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Link Between Mathematics Pedagogy and Missouri Assessment

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LINK BETWEEN MATHEMATICS PEDAGOGY AND MISSOURI ASSESSMENT PROGRAM MATHEMATICS TEST SCORES IN FIFTH GRADERS

by

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Dedication

I delayed starting this Ed.D. journey for nearly 10 years. I realize looking back, the reason was my fear that I would be unable to succeed. I rarely start a journey I know I can't complete successfully. I know now I always had the intelligence and drive to complete this program. Self-confidence was what I lacked. I dedicate this project to my four sons: John, Elliot, Jack, and Charlie. I pray they will always have the confidence to pursue their wildest dreams, regardless of others' thoughts. May they always know what amazing and wonderful men they are and may they always see themselves through my eyes..as my guiding force and motivation. To my husband, Andy, who was able to see me seven years ago as I am able to see myself today. He strengthened me and brought trust and safety into my life that I hadn't known as an adult. I am a better version of myself most days because of him. To my parents and brother who showed me that education is a journey that lasts a lifetime, I thank them for their support. To my colleagues who became my friends and sisters, the daily struggle was real, but the laughter, tears and honest loving talks got us through. I hope to always have colleagues with whom to share and bond like family. Finally, to my committee, who put up with my crazy self-imposed timelines.

Abstract

The researcher studied the correlation between mathematics pedagogy and fifth grade test scores on the Missouri Achievement Program Mathematics Test, utilizing data from 2019 to avoid the effects Covid-19 had on the education system. All fifth graders attending public schools in Saint Louis County were studied using the data released by the Department of Elementary and Secondary Education. The first research question pertained to a correlation between mathematics pedagogy (Spiral, Strand or Blended Method) and overall fifth grade test scores on the Missouri Assessment Program Mathematics Test. The second question tested whether correlation existed between mathematics pedagogy and test scores for Lower SES students. The third question tested whether correlation existed between mathematics pedagogy and Black fifth grade test scores on the Missouri Assessment Program Mathematics Test. The final research question tested whether pedagogy closed the achievement gap between Low SES, minority students and the overall population on the fifth grade MAP Mathematics Test (MAPMT). The researcher found the Strand Method correlated with higher test scores for the overall population and the Low SES population, but the Black population scored best utilizing the Spiral Method. The Blended Method had the lowest difference between all subgroups. The researcher recommends that districts adopt a methodical mathematics program that utilizes the Strand Method. Further, the researcher suggests students be grouped by both learning style and ability. Mastery is required before students proceed to subsequent concepts.

Keywords: mathematics, pedagogy, MAP

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Chapter I: Introduction

Introduction

The United States does not fare well when compared with other countries in mathematics (Venezky, 2018). In 2018, the United States ranked 37th out of all countries taking the Program for International Student Assessment (PISA) Mathematics test (PISA, 2018). Conjecture exists on why the United States is behind. The difference between the United States and other countries is mathematics pedagogy in the elementary grades. Educators in the United States teach multiple concepts on a surface level whereas other countries teach fewer concepts, delving deeper into each concept (Richards, 2020). The achievement disparity is exacerbated when mathematics achievement scores for Low SES students and minority students are considered (Ansari, 2015).

Mathematics scores from primary school can be tied to economic success later in life (Richards, 2020). Students in the United States who master mathematics skills can lower the poverty rate. The purpose of the present study was to examine whether a correlation existed between mathematics pedagogy at Missouri elementary schools and Missouri Assessment Program Mathematics Test (MAPMT) scores in fifth grade. Currently elementary schools in Missouri split between teaching mathematics using two different pedagogies: Strand and Spiral. Since these two pedagogies are not complementary, districts pick one or the other, although the Bridges Mathematics Program attempts to blend the two. Middle schools mainly teach using the Strand Method since it aligns with high school mathematics teaching pedagogies. The researcher isolated independent variables such as minority populations and socioeconomic status (SES), reported through the Missouri Department of Elementary and Secondary Education, to test whether a relationship existed between pedagogy and achievement. Results from the present

study could inform mathematics educators regarding a theoretical framework and pedagogy that is advantageous to student success in mathematics education.

