged learners (Brown & Bogiages, 2019).

**The Role of School Leaders**

Administrators can offer support for stakeholders of their schools by providing resources, encouragement, motivation, and professional guidance. School leaders should have a clear vision of what is needed from instructional and non-instructional staff to help all students be successful (Villa & Thousand, 2017). When individuals feel heard, cared for, and appreciated, they will be more likely to trust the school leader and be motivated to proceed with tasks or tackle challenges therein (Bearden, 2018). Everyone wins when the school leader develops and maintains a positive school culture (Burgess & Houff, 2017). To strengthen and motivate others, effective leaders share their own leadership philosophies while, at the same time, help others to
develop self-confidence and self-determination through active listening (Kouzes & Posner, 2017).

**Students.** Persistently believing in the abilities of the students and capturing moments to praise them where they are showing that they can do something is motivating for students (Hege & Dovico, 2018). By listening to and forming positive relationships with students, school leaders are better able to develop trust and connections (Bearden, 2018). When leaders know the learning styles and abilities of the diverse range of students in their building, they are able to provide what is necessary to address the needs and help to create meaningful learning experiences for all (Villa & Thousand, 2017).

**Teachers.** School leaders should carve out time for educators to collaborate, explore, and reflect on what they have learned so they can more effectively instruct their students (Couros, 2015). Teachers need time to understand new school and division initiatives, provide feedback on curriculum, and be celebrated for their determined work with students and each other (Villa & Thousand, 2017). Senior high school teachers in Medan who are educated, validated, and celebrated offer broader opportunities and motivational strategies to the recipients of their instruction: the students (Nasution, 2018).

Leaders can influence teachers by supporting their need to learn more about the multifaceted, changing ways that subjects such as mathematics can and should be taught with aligned instructional materials (Urick, Wilson, Ford, Frick, & Wronowski, 2018). When teachers understand what is expected of them as instructional leaders, they are able to design lessons that are meaningful, engaging, and motivational for optimal student learning (Villa & Thousand, 2017). Developing teachers and instructional programs is part of being a leader; however, guiding teachers to make magic happen for students is a valuable role for a school
leader (Burgess & Houf, 2017). A key component in effectively leading teachers is credibility (Kouzes & Posner, 2017). As teachers trust their leader’s words and actions, they are more likely to adopt new ways of thinking and teaching to help students to be motivated to learn (Clark, 2015).

From both the student and teacher standpoint, principals who build positive relationships with all stakeholders are expected. Sitting in the principal’s office and being non-visible to the students and staff is undesirable (Villa & Thousand, 2017). Principals of three State Islamic Senior High Schools in East Java, Indonesia confirm the need for positivity and presence in the buildings that they lead. Teachers and students reported that their intensive communication, incentives, encouragement, and transparent management styles were motivators for them in both their daily work and interactions at school and also in their college careers post high school (Muwahid, 2018).

Summary

*Perspectives, priorities, protocols, and practices* are the four *P* words to describe the summation of this literature review. First, the *perspectives* of students, teachers, and parents are important to understand as they bring their own ideas, culture, and concerns to the math table. Math may not be a favored subject or activity for students in all grade levels, and understanding and validating their frustrations, anxieties, and viewpoints is necessary. Teachers and parents may also have some pre-existing biases or challenges regarding math. School leaders should be prepared to validate all stakeholders’ input and viewpoints and work towards guiding all individuals to clearer understandings and directions for learning math.

Once students’ and teachers’ perspectives are unveiled, *priorities* for helping the struggling mathematicians are needed as the connections to the subject matter should outweigh
mandated and rigorous tests. For students to be successful in math, they must be able to relate to the teacher and be motivated to engage in math activities and problem solving. To best help students, pre-service teachers and current classroom teachers need to be proactive and seek innovative practices and programs to address the needs of the unmotivated learners.

In the process of the planning and implementation of specialized programs and practices, state and division wide protocols and mandates cannot be ignored. Woven into the work that teachers must do are clear guidelines and expectations for student understanding and mastery. NCTM serves as a baseline of knowledge and principles that guide teachers’ practice and program development.

The last P word that is added to this summary is what the researcher refers to as “purposeful ponderings.” In this, the future of math achievement and success for all students is in the hands of educators at the local, state, and national level where fair and reasonable expectations for math are devised and implemented. Present day opportunities for teaching math are quite different from long ago when worksheets and drill and skill activities were predominant. Now, there are, and can be more creative methods, technology, and tools to more fully engage students in math.

Interventions to improve student engagement in and success with other subjects has been studied by researchers such as reading, science, and English Language Learning (ELL). The emphasis of this literature review revolves around math as Kindergarten through 12th grade students from all walks of life are affected by it.

The gaps in the literature in regard to achievement in math as a result of virtual math mentorships with college students in teacher preparatory programs has yet to be determined. Using the other research as a guideline and support, this study will offer more in depth
understandings of the impact of virtual math motivation and instruction on elementary students’ math growth scores on math assessment tests.
CHAPTER THREE: METHODS

Overview

The purpose of this quantitative study is to determine if third grade students who participate in specialized virtual mentoring programs with college students in teacher preparation programs demonstrate increased gains on standardized math assessments due to the specialized interventions provided by the college students. Chapter Three begins by introducing the design of the study, including full definitions of all variables. The research questions and null hypotheses follow. The participants and setting, instrumentation, procedures, and data analysis plans are also presented. Better motivation for and engagement in math understandings and tasks is investigated in this study to determine if math achievement on standardized tests is impacted with specialized interventions like VMM.

Design

This quantitative, quasi-experimental study used a nonequivalent control group design where control groups of third grade classes from two schools were compared to experimental groups of third grade classes from two different schools. In using this nonequivalent control group design, the students from the classes were not randomly assigned to the experimental or control groups since they had already been assigned to these classrooms for the school year (Gall et al., 2007). The control groups received no interventions from the study, and the experimental groups received eight-weeks of virtual math mentoring and instruction from teacher preparatory candidates from a nearby accredited college. At the end of the study, the pretests and posttests were compared with an analysis of covariance (ANCOVA) to determine if interventions from the college students impacted student math achievement.
The purpose of this design was to determine whether posttest scores on math achievement tests differed when measured against the pretest scores due to specialized interventions given to students through a virtual math mentorship. The independent variable was virtual mentoring; the dependent variable was student scores from Performance Matters 3rd Grade Math Assessments; and the covariate was the pretest scores on the Performance Matters 3rd Grade Math Assessments. This design was most appropriate for this research study because the experimental groups’ exposure to the interventions determined the potential differences between the pretests and posttests (Gall et al., 2007).

**Research Question**

**RQ:** Is there a difference in math achievement scores between third grade students who participate in a math mentor program and those who do not when controlling for prior math achievement?

**Hypothesis**

The null hypothesis for this study is:

**H₀:** There is no difference in math achievement scores between third grade students who participate in a math mentor program and those who do not when controlling for prior math achievement.

**Participants and Setting**

Third grade students from four elementary schools with similar demographics were the participants of this study. These small community schools were chosen due to their comparable sizes in student numbers, qualifications for Title 1 services, and similar free and reduced lunch rates of approximately 50%. The four schools have a slightly higher ratio of males to females. They all are located in a semi-rural school division located in the northwest region of Virginia.
The division is made up of 15 elementary, four middle, and four high schools. The division’s total enrollment is 11,400 students along with approximately 2000 full time staff.

Non-random assignment of students from all third grade classes in each school was the intended sample of this study which began in January 2021. The goal was 100% participation from all students; however, this was not only dependent upon parent permission but also the impact of Covid-19. Due to the pandemic, many parents chose to homeschool their children or place them in an all-virtual learning environment. As a result, there were fewer in-person third graders to take part in the study.

Each of the schools’ principals provided student enrollment information from the 2019-2020 school year as it was the initial source of the data that would be used for this study. The following tables provide a breakdown of the ethnicities and special populations of the third graders in the four schools that were considered for this research. All of the third grade students are taught by licensed teachers, and students range in age from 7 – 8 years.

**Table 1**  
*Demographic Information for All Schools (2019-2020)*

<table>
<thead>
<tr>
<th>School</th>
<th>Enrollment</th>
<th>Hispanics</th>
<th>Special Education</th>
<th>English Language Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td>School A</td>
<td>234</td>
<td>25</td>
<td>33</td>
<td>11</td>
</tr>
<tr>
<td>School B</td>
<td>227</td>
<td>24</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td>School C</td>
<td>260</td>
<td>45</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>School D</td>
<td>194</td>
<td>2</td>
<td>17</td>
<td>3</td>
</tr>
</tbody>
</table>
Table 2
Demographic Information – School A (n=32)

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>17</td>
<td>13</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Special Education Students</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

94% of the third grade students in School A are Caucasian; 6% are English Language Learners; and 6% receive Special Education services. The ratio of males to females is slightly higher.

Table 3
Demographic Information – School B (n=26)

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Special Education Students</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

85% of the third grade students in School B are Caucasian; 8% receive Special Education services; and 8% are English Language Learners. The number of males and females is equal.
Table 4
Demographic Information – School C (n=40)

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>23</td>
<td>12</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Special Education Students</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

88% of the third grade students in School C are Caucasian; 13% are English Language Learners; and 8% receive Special Education services. The ratio of males to females is almost double.

Table 5
Demographic Information – School D (n=25)

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>14</td>
<td>11</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Special Education Students</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

100% of the third grade students in School C are Caucasian; 0% are English Language Learners; and 0% receive Special Education services. The ratio of males to females is slightly higher.
Impact of Covid-19 and Changes to Demographics

When Covid-19 entered our world in March 2020, schools were impacted greatly.

The following tables represent the aforementioned changes from the 2019-2020 demographics.

Table 6
Demographic Information for All Schools (2020-2021)

<table>
<thead>
<tr>
<th>Enrollments</th>
<th>Hispanics</th>
<th>Special Education</th>
<th>English Language Learners</th>
</tr>
</thead>
<tbody>
<tr>
<td>School A</td>
<td>223</td>
<td>24</td>
<td>25</td>
</tr>
<tr>
<td>School B</td>
<td>191</td>
<td>29</td>
<td>12</td>
</tr>
<tr>
<td>School C</td>
<td>251</td>
<td>48</td>
<td>25</td>
</tr>
<tr>
<td>School D</td>
<td>184</td>
<td>4</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 7
Demographic Information – School A (n=17)

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caucasian</td>
<td>10</td>
<td>6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Special Education Students</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

95% of the third grade students in School A are Caucasian; 0% are English Language Learners; and 5% receive Special Education services. The ratio of males to females is slightly higher.
Table 8
*Demographic Information – School B (n=17)*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Hispanic</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

English Language Learners | 0    | 0      |

Special Education Students | 2    | 1      |

76% of the third grade students in School B are Caucasian; 12% receive Special Education services; and 0% are English Language Learners. The number of males is slightly higher than females.

Table 9
*Demographic Information – School C (n=13)*

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

English Language Learners | 1    | 0      |

Special Education Students | 0    | 0      |

85% of the third grade students in School C are Caucasian; 7.6% are English Language Learners; and 0% receive Special Education services. The ratio of males to females is less.
Table 10
Demographic Information – School D (n=19)

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caucasian</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>English Language Learners</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Special Education Students</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

100% of the third grade students in School C are Caucasian; 0% are English Language Learners; and 11% receive Special Education services. The ratio of males to females is slightly higher.

Two schools’ third grade classes (School A and School B) served as the experimental group with an approximate sample size of 34 (n=34) students (School A with 17 students and School B with 17 students). These schools’ students were chosen as the experimental group due to the schools’ close proximity to each other and for opportunities for the college students to work with the third grade students at the beginning and end of the eight-week intervention.