Context

Fifth grade students who take the MAPMT and score between 410 and 434 are deemed Proficient in mathematics (DRC, 2019). The overall fifth grade population in Saint Louis County scored 313.6 in 2019 whereas the subgroup population (minority and low SES) scored an average of 272.3 in mathematics. Data from 2019 was the focus of the present study, as it was the most recent data exempt from the required teaching changes imposed by Covid-19 mandates. The present study examined the different methods for teaching mathematics, focusing on the Strand, Spiral and Blended Methods. The research goal was to identify a pedagogy that ensures all students are taught in a way that promotes success.

Methods of Teaching Mathematics

The International Bureau of Education (IBE) defines the Strand Method of teaching as, "grouping the general and specific learning outcomes or achievement aims and objectives within a particular learning area or discipline" (International Bureau of Education, 2016). The Strand Method of mathematics adheres to the philosophy that fewer mathematics topics need to be taught each year, allowing students to delve deeper into each topic, increasing true understanding (Clark, 2014). This is the more traditional pedagogy where each chapter in a text focuses on one skill and is assessed at the end of the chapter. At the national level, the Common Core Standards advocate for a Strand based method of teaching mathematics, focusing on fewer standards, but attempting to develop deeper student understanding of each standard (Kornhaber et al., 2014). Common Core focuses less on memorization and more on understanding of concepts, often having students explain their reasoning or demonstrate problem solving skills (Mongeau, 2016).

Common Core Standards removed memorization requirements and instead placed focus on teaching processes that promote understanding number concepts and strategies in elementary schools.

The Spiral Method, in contrast, for teaching mathematics focuses on more topics each year over the span of many years, repeating each topic every few days (Clark, 2014). With this method, students are introduced to more concepts than when using the Strand Method, but are only given surface-level exposure. The Spiral Method spaces learning over time, allowing for better mastery (University of Chicago Mathematics Project, 2022). The Spiral Method introduces concepts early and repeats the same skills in a cycle, allowing students time to process and master each skill. Spiraling also introduces concepts at a much younger age than the Strand Method of teaching. The Spiral Method is widely used in elementary schools in the United States, though other countries typically use the Strand Method (Clark, 2014).

The Blended Method is a mix of the Spiral and the Strand Method. One mathematics text, *Bridges*, utilizes this methodology. *Bridges* utilizes a Spiral Review during calendar time, at all grades, and a Strand Method for the main lesson. Districts claiming to use the Blended Method may also use a Spiral Review at the start of class and a Strand Method for the main lesson. The researcher counted both examples as a Blended Method in the research.

SES and Race Gap in Mathematics

The United States suffers from two learning inequities in mathematics, one regarding a learning gap based on race and another regarding socioeconomic status (Garcia & Weiss, 2020). Attending a school with a higher than 50% free and reduced lunch population positively correlates to lower mathematics scores on National Assessment of Educational Progress (NAEP) and MAPMT (Carnoy & Garcia, 2017). Schools in the United States are highly segregated,

meaning schools with low SES students often have higher numbers of minority students. Further, schools in poorer neighborhoods typically have less resources to help students (Amadeo, 2022). In addition, poorer schools frequently have less experienced teachers because they pay less, so more experienced teachers move to higher paying districts (Carnoy & Garcia, 2017). When poverty is isolated on the PISA, the United States' scores become comparable with other leading countries (Marchant & Holmes, 2016).

How to Raise Achievement in Schools in the United States

In 2018, the United States ranked 37th among 79 countries in mathematics (Richards, 2020). This statistic is troubling given the US is considered a leader among developed countries. The difference between the US and other countries is how the US teaches mathematics. According to the NAEP, the fourth grade is where the US starts to fall behind other countries (Snider, 2004). Countries scoring higher than the United States tend to focus on fewer skills, focusing on those skills for about three years. Students dive deeply into skills, mastering them, before pursuing new skills. Students develop a solid mathematics foundation when given the time to master concepts completely. In contrast, districts in the US focus on 10 to 15 concepts each year and repeat the same skills, often without mastery attainment (Snider, 2004). The Common Core Standards attempt to focus on fewer concepts in mathematics (Kornhaber et al., 2014), but this change has yet to have an impact on how mathematics is taught. Committing to change in mathematics pedagogy will foster greater achievement in the US.

Purpose of Study

The purpose of the present study was to determine the best pedagogical method for mathematics instruction. The data reflects the most effective pedagogies for mathematics instruction in elementary grades, the Strand Method, the Spiral Method, or a Blended Method.

Since mathematics is such a large indicator of future success, finding a way to teach mathematics that reaches all students, regardless of race or SES, is imperative to US global competitiveness. Results from the present study could affect the number of people living in poverty in the US, since negative mathematics scores are correlated to lower income (Ansari, 2015). After completion of the present study, the researcher will organize the mathematics standards into a sequential order based on Cognitive Learning Theory. This sequential organization will help determine when particular skills should be taught as well as how many skills should be taught each year.

Further, data from the present study may be used to help determine which pedagogical method works best for the overall population of Missouri elementary students, including low SES and minority students. The data can also be used to determine how best to identify students who are falling behind. Research-based instruction helps students to receive the mathematics education needed for success.

Conceptual Framework

Elementary mathematics is an area of struggle for students in the United States (Richards, 2020). Since the US teaches mathematics differently than other countries, some believe the methods used in the US are wrong (Ansari, 2015). To gain perspective, researchers must determine the mathematics pedagogy used in the US and compare them with other countries. Further, achievement data must be considered. The present study focuses on finding the best pedagogy to teach elementary mathematics to achieve the best results as measured by the fifth grade MAPMT.

Gaps exist for low SES and minority students when compared with the overall population (Carnoy & Garcia, 2017). Finding ways to close achievement gaps are critical to student success.

The present study examines the scores of students from low SES populations as well as Black students and compares their scores on the MAPMT with the overall population. As a further step, the present study considers the mathematics pedagogy used.

Research Questions/ Hypotheses

The overarching problem is determining which pedagogy results in higher test scores on the MAPMT for fifth grade students. Currently, three types of pedagogy are used. The first is the Spiral Method, where concepts are introduced frequently and then repeated often, with new concepts mixed in daily. The second pedagogy is the Strand Method, where competencies are clustered by concept and taught until mastery. The third is the Blended Method, an approach utilizing Spiral and Strand, used by some school districts.

The second set of guiding questions relates to the inequity of mathematics education in the United States, identifying which teaching method works best to close achievement gaps for subpopulations. Factors such as poor schooling, SES, race, and exposure to early education require consideration. Teachers who understand mathematics pedagogy need to be recruited to poorer districts to help decrease the differences in student educational experiences. The goal, therefore, is to determine which mathematics pedagogy results in mastery for all students so a comprehensive and cohesive mathematics program can be created. A comprehensive and cohesive program facilitates mathematics mastery and makes the US more globally competitive.

Significance of Study

The current research has implications for preschool through post-secondary education as well as implications for practical use. Focused and efficient mathematics instruction influences all education levels. A stronger mathematics education also affects the workforce (Ansari, 2015). When the United States maintains a mathematically capable job force, it can compete with other

countries (Richards, 2020). In addition, the US will maintain a pool of mathematically adept employee candidates, fostering hiring from domestic sources as opposed to outsourcing for foreign workers. According to Ansari (2015), this creates a much stronger US economy.

The highest performing pedagogy can be used to construct a learning continuum for mathematics that aligns with brain development, one that starts in early childhood and continues through higher education. A learning continuum ensures students have the same skills when entering higher education, requiring fewer remediation courses. In addition, this creates a sense of equality as students receive the same access to mathematics instruction, regardless of the elementary or high school they attend.

A mathematics program that fosters mathematics understanding as opposed to memorization makes students globally competitive (Richards, 2020). Students graduate job-ready, saving employers money. A study conducted by The National Center on the Educational Quality of the Workforce found that a one-year increase in mathematics education equated to an 8.6% gain in productivity in the workforce (Lappan, 1999). The same study also found that employees in the 25th percentile in mathematics achievement earned roughly 37% more than their peers. Higher paying careers help mitigate the poverty problems in the US, increasing career mobility and earning power (Ansari, 2015).

Definitions/ Terms/ Symbols/ Abbreviations

Low SES. For the present study, low Socioeconomic status is defined as any student who is on free and reduced lunch according to the state records (DRC, 2019).

Missouri Assessment Program Math Test (MAPMT). MAPMT is the test that is given annually to students in Missouri (DRC, 2019).

Spiral Method. The form of teaching in which a new concept is taught each day, and then retaught a few days later. The tests for this method are over several concepts (University of Chicago Mathematics Project, 2022).

Strand Method. The method of teaching each concept for several days or even weeks and then testing over it, before moving on to the next skill (International Bureau of Education, 2016).