The other two schools’ third grade students (School C and School D) served as the control group with an approximate sample size of 32 (n=32) students (School C with 13 and School D with 19). The sample size for this quasi-experimental study was adequate since there were at least 15 participants in each group that was compared and 66 participants for the ANCOVA sample size (Gall et al., 2007). Table 6 includes the demographic information for the four schools. The percentage of each school’s enrollments that were used for this study include:
School A, 7.6%, School B, 9%, School C, 10%, and School D, 6.5%.

**Instrumentation**

The pretest and posttest for this study was the school division’s Performance Matters (formerly Powertest IA) 3rd grade Student Growth Assessment (SGA). In this, sample multiple-choice test questions that align with the Virginia Standards of Learning were used to assess students. The pretest and posttest contain forty questions for students to complete, and they had unlimited time to answer all questions on this computerized testing program. They had access to extra paper to solve all math problems. This multiple choice test is similar to other tests that third grade students already take on the computer. Permission to use this test was already granted as our school division uses it to assess students at the beginning, middle, and end of the school year.

The questions are representative of the Virginia SOL curriculum standards where students answer questions pertaining to:

- numbers and number sense
- computation and estimation
- measurement and geometry
- probability and statistics
- patterns, functions, and algebra

Performance Matters SGAs are part of the PowerSchool online program and are performance based, reliable, and scalable assessments that use data to drive instruction for student success (PowerSchool, 2020). They provide comprehensive analytics and scatterplots to review students’ achievement and growth (PowerSchool, 2020). The validity of Performance Matters SGAs is noted through our division-wide use of this online test as it has questions that
are similar in design to the Virginia’s state Standards of Learning (SOL) tests (Shelly, 2015), and they are used to better understand the link between Performance Matters and the SOL tests.

Performance Matters tests are benchmark assessments “to understand individual student progress towards meeting the Standards of Learning” (Shelly, 2015). An SGA on Performance Matters tests is compared to future SOL test success where a strong Pearson correlation (coefficient value close to 1) exists between 2013-2014 SGA and SOL tests which shows further support for the strong relationship between the two (Shelly, 2015; Gall et al., 2007). To further confirm the validity of the pretest/posttest questions, the school division’s Supervisor of Math Assessment and Data Analysis reviewed the questions prior to the study. A Cronbach Alpha analysis was run during the pilot study to determine the test’s reliability prior to the actual study.

Similar Performance Matters tests that focus on individual student progress with researcher designed assessments are found in the St. Mary’s County Public School system. Using Performance Matters Assessments, teachers in this district are able to design their technology enhanced item (TEI) test bank questions to align with their division’s and state’s assessment goals (PowerSchool, 2016). From the assessment results, they can dive in deeper with more effective instructional practices to meet the needs of diverse learning modalities (PowerSchool, 2019). Garland R. Quarels Elementary School also used Performance Matters Assessments to not only devise their assessments, but they also reviewed third grade students’ performance data to guide necessary instruction to increase reading achievement (PowerSchool, 2016).

The pilot study revealed the test-retest reliability where a correlation coefficient between individuals’ scores on the same test for the two different testing opportunities took place (Gall et al., 2007). Both the pretest and posttest had the exact same questions so progress was noted after
the intervention had been given to the experimental group. The scoring process used raw scores where 30 out of 40 questions answered correctly translated to a passing score similar to the Virginia Department of Education scoring guidelines.

**Figure 1**

*Pilot Study Case Processing Summary*

<table>
<thead>
<tr>
<th>Case Processing Summary</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cases</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valid</td>
<td>12</td>
<td>100.0</td>
</tr>
<tr>
<td>Excluded(^a)</td>
<td>0</td>
<td>.0</td>
</tr>
<tr>
<td>Total</td>
<td>12</td>
<td>100.0</td>
</tr>
</tbody>
</table>

\(^a\) Listwise deletion based on all variables in the procedure.

**Figure 2**

*Pilot Study Reliability Statistics*

<table>
<thead>
<tr>
<th>Reliability Statistics</th>
<th>Cronbach's Alpha</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.890</td>
<td>2</td>
</tr>
</tbody>
</table>

**Procedures**

After submission of the dissertation prospectus to the chair and committee members during the first week of June of 2020, the manuscript was revised as necessary and sent to the Liberty School of Education Director of Quantitative Research for review. Once approved by the aforementioned and the assistant superintendent of our school division (See Appendix A and B), the proposal was defended through a PowerPoint presentation in a Microsoft Teams
conference in August 2020. Once the defense of the proposal was secured, Institutional Review Board (IRB) approval was requested through a detailed letter explaining this comprehensive research proposal.

After IRB revisions were made and approval was received (See Appendix C), the pilot study was planned for Fall 2020. The pilot study gave clarity to potential problems that could occur during the actual proposed research study and was needed “to determine whether the procedure has merit and to correct obvious flaws” (Gall et al., 2007, p. 56). The IRB approval for both the pilot study and actual research study was secured at the same time (See Appendix C).

Prior to the pilot study, multiple permissions were secured to approve the work of and to be involved in the study: (a) the assistant superintendent, (b) the principals of the schools, (c) the professor of the college class, (d) teachers who would help with the students in the study, and (e) elementary students’ parents giving permission for their child to participate. Permission forms included directions and expectations, and student permission forms emphasized that the children’s names and test scores would remain anonymous.