Summary

The United States lags mathematically when compared to other countries, according to the PISA Mathematics Assessment (Richards, 2020). Other countries teach mathematics using the Strand Method, focusing on fewer skills for longer amounts of time, building a strong foundation for mathematical thinking. However, US schools, for the past 20 years, have mainly utilized the Spiral Method, teaching many concepts over and over in a cycle, to ensure exposure to all concepts (University of Chicago Mathematics Project, 2022). Currently, Missouri is split between three mathematics teaching pedagogies: The Spiral Method, the Strand Method, and the Blended Method. The researcher examined all pedagogies to determine which pedagogy is most effective for educating students, as determined by results on the fifth grade MAPMT. This information is critical because mathematics ability closely correlates to future success. In addition, improvements in mathematics education could help break poverty cycles, as mathematics scores positively correlate to adult income levels (Ansari, 2015).

Chapter II: Literature Review

Introduction

Elementary mathematics pedagogy needs data-driven research to determine the best pedagogies for instruction. Middle school mathematics is taught predominantly using the Strand Method. Elementary mathematics is still taught using various methods with texts lending themselves to pedagogical methodologies. The three main instructional methods utilized for mathematics in the United States are the Strand Method, the Spiral Method, and the Blended Method. The National Testing Assessment Program asserts that the United States falls short compared to international mathematics scores (Venezky, 2018). Mathematics learning theory and brain development need to be considered to find the best way to teach mathematics to elementary students. Further, a gap in standardized test scores across the nation exists between minorities and low socioeconomic status (SES) students (Garcia, 2020). Elementary mathematics scores are correlated to pay and employee productivity in later years (Garcia & Weiss, 2020). One way to secure economic stability is for the US to adapt a mathematical pedagogy that ensures students' mathematics skills are internationally competitive.

Cognitive Learning Theory and brain development need to be accounted for when planning mathematics instruction. Learning theorists focus on different approaches to learning, but all can be applied to mathematics education. Different texts also lend themselves to differing pedagogies and theories. Piaget asserted that there exist four main stages of brain development: sensorimotor, preoperational, concrete operational, and formal operational (McLeod, 2023). Students need to be taught in a way that accounts for their stage of brain development. Concepts need to be presented to students when their brain is developmentally ready, meaning US mathematics programs need to change the way math is taught.

No prescribed methodology for mathematics instruction exists in the US. In fact, the US relies on three different mathematical pedagogies for teaching elementary students. The Strand Method utilizes units based on one concept and concepts become increasingly difficult over time (International Bureau of Education, 2016). The Spiral Method utilizes multiple concepts taught in rotation, with the teacher spending a day or two on each concept before circling back and going deeper into a previously taught concept (Braams, 2003). The third method is a blend of the previous two, called the Blended Method, utilizing a Spiral Review at the start of class and a strand-based lesson as the main lesson. *Bridges*, an elementary mathematics text, attempts to combine the two by including a morning meeting component that uses the Spiral Method and the mathematics block that utilizes the Strand Method (The Math Learning Center, 2022).

It is commonplace for US teachers to use broad strokes when covering mathematics concepts. Other countries focus on fewer skills each year, taking time to ensure mastery (Venezky, 2018). Common Core Standards were released nationwide and were adopted by 45 states in 2009 (Strauss, 2021). Importantly, these standards focus less on memorization and more on explaining and understanding processes (Public Broadcasting Services (PBS), 2020). However, state high-stakes testing quickly required teachers to revert to "teaching to the test," focusing on skills for the test. Teaching to the test negates the deeper understanding that Common Core Standards hope to emphasize (Venezky, 2018).

Standardized mathematics testing reflects gaps in scores for both non-White and low SES students (Garcia, 2020). According to Amadeo (2022) Black students scored roughly two years behind their peers on standardized mathematics tests. Students from a low SES background, as determined by free and reduced lunch status, scored even further behind their peers with the achievement gap nearly double that of the racial achievement gap (Russ, 2020). There are several

contributing factors to these achievement gaps, including poorer schools, lack of pre-existing knowledge, and a difference in quality teachers.

Mathematics education is the key to future success in the workforce. Correlation exists between mathematics achievement in elementary school and adulthood productivity, pay, and career mobility (Boser, 2020). Mathematics education in the United States lags compared to other developed countries (Strauss, 2021). Differences include the number of concepts taught per year and the amount of time spent on each skill, as well as the depth teachers take with each concept (Lessani et al., 2016). The US can enhance its mathematics programs and help end the poverty cycle by teaching fewer skills and providing resources to poorer schools, making mathematics education more equitable (Flores, 2013).