Pilot Study

The virtual mentoring sessions by the pre-service teachers were shortened to five weeks instead of eight weeks due to circumstances beyond the researcher’s control. Along with this, since 10 of the third grade students were not at school for their pretest due to Covid-19 restrictions, a Zoom session was arranged for students to take the pretest with me. As I shared the SGA 40-question paper copy of the pretest with students on the Zoom session, they provided their answers to the questions on a separate piece of paper after which they took pictures of these answers with their Chromebooks and uploaded the pictures to Seesaw, an interactive, web-based
learning tool that engages students in remote learning activities and includes opportunities for teacher instruction and student and parent feedback. Two other students, one an English Language Learner (ELL) and the other, a special education student, were on site for the pretest. The ELL student took her pretest under the supervision of her classroom teacher. The SPED student, per his accommodations, had his test read to him by the special education assistant.

The pilot study involved virtual math mentoring and instruction from college students in a teacher preparatory program that occurred on a small scale similar to the work of Carr and May (2019). College students were paired one-on-one with third grade students who were having difficulty with math computation, basic skills, and overall motivation for math. Through their weekly virtual connections through Seesaw, the younger students were given specially designed activities to encourage engagement in math with math games and activities. The class enrollment in the teacher preparation program was twelve students which meant that 12 third graders were paired with them.

From the initial pretest data, the college professor provided instruction and training to the college students on how to encourage, motivate, and teach the third grade students using assessment data to guide their lesson preparations. Moreover, college students were trained on the use of Seesaw and how to navigate the various aspects such as uploading videos, adding games and activities, and retrieving student feedback from assignments.

The college students’ specialty designed activities and lessons that elementary students accessed through Seesaw included an initial “Get to Know You All About Me –Emoji Style” and “How Do You Feel About – Emoji Style” projects. During weeks one and two, elementary students could respond to these interest inventories with only emojis so as to peak their curiosities and engage them in the activity in an enjoyable way. Moreover, students were able to
express and discuss their frustrations and fears about math so preservice teachers could have a better perspective of students’ likes or dislikes of math.

When week three of the virtual mentorships began, elementary students were asked to watch a video entitled, “Growth Mindset and the Incredible Power of Yet.” After viewing the video, students were asked to respond to the following question in Seesaw: “Explain a time where you got ‘unstuck’ and had to use your brain like a muscle.” The college students chose this video as a way of encouraging students to persevere even when math problems may seem difficult or overwhelming. Elementary students also had the option of viewing another motivational video entitled, “Why I Can Do It” and how to develop a growth mindset instead of staying stuck in a fixed mindset.

The following week, the preservice teachers prepared a special video message that elementary students could view through their Seesaw accounts. The purpose of this was to continue to build relationships with the children and to engage them in conversations about math and questions therein. They also provided some encouragement and motivation on how to continue to work hard in math computation and number sense.

An actual face-to-face Zoom session where the college students prepared a comprehensive lesson that they taught to their third grade math buddies was the final week’s activity. This lesson included math concepts and skills that students had shared concerns about, and it was designed using specific interests that students revealed in the previous week’s session. Examples of the subject matter in lessons included pandas, Minecraft, football, and video games.

At the close of the five-week intervention from the college students, third grade students responded to instructions on their Seesaw accounts for a “Thank You Video” that their college buddies prepared for them. They recorded and uploaded a video of themselves sharing about
their experiences in this mentorship program.

Over the course of the next week, students took the 40-question posttest in person at school since Covid-19 restrictions were lifted. The researcher determined if the interventions were beneficial for students’ academic achievement. Changes in posttest scores as a result of the interventions were documented. A Cronbach Alpha test was run to determine the reliability of the tests that would be used for the actual study. No problems were detected with the pretest and posttest as the Cronbach Alpha result was .890 (See Figure 2).

**Research Study**

Once the pilot study was completed and reviewed, the actual proposed research study began after obtaining permission forms from all participants and stakeholders of the study: (a) the assistant superintendent, (b) the principals of schools A, B, C, & D, (c) the professor of the college class, (d) teachers who helped with the students in the study, and (e) elementary students’ parents giving permission for their child to participate.

In January 2021, teachers from the experimental groups’ schools were oriented to the eight-week study and given information from the local college professor regarding the virtual math mentoring set-up and time requirements. To facilitate the virtual mentoring that would take place, two of our division’s Instructional Technology Resource Team (ITRT) members set up the actual Seesaw accounts and Zoom meetings. They, too, were included in the conversations on how the study would evolve using the online forums and Zoom sessions.

Both the control group and experimental group teachers were given specific instructions on how to administer the online Powertest SGA pretest and posttest from our school division’s math coordinator. The pretest and posttest was the online 40-question test as previously described in the Instrumentation section.
The Virtual Math Mentorship

The virtual math mentorship program involved 17 college students each assigned to 2 or 3 third grade students at School A and School B. This created a 1:2 or 1:3 ratio for the virtual mentoring and instruction to take place. At the onset of this eight-week intervention, Covid-19 restrictions were still in place, so all interactions between the elementary students and preservice teachers were virtual. Initially, the plan was for students to meet their college student mentors in person at the beginning and ending of the mentorship; however, this was not possible, and the college students’ interactions with the elementary students were monitored by the college professor during class Zoom meetings and Zoom breakout room sessions.

Prior to the virtual mentorship program, interest surveys were sent to all students in the experimental groups at school A and school B. The purpose of this survey was to match the elementary student to a preservice college teacher with similar interests such as dogs, cats, video games, hunting, farming, music, art, and outdoor play and activities therein. This was the first step in building the necessary relationships for the virtual math mentoring.

The next step was to determine the days that students would have access to the activities that the preservice teachers would create for them. Due to Covid-19 mitigation strategies, our third grade students were attending school 2 days per week based on their last names: Students with last name beginning with A – K attended school on Mondays and Thursdays, and students with last name beginning with L – Z attended school on Tuesdays and Fridays. With this in mind, the posted activities to Seesaw and Zoom meetings for face-to-face instruction had to be strategically designed to ascertain that students would have full access to both of the aforementioned. With classroom teachers and the college professor facilitating all activities and virtual meetings, this was a critical piece in the planning process.
The ITRTs secured the necessary information from the elementary and college students to make the connections take place on the specified days. In addition, it was decided that the elementary students would be given actual activities and specially designed assignments on their individual Seesaw accounts on Monday so that they would have a full week to complete them either at home or at school. This was quite helpful especially when the snow days came along.