Learning Theory

Different learning theories exist and have trended differently throughout history, dependent on the needs of education. Behaviorist, Humanist, and Cognitivist learning theories comprise the most well-known in the scholarship. Each theory ties to mathematics instruction through the application of different pedagogical approaches.

Behaviorists advocate for memorization, encouraging repeated procedures to gain understanding (Handal, 2003). Further, teacher-directed and teacher-led learning is a key belief. For example, the teacher delivers the mathematics lesson and the teacher instructs students on which processes to use and which steps to follow to solve mathematics problems (Lessani et al., 2016). Handal (2003) asserted, the mathematical pedagogy of the Behaviorist is to encourage one-way problem solving and rote process memorization.

Humanism is a popular learning theory in the current educational context. The closing of schools caused by Covid-19 lockdowns required educators to employ a whole person approach

to education (Saunders & Wong, 2020). Humanists assert that teaching mathematics through historical connections works best, discussing when the mathematical theory was founded, starting with concrete examples before moving on to more abstract thinking (Tennant, 2022), The popular mathematics program, *Mathematics in Focus,* adheres to this theory. *Mathematics in Focus* begins with concrete examples supported by manipulatives and then scaffolds students to more abstract thinking (Cavendish, 2022). For example, using counters to show addition or having students draw pictures of the problem comprise the first, manipulative supported steps. Afterwards, students are moved forward to numbers-only models. In contrast to Behaviorist Theory, Humanist Theory is teacher led, with a slow, guided release of information to students (Tennant, 2022).

Cognitivist Theorists desire students to focus on mathematical thinking (Pea, 2007). The Cognitivist approach encourages mathematical processes to be memorized, but ensures students can explain their thinking, describing why a process worked. Cognitivists believe quick recall is the key to success in all areas (Saunders & Wong, 2020). For example, drill and practice are encouraged in mathematics with timed fact tests that require quick recall, requiring students to correctly apply processes to derive solutions. In addition, cognitivists find interleaving useful in mathematics (Mills, 2020). Interleaving occurs when students receive mixed practice sheets, forcing them to demonstrate understanding of which process to use in specific situations. Teachers using a skill that was previously taught as a bell ringer activity later in the week is an example of interleaving.

Brain Readiness

While mathematics learning theories explain how students learn best, the key to implementing any education program is deciding the sequence in which to teach skills. Brain

development should be considered to make wise determinations about the mathematics sequence (Saunders & Wong, 2020). Further, brain development should be considered when deciding the appropriate pedagogical method needed to teach mathematics skills. Piaget asserts four main stages of development exist: sensorimotor, preoperational, concrete, and formal.

The first stage of brain development is sensorimotor, lasting from birth until the acquisition of language (Ojase, 2008). Sensorimotor development includes oral counting and using objects to show one-to-one correspondence. The best ways to help mathematics development at this age, and at this stage, includes reading about numbers and allowing children to explore their environment (Saunders & Wong, 2020). Teachers should allow students to explore using blocks, shapes, counters, and pictures of numbers.

Preoperational brain development occurs from ages two through seven (Rice, 2011). The preoperational stage, Ansari (2015) asserted, is where basic concepts should be taught such as numeric operations and fact families. The preoperational stage includes two stages: preconceptual, lasting from ages two to four, and intuitive, lasting from ages four to seven (Rice, 2011). During the preconceptual stage, students focus on concrete learning, using shape models or concrete manipulatives, describing them and/or listing their attributes. Teachers can ask students to notice patterns using shapes, numbers, or colors. In the intuitive stage students begin to order objects and compare pictorial representations of more and less. Students are encouraged to ask and answer questions and to start putting words to their thinking process.

The third stage of development is the concrete operational stage (Saunders & Wong, 2020). This stage occurs from ages seven to eleven and, Rice (2011) asserted, needs to be the focus of elementary schools. Students do best with hands-on activities at this age and use those experiences to apply the concepts abstractly (Ojase, 2008). During this stage students use logic

for the first time (Rice, 2011), thinking through problem solving, explaining the steps they took, and applying the process to other problems. Students benefit from talking about mathematical processes with peers as well as hearing how others solved problems (Digitale, 2011). In addition, students at the concrete operational stage apply the concept of inverse operations using reversibility (Rice, 2011). The benefit from scaffolding, building from concrete, to pictorial, to abstract representations is critical at this stage of development (Cavendish, 2022). Finally, students at this stage combine numerical thinking and working memory, allowing them to recall and solve problems (Digitale, 2011).