During the first week of the mentorship program, initial connections were made by the college students posting a welcome video to their corresponding students’ Seesaw pages and asking elementary students to respond to the prompt, “Videotape yourself sharing three fun facts about yourself.” Students were able to give more details about their lives and interests to help the college students know how to better relate to and instruct them during the eight-week project. After this initial introductory video was reviewed, college students worked with their professor to design the first 2 week’s activities.

Like the Pilot Study, during week 2, as a way of college students better acquainting themselves with the elementary students, the third graders were assigned the Seesaw Activity entitled, “All About Me…Emoji Style.” In this, they were to use emojis to describe the following as it related to them by posting the emojis on the corresponding page: My family, favorite animals, favorite foods, favorite sports, favorite emojis, and future job.

The Seesaw Activity entitled “How do you Feel About….Emoji Style” for week 3 was similar to week 2 as it asked students to use emojis when answering the questions for the week. This time, the activity was more math specific, asking students to respond with emojis to describe their feelings regarding school, virtual learning, math, using math tools, adding, subtracting, place value, and being with a college buddy.

By week 4, A day third graders were able to participate in a live Zoom chat with their
college buddies. Unfortunately, a snow day prevented the B day students from chatting, so an alternative video presentation by the college student was sent to the elementary students through their Seesaw accounts. During this virtual face-to-face meeting, all students were able to not only connect and communicate, but they could have conversations that further strengthened their relationships.

“Growth Mindset – The Incredible Power of Yet” was the next Seesaw Activity that was assigned to the elementary students. For this week 5 activity, elementary students watched a video about a character named Mojo who struggled with feeling “stuck” and had to use his brain muscle to get out of a difficult situation. After watching the video, students videotaped themselves sharing about a time when they were “stuck” like Mojo and had to use their brains like a muscle to get “unstuck.” After videotaping themselves, they uploaded the video to their Seesaw accounts for the college buddies to review and respond to.

Another optional video was uploaded to Seesaw for elementary students to view entitled, “It’s Good to Struggle.” This activity was assigned so that elementary students could videotape themselves sharing about a time in math when something was hard, but then they were able to learn it. Once they videotaped their responses, they uploaded them to the Seesaw page for college students to review as they prepared for their upcoming Zoom face-to-face meetings. During Zoom breakout sessions, the college students continued to not only build relationships with the students, but they also encouraged them to continue to strive to do their best on all math assignments. They validated their buddy’s concerns about math since the elementary students had shared them the previous week on their videos.

For week 7, the college students shared a video with their buddies entitled, “Believe in Yourself.” The focus of this video was to encourage students to try hard and believe in their
abilities. Students were able to hear from the video the power of believing in themselves, and that if they can work to believe in their abilities, their brains can operate better, too, especially in math.

The final week of this partnership included a Zoom meeting where the college students used information gained from their buddy’s videos and interests to construct an engaging, enjoyable, and educational math lesson. Not only were students able to meet face-to-face in the Zoom breakout sessions, but they were also able to receive specialized instruction on how to better understand and solve difficult math problems.

One week after the aforementioned lesson, the elementary students completed their final Seesaw activity entitled, “Thank You Message”. Elementary students were asked to record and upload a message to Seesaw indicating what they liked about their time with their college buddy. This was also an opportunity for the college students to hear how their efforts impacted their young and impressionable elementary students.

**Pretest and Posttest**

In early January 2021, classroom teachers gave the computerized SGA pretests to all third grade students (control and experimental groups) at all schools. Individual student scores on the pretest were entered into the SPSS software for the initial set up for the study and for mean and standard deviations to be determined. Within one week of pretesting, the virtual math mentoring as previously described began with third grade students in the experimental group (School A and School B). After the eight-week virtual math mentoring concluded, the posttests (same test questions and format as the pretests) were given to all third grade students in both schools. This data was entered into the corresponding SPSS software program for data analysis.
Data Analysis

An analysis of covariance (ANCOVA) was used to analyze the data from the pretest and posttest scores. ANCOVA adjusts the posttest scores for differences between the treatment and control groups on the corresponding pretest (Gall et al., 2007). The pretest is the covariate in this analysis, the intervention is the independent variable, and the posttest scores are the dependent variable. ANCOVA was the preferred analysis as it uses a covariate in the adjustment of the treatment effects thereby reducing variance in errors reported (Shieh, 2019). This ratio testing evaluated whether the means of the dependent variables (posttests) were equal across levels of the independent variable (virtual math mentoring interventions) while controlling for the effects of the covariate (pretests). ANCOVA assessed if the mean outcome scores differed across the experimental and control groups when an adjustment or intervention was made in the groups.

All of the observations were independent as there was one score from each student being represented in the experimental and control groups. The covariate (pretest) was not influenced by the intervention as it was given to all students (both experimental and control groups) prior to the intervention (Warner, 2013).

Using SPSS software, preliminary data screenings and descriptive statistics for this ANCOVA analysis were used to screen for violations of assumptions: (a) Outliers – using a Box and Whiskers plot for each variable, extreme outliers were determined; (b) Assumption of Normality - since the sample size was greater than 50, a Kolmogorov-Smirnov test was used to determine normality of the distribution of the data; (c) Assumption of Linearity - Scatterplots between pretest variables and posttest variables were examined; (d) Assumption of Bivariate Normal Distribution – a classic “cigar shape” in the scatterplots between the pretest variables and posttest variables was determined; (e) Assumption of Homogeneity of Slopes – interactions
between the pretest and posttest variables were noted; and (f) Assumption of Equal Variance – a Levene’s test was run to note the degree that the pretest was confounded with the intervention (Warner, 2013).

A power analysis was run on the sample with \( p = .05 \) and power of 0.7 to determine the minimum sample size needed to get a significant outcome (Warner, 2013). Standard deviations, degrees of freedom, and effect size information was also reviewed and recorded from the SPSS program. Descriptive statistics of adjusted marginal means and standard error were reported. Means and standard deviations of the pretests and posttests were included before adjusting for the covariate. To test the null hypothesis, the statistical significance level to reject the null hypothesis was \( p < 0.05 \). Effect size was reported using partial Eta squared noted as small (.2), medium (.5), or large (.8) as it showed the variance between the independent and dependent variables. The null hypothesis will be rejected at the 95% confidence level with \( a = .05 \).
CHAPTER FOUR: FINDINGS

Overview

In order to determine if virtual math mentoring by college students may impact third grade students’ academic growth on standardized tests, the results of this study can be determined from the descriptive statistics and assumption tests in this study. The experimental group students received virtual math mentoring and instruction from preservice teachers from a local college, and the control group received none. At the close of these mentoring sessions, the control group and experimental group were both given the same posttest, and from the results of this study, the experimental group demonstrated more academic growth on the standardized tests than the control group. This chapter will unveil detailed information regarding the descriptive statistics and assumption tests that validate the findings of this study.

Research Question

RQ: Is there a difference in math achievement among third grade students who participate in a math mentor program and those who do not when controlling for prior math achievement?

Null Hypothesis

The null hypothesis for this study is:

H₀: There is no difference in math achievement scores between third grade students who participate in a math mentor program and those who do not when controlling for prior math achievement.

Descriptive Statistics

An ANCOVA was run to determine if there was a difference in math achievement scores among third grade students who participated in a math mentoring program. Descriptive statistics
were obtained on the covariate (pretest scores on the 3rd grade Performance Matters SGA),
dependent variable (posttest scores on the 3rd grade Performance Matters SGA), and the adjusted
dependent variable (virtual math mentoring) for each group. Descriptive statistics can be found
in Tables 11, 12, and 13.

**Table 11**

*Descriptive Statistics*

Covariate: Pretest Scores

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – VMM</td>
<td>39.41</td>
<td>11.89</td>
<td>34</td>
</tr>
<tr>
<td>2 – CONTROL</td>
<td>44.38</td>
<td>12.73</td>
<td>32</td>
</tr>
</tbody>
</table>

**Table 12**

*Descriptive Statistics*

Dependent Variable (Posttest Scores)

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – VMM</td>
<td>46.04</td>
<td>11.82</td>
<td>34</td>
</tr>
<tr>
<td>2 – CONTROL</td>
<td>55.84</td>
<td>14.43</td>
<td>32</td>
</tr>
</tbody>
</table>
### Table 13

*Descriptive Statistics*

Dependent Variable (Adjusted Means)

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Standard Error</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – VMM</td>
<td>47.77</td>
<td>1.69</td>
<td>34</td>
</tr>
<tr>
<td>2 – CONTROL</td>
<td>54.01</td>
<td>1.75</td>
<td>32</td>
</tr>
</tbody>
</table>

**Results**

**Data Screening**

Data screening was conducted on each group’s covariate and dependent variable. The researcher sorted the data on each variable and scanned for inconsistencies. No data errors or inconsistencies were identified. Box and whiskers plots were used to detect outliers on each dependent variable (See Figure 3). No outliers were identified for the pretests as data point 3.04 was denoted with a circle on the box and whisker plot which did not deem it as extreme (See Figure 4).
Figure 3

*Box and whisker plots (covariate and dependent)*

Figure 4

*Box and whisker plot (standardized residual)*
Assumptions

An Analysis of Covariance (ANCOVA) was used to test the null hypothesis. The ANCOVA required that the assumptions of normality, assumption of linearity and bivariate normal distribution, assumptions of homogeneity of slopes, and the homogeneity of variance, were met. Normality was examined using a Kolmogorov-Smirnov test since the sample size was more than 50. No violations of normality were found. See Table 14 for Tests of Normality.

Table 14

Tests of Normality

<table>
<thead>
<tr>
<th>Kolmogorov-Smirnov</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
</tr>
<tr>
<td>-------</td>
</tr>
<tr>
<td>1 – VMM</td>
</tr>
<tr>
<td>2 – CONTROL</td>
</tr>
</tbody>
</table>

The assumption of linearity and bivariate normal distribution were tested using scatter plots for each group (See Figure 5). Linearity was met and bivariate normal distributions were tenable as the shapes of the distributions were not extreme.
The assumption of homogeneity of slopes was tested and no interaction was found where $p = .538$. Therefore, the assumption of homogeneity of slope was met as $p > .05$. The assumption of homogeneity of variance was examined using the Levene’s test. No violation was found where $p = .646$. The assumption of homogeneity of variance was met.

**Results for Null Hypothesis**

An ANCOVA was used to test the null hypothesis that there is no difference in math achievement scores between third grade students who participate in a math mentor program and those who do not when controlling for prior math achievement as shown by a Performance Matters 40-question test. As the statistical significance value is less than .05, it can be concluded that there no statistical significant differences in posttest scores for the two different groups in
this study (VMM and CONTROL) after adjusting for the covariate. The null hypothesis was rejected at a 95% confidence level where $F(1, 63) = 6.391, p = .014, \eta^2_p = .092$. The effect size was medium.
CHAPTER FIVE: CONCLUSIONS

Overview

As discussed in the introduction, math has remained a topic of concern with elementary teachers as students continue to struggle with math concepts and skills (Bodovski et al., 2017). This current study contributed to a greater body of knowledge regarding student achievement in math. The results of this study may be impactful for school division leaders and elementary school teachers who research innovative and engaging practices to improve math achievement for third grade students. Based on the findings of this study which took place during the uncertainty of a pandemic, the future work of motivation and achievement for student success should be highly reviewed under more normal school year circumstances.