The final stage of brain development is the formal operational stage which lasts from ages eleven to fifteen (Rice, 2011). In this stage of development students apply known concepts to abstract or hypothetical situations. According to Osaje (2008), students apply previously learned concepts in new situations, predicting outcomes for events they have not experienced. Further, in the formal operational stage students, asserted Rice (2011), start applying what they have learned to real life experiences and situations. Classes such as engineering or computer programming, that tie the concepts to the real-world, work best at this phase. Students benefit from using the theories they have learned to practice, creating, and interpreting data and applying skills to computer programming and coding (Digitale, 2011).

Brain development means students master certain skills during different stages in their development. The stages of brain development help educators decide which skills should be taught when. Because the brain cannot think abstractly until later in development, it is imperative to scaffold mathematics skills and concepts (Saunders & Wong, 2020). Brain-based theory, according to Jensen (2008), helps correct for trauma in mathematics education, decreasing the achievement gap.

Mathematics Pedagogies

Mathematics is primarily taught three different ways in elementary schools in the United States. The Strand Method of teaching focuses on learning skills to mastery and then moving on to the next skill (International Bureau of Education, 2016). The Strand Method teaches students one-digit by one-digit addition. When mastered, the teacher moves on to two-digit by one-digit addition. At the conclusion of the addition unit the teacher gives a formal assessment. The Spiral Method teaches a new skill every day and loops back to the previously taught skills over time (Braams, 2003). Spiral Method teachers may teach one-digit by one-digit addition one day and, the next day, they would work on subtraction. On the third day the teacher may expose students to shapes. On day four, the teacher would review the addition introduced on day one. The Blended Method is a combination of the Strand Method and the Spiral Method. A teacher using the Blended Method provides a Spiral Review at the beginning of class, reviewing previously taught skills. The main lesson focuses on the Strand Method of instruction. Limited analytical research exists comparing which of the three pedagogies works best for elementary mathematics students. Due to the nature of middle and high schools, where work is divided into quarters or semesters, each typically relies on the Strand Method (International Bureau of Education, 2016). Because children's brains are still in the preoperative stage in elementary school a different pedagogy for teaching mathematics may be appropriate (Saunders & Wong, 2020).

Spiral Method

The Spiral Method presents the same concept to students repeatedly with other skills included. The difficulty level of the skill increases incrementally each time the skill is introduced (Orale & Uy, 2018). One drawback to the Spiral Method relates to mastery. For example, if students do not master the skill the first time, the next time the skill is taught it carries more

complexity, widening the student deficiencies. Advocates of this method believe increasing amounts of exposure reduces the likelihood of forgetting (Braams, 2003). The Spiral Method suggests misunderstandings can be overcome in small groups before the concept is retaught again a week or two later (Orale & Uy, 2018). Teachers must utilize small group targeted instruction to work with the struggling students between the different "Spiral" loops (Braams, 2003).

Strand Method

The Strand Method is based on mastery learning. Students are taught the same concept for days or even weeks until mastery is achieved and then the next concept is introduced (International Bureau of Education, 2016). The Strand Method focuses on scaffolding and building on previous knowledge. Elementary schools rely on teaching skills using manipulatives, then pictures, then the abstract method. Opponents of the Strand Method believe focusing on the same skill for long periods of time risks losing students who struggle with the current concept (Saunders & Wong, 2020). The fear is that there will not be time for reteaching before building onto the current skill and scaffolding to the next level. Further, students may forget the skill later in the year if the skill has not been taught for months. The Strand Method gives an assessment upon completion of the unit to assess mastery before moving on to the next skill (International Bureau of Education, 2016). Yang (2007) found use of the Strand correlated to higher grade point averages for students in fifth grade.

Blended Method

The Blended Method attempts to combine Spiral and Strand. The Blended Method focuses on a quick Spiral Review during the day, usually at the beginning of the mathematics lesson, used to review previously taught skills. The main lesson is taught using the Strand

Method, with the same concept in focus for several weeks. Proponents of the Blended Method believe it offers a mix which allows mastery without risking a loss of knowledge. Opponents of the method believe students' confusion occurs when different skills are taught and reviewed on the same day. Currently, *Bridges*, a mathematics textbook is the sole source utilizing the blended pedagogy (The Math Learning Center, 2022). However, some schools make use of the Blended Method with their own resources.

Learning Theories Within the Pedagogies

Each learning previously discussed can be applied to each pedagogy. Behaviorists would favor the Strand Method's approach of daily repetition (Saunders & Wong, 2020). Behaviorists would disagree with the Spiral Method's approach for teaching multiple ways to solve one problem. The Humanist view of studying the history of a concept and then applying the mathematics skill more closely aligns with the Strand Method philosophy of spending consecutive days on the same skill. Humanists support the idea of scaffolding which is key to the Strand Method. Finally, Cognitivists align best with the Spiral Method of teaching, relying on the idea of interleaving, frequent revisiting of concepts, to help students remember previously taught concepts.

Textbook Adoption and Pedagogies

The adoption of mathematics textbooks at the elementary level is crucial as texts determine how a subject is taught and what pedagogy is used (Crawford & Snider, 2000). The problem is district textbook adoption committees are not trained in education or mathematics pedagogy. An additional problem stems from statewide adoptions, limiting the variability of textbooks. Twenty-two states have mandated statewide adoption. Textbook companies further complicate the process. They design their texts to obtain the largest contracts and they match the

writing to the desires of states whose statewide adoptions steer decision-making. Further, textbook publishers are the same companies that write high stakes tests, creating a monopoly of thinking regarding teaching pedagogies, manipulating the test content to show that their specific text is the best (Strauss, 2021). Finally, field testing is rare when considering new textbook adoption. As a result, districts do not have any data to substantiate adoption decisions. Data collection is increasingly difficult given standardized testing results delays, often months until after the adoption time frame.

Spiral versus Strand Methods

Limited research exists concerning the best pedagogy for elementary level mathematics. The researcher located two studies that examined elementary mathematics pedagogy. The first study, Crawford and Snider (2000) was conducted over 20 years ago on fourth grade students. It compared the Strand Method to the Spiral Method. The second study, Agodini (2013), focused on teacher lesson delivery. Agodini followed four different texts: one that was teacher-led, two that used short mini lessons, and the fourth text emphasized student-led investigations. Further research, focused on mathematics pedagogy for elementary students is limited.

For example, Crawford and Snider (2000) followed a fourth-grade cohort for two years. Their study compared two classrooms finding students using the Strand approach scored better on the standardized test at the end of the first year. Because the researchers wanted to ensure that it was the teaching approach and not the teacher, in the second year, both teachers used the direct approach. At the conclusion of year two, the second teacher's scores also showed higher growth than her scores from the previous year (when she used the Spiral Method). The authors concluded the direct instruction approach for mathematics worked better. Given their limited

focus, however, study results cannot be generalized to include all fourth-grade students. Further, similar studies are needed to determine generalizability.

In 2013, The Institute of Education Sciences (IES) studied three different types of mathematics textbooks. One text utilized student-directed, self-paced investigations (Agodini, 2013). The second text was teacher led. The third used a blend of mini-lessons led by the teacher as well as student independent work time. The IES study compared standardized test scores of students using the different texts, concluding students scored better on standardized tests when teacher direction was involved. Further, the study found self-guided texts did not work for students in early elementary. There was no statistically significant difference for the text that included mini-lessons when compared to the text that was entirely teacher led.

Research supports the notion that focusing on fewer mathematics skills, in elementary grades, leads to increased mastery (Snider, 2004). Other countries focus on three or four skills each year in the primary grades, taking the time to dive deeply into those concepts, building strong mathematical skills foundations. Snider found when harder skills were not introduced until upper elementary, students had better foundational understanding of mathematics and, as a result, scores on international mathematics tests improved. Snider further found that the largest decrease in scores for the United States occurred around the fourth grade. This drop was attributed to the skills on the National Assessment of Education Progress (NAEP) becoming more abstract at the fourth-grade level. Simply stated, US students lacked the foundational skills needed to complete abstract problems.

Limited research exists comparing different mathematics pedagogies in the US. Research is clear that the US lags compared to other countries on international mathematics tests, such as the PISA and NAEP. However, the US pedagogy itself has not been studied in depth (Garcia &

Weiss, 2020). The Strand Method and the Spiral Method for teaching mathematics are the most used forms of instruction in elementary schools (Strauss, 2021). Though the mathematics textbook, *Bridges,* introduced a blend of the two methods, the preponderance of textbooks choose one method or the other (The Math Learning Center, 2022). Research on which method works best for elementary students is warranted. Further, texts and testing need to be shifted to match the pedagogy that is most effective for students.