Discussion

The purpose of this quantitative, quasi-experimental study was to examine the relationship between college students’ virtual math mentorships and instruction on third grade students’ math academic growth. The research question, “Is there a difference in math achievement among third grade students who participate in a math mentor program and those who do not when controlling for prior math achievement?” was answered through this study. A difference was detected in students’ pretest and posttest scores as a result of the interventions by the preservice teachers from the local college.

With the outbreak of Covid-19 in March 2020, students of all ages were forced to learn in virtual ways outside of school. Students only had opportunities to engage in face-to-face learning with their teachers on a weekly basis using their Chromebooks or iPads. Once a new school year started in September 2020, students could return to school two days per week, be homeschooled, or be enrolled in a Home Learning Academy where they would be taught by
licensed educators in a virtual way. This, too, was a disruption in the way that they had been accustomed to learning prior to the outbreak of Covid-19. With the aforementioned confounding factor in mind, the results of this study can possibly be better understood.

Motivation to learn is described by Vroom’s Expectancy-value Theory where students are intrinsically motivated to learn and achieve if they feel there is value and enjoyment in the work or activities that they are involved in (Lunenburg, 2011). Although students were given the standardized pretest and posttest at the beginning and end of the study, they were also presented with motivational and encouraging messages and feedback to motivate and encourage them to do their best. Similar to Carr and May (2019), the specially designed lessons by the college students were intended to capture the students’ attention and better connect them to the learning of the math skills that they needed help with.

Knowing that students already had some negative attitudes towards math, the pre-service teachers from the college program were instructed on how to best meet the students’ needs while also helping them to overcome their concerns about math. Larkin and Jorgensen (2016) specify that students’ attitudes towards math can create anxiety, hopelessness, and avoidance of work, so to address this in the study, the researcher and college professor focused on students’ motivation and self-awareness. This would align with Vroom’s theory where students will be more successful in completing tasks if they are encouraged to recognize the value of the work or task they are completing (De Simone, 2015). When there is no purpose or value seen in learning, students will demonstrate poor achievement (Putwain et al., 2019).

With Vroom’s theory and other ideas of motivation and academic success at the forefront, Laur and Ackers (2017) determined that a variety of learning opportunities and experiences peaked students’ curiosities and increased their learning abilities. The current
study’s results would concur with the findings of Laur and Ackers (2017) in that students were engaged in the creative activities as designed by the college students, and the results of the posttests of the VMM group compared to their pretests showed an increase in math achievement and learning overall. The variety of learning opportunities for these students through the engaging and enjoyable Seesaw activities is similar to the work of Weidinger et al (2017) who found that an intrinsic desire to learn is consistently related to better achievement.

This study also aligned closely to the work of researchers who focused on academic self-concept (Schmidt et al., 2017). When students convey their perceptions of their own abilities, educators can design and implement lessons that can address their feedback and motivate them accordingly. Motivation to achieve increases when students feel they are capable. Beliefs in abilities and task completion are related, which, in turn, motivates students to feel more capable of the work that engage in (Rosenzweig et al., 2018).

Although the results of this study are not tied directly to preservice teacher preparation, it must be noted that through this study, not only did the elementary students benefit, but the college students did, too. Similar to the work of Loukomies et al. (2015), Hastings et al. (2015), and Villa and Thousand (2017), the professor of the college course focused on preparing the preservice teachers for the real world of teaching with practical tools and information on how to best instruct elementary students. Accordingly, like Smith (2018), the emphasis on the use of technology as a means to instruct students at their individual levels of learning was an area of focus of the work of the college students in this study. Differentiating the lessons for the elementary students was emphasized by the professor as it would hopefully give them more engagement in the tasks that needed to be completed (Harris et al., 2016).
Implications

In full disclosure, the results of this study completely took the researcher by surprise. As this eight-week study evolved, students demonstrated excitement and joy when seeing their college buddies online. The Seesaw activities were eye appealing and engaging, and students completed the activities on the days that they were at school; however, they had to be coaxed and reminded to complete the activities at home on the days that they were not at school. This created frustration for both the researcher and college professor who were trying to maintain the sequential flow of the work of the project.

Another area of surprise for the researcher was the improvement in the control group students’ posttest scores after the eight-week study concluded. Some of the students’ scores exceeded those of the experimental group which led the researcher to believe that the control group teachers may have felt pressured to help their students more since they were not receiving an intervention.

Although the study yielded results that showed the researcher the positive impact of virtual math mentoring on student achievement, it should be noted that future research should be conducted in a non-pandemic year. This worldwide situation with Covid-19 negatively impacted attitudes and dedication to school and the processes therein. The normal classroom learning environments, combined with student, teacher, and parent attitudes about the regularity of daily learning should be considered in a study that is similar to this one.

Limitations

To say that limitations do not exist for this study is not an accurate statement as several are evident as a result of this study. First, this study took place during a worldwide pandemic, and students and parents had already somewhat “checked out” when it came to learning and
academic achievement. Even during the study, when students were attending school only two days per week, their engagement in most school activities and overall learning was lax. Unfortunately, the effects of the pandemic were students who needed more emotional and social opportunities rather than academic pushes. The aforementioned emphasizes the threat to the internal validity of the study as students did not demonstrate engagement in learning and work accomplishment.

Another limitation from this study was the size of the sample. Although the sample size was adequate since there were at least 15 participants in each group that was compared (Gall et al., 2007), a larger size would have yielded more statistical power the results. Again, the effects of the pandemic were far reaching in this regard. Even though the original sample size as specified in the Pilot Study included 123 students from four schools, the actual sample size was sixty-six students from three schools. This was a result of several factors: (a) parents pulled their children from the public school and chose to homeschool, (b) parents enrolled their children in the Home Learning Academy where their children received all virtual learning from certified division teachers, and (c) parents chose to not allow their children to participate in the study as they did not see the educational need to do so.

There are several areas of the internal validity of this study that may have affected this study. First and foremost, elementary student and preservice teacher relatability and learning styles may not be optimal. Meeting online several times throughout the course of the virtual eight- week study may be less effective than in-person mentoring. Elementary students may feel less “connected” to the preservice teacher candidate who is trying to motivate and encourage them in their math work and skills therein.
Another threat to the internal validity of the study is the social-emotional wellness of both the elementary students and the preservice teachers. By listening to the news and other conversations from others around them, students may have felt angst or concerns to such a degree that they were unable to focus on the activities and potential learning taking place. This, in turn, impacted preservice teachers’ abilities to teach and elementary students’ opportunities to engage and learn.

As an eight-week research study taking place during a pandemic and with continued changes and quarantining in effect, the threat to the internal validity was evolving weekly. For example, soon after the study began, several college students chose to drop the class which left four of the experimental group students without a mentor, and this impacted the sample size of the study. Along with this, two of the control group students were quarantined and missed almost two weeks of school. This, too, was an unanticipated threat and impact on the study.

Besides the challenges and concerns related to the internal validity of the study, the external validity of this study was also noted. To best describe this as it connects with the control group, the Hawthorne Effect can be used. This refers to how some people work harder and try to perform better when they know they are participants in a study (Cherry, 2020). Related to this study, the control group, despite not having any interventions from the college students, did demonstrate noticeable improvement on posttests at the end of the study. This could possibly be due to the teachers working harder with their math instruction due to the pretest findings.

Other confounding factors include:

1. Gender – Since there were more males in the study than females, did this impact the study since there were more female preservice college teachers?
2. Test anxiety – When anxiety is present, testing achievement is negatively impacted (Mutlu, 2019)

3. Snow days – When students miss multiple days of school in a row, this can create inconsistencies in both elementary students and college students’ schedules. Along with this is less engagement in and focus on school related tasks and work.

4. Uninvolved parents – Supporting, encouraging, and instructing their children with academic tasks improves students’ math success (Dinkelmann & Buff, 2016).

**Recommendations for Future Research**

Research on this topic could be pursued by school divisions and educators to further understand the impact of motivation on learning. Although this study focused on 3rd grade students and math achievement, other studies could be conducted in the following ways:

1. Gender – Are boys or girls more motivated to learn with help from preservice college students?

2. Socioeconomic status – Can students who live in poverty demonstrate improvements in learning with a program like VMM?

3. Attitudes towards math – Using Likert scales, can students’ attitudes towards math be assessed prior to a virtual mentoring program?

4. Parental support at home – Does increased encouragement and motivation from parents, guardians, and caregivers impact student learning and achievement?

5. Teacher’s personality – How are teachers’ personalities impactful on students’ motivation to learn and achieve?
6. Virtual mentoring versus in-person mentoring – Is there a difference in how students will react, perform, and succeed in response to preservice teachers at a college when virtually mentored or mentored in person?
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APPENDIX A: PERMISSION EMAIL FROM SCHOOL DIVISION

September 7, 2020

Dr.
Assistant Superintendent
County Public Schools

Dear Dr.,

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for an Ed.D degree. The title of my research project is “Effects of Virtual Math Mentorships on Elementary Student Math Scores,” and the purpose of my research is to determine if third grade students who participate in virtual math mentoring programs with college students in teacher preparation programs demonstrate increased gains on math assessments due to the specialized interventions provided by the college students.

I am writing to request your permission to conduct my research in __________ County Public Schools with 3rd grade teachers and students at __________ Elementary, __________ Elementary, and __________ Elementary. The pilot study will take place from September or October to November or December, 2020, and the actual research study will take place from January or February to March or April, 2021. Elementary students will take pretests and posttests on their iPads using the divisions Performance Matters Student Growth Assessment (SGA) Assessments. Two schools’ third graders will serve as the experimental groups where students will have the virtual mentoring from the preservice teachers from __________ College after they take the pretest. The other two schools’ third graders will serve as the control groups where they will not have virtual mentoring from the preservice teachers.

The data from students’ pretests and posttests will be used to help me to determine how virtual math mentorships from preservice teachers can affect student achievement. Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission, respond by email to tmay14@liberty.edu.

Sincerely,

Tammy T. May
Doctoral Candidate
Liberty University
APPENDIX B: EMAIL PERMISSION FROM SCHOOL DIVISION ASSISTANT SUPERINTENDENT

Tue, Sep 8, 2020, 8:54 AM

Mrs. May,

I grant permission for you to conduct your study, "Effects of Virtual Math Mentorships on Elementary Student Math Scores" in County Public Schools. I wish you the best in your research.

Sincerely,

Ed.D.
Assistant Superintendent of Leadership and Academic Support
County Public Schools.
2020-10-14

Tammy May
Alan Wimberley

Re: IRB Approval - IRB-FY20-21-110 Effects of Virtual Math Mentorships on Elementary Student Math Scores

Dear Tammy May, Alan Wimberley:

We are pleased to inform you that your study has been approved by the Liberty University Institutional Review Board (IRB). This approval is extended to you for one year from the date of the IRB meeting at which the protocol was approved: 2020-10-14. If data collection proceeds past one year, or if you make modifications in the methodology as it pertains to human subjects, you must submit an appropriate update submission to the IRB. These submissions can be completed through your Cayuse IRB account.

Your study falls under the expedited review category (45 CFR 46.110), which is applicable to specific, minimal risk studies and minor changes to approved studies for the following reason(s):

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Your stamped consent form can be found under the Attachments tab within the Submission Details section of your study on Cayuse IRB. This form should be copied and used to gain the consent of your research participants. If you plan to provide your consent information electronically, the contents of the attached consent document should be made available without alteration.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

G. Michele Baker, MA, CIP
Administrative Chair of Institutional Research
Research Ethics Office