Mathematics Pedagogy in the United States

Literacy has been the primary focus of the US education system for many years. Mathematics, for the past twenty years, has seen an increased push in research and focus. Currently, the US focuses on teaching students as many concepts as possible, as quickly as possible, due to the demands of high stakes testing (Venezky, 2018). However, teaching multiple concepts quickly brings problems, failing to give students time to gain the kind of in-depth understanding needed to compete with other countries. Scores on both PISA and NAEP show students from the US lag compared to their peers, especially in upper grades when the skills require a stronger mathematics foundation. Further, students in the US perceive themselves as poor mathematicians by middle school, an attitude affecting their ability to achieve (Wagner, 2015). Simply stated, mathematics mastery needs to be achieved before moving on to subsequent concepts (Bitgood, 2022).

Without debate, the US relies heavily on high stakes tests to prove success in elementary school. The US tests students more than any other nation (Strauss, 2021). One downside of high stakes testing resides in the fact that teachers often teach to the test, instead of focusing deeply on concepts, leading to a weak mathematical understanding (Venezky, 2018). On international tests, such as the PISA, students from the US score equally as well as students from other countries on

multiple choice questions. The same is true for state testing such as the Missouri Assessment Program Mathematics Test (MAPMT). The gap in scores is reflected in the short answer section, where students are required to explain their work. Further, the gap in achievement between students from the US and their international peers widens as the students enter high school and the mathematics concepts become more complex and abstract (Strauss, 2021).

In 2010, Common Core Standards were written and adopted by 45 states to help curb the memorization approach to teaching mathematics (Strauss, 2021). The new standards promised to focus more on mathematics processes and critical thinking instead of memorization, exclusively (Kornhaber et al., 2014). The elementary school years should be focused on learning the foundational skills in mathematics, skills such as counting, composing numbers, decomposing numbers, and fact families. These are the building blocks to mathematics foundations. Strong mathematics foundations would, according to Richards (2020), make learning new concepts easier in middle school. Common Core aimed to do this by having standards focus on teaching students how to explain their work and on mastering different processes (PBS, 2020). However, Common Core links to high stakes tests meant teachers still taught to the test (Strauss, 2021). Further, texts, written by test makers, focus on exposing students to as many skills as possible each year, encouraging teachers to introduce new concepts before mastery to ensure comprehensive exposure prior to the test (Venezky, 2018). However, exposure is not the same as mastery, and moving on before mastery creates conceptual gaps in learning (Bitgood, 2022).

The memorization and fast paced approach to teaching mathematics leaves students confused and unable to dive deeply into mathematical concepts (Venezky, 2018), causing students to feel as if they lack understanding. Students need a solid base of procedures and concepts to feel confident in skills (PBS, 2020). A negative perception of a student's own

achievement in mathematics hinders their future success. As a result, teachers need to take time to watch students work on mathematics problems and understand the processes that the students are using to catch errors in thinking (Samara & Clements, 2009). Further, time needs to be given to students to talk about mathematics, to explain their thinking, to determine true mastery. Discussion, commonly known as "mathematics talks," allows teachers insight into how students are solving problems and where there may be misconceptions. Venezky (2018) argued, discussion helps students gain confidence in their own mathematical skills.

Overall standardized test scores in mathematics in the US have remained flat for the last 20 years (Richards, 2020). In 2013, middle school mathematics students scored 36th out of 65 nations taking the PISA (Barshay, 2020). In 2018, the US scored 37th out of 78 nations, showing little forward growth in five years. These statistics call for action to approve mathematics in the U.S.

Missouri and Mathematics

Missouri teaches mathematics using standards created specifically for Missouri (DRC, 2022). Missouri mathematics begins with the broad Show-Me Standards which include six overarching concepts that all students should know upon completion of high school. The Show-Me Standards are broken down into Missouri Learning Standards, grade specific and detailed descriptions of what skills should be taught in each grade. The Learning Standards are broken into five strands:

1. Number Sense and Operations in Base Ten
2. Number Sense and Operations in Fractions
3. Relationships and Algebraic Thinking
4. Geometry and Measurement

5. Data and Statistics.

The strands are further broken down into the specific learning skills. Fifth grade mathematics in Missouri covers 32 different skills in the five strands. The state test, which is only used by Missouri, is called the Missouri Assessment Program Math Test (MAPMT) and is based on the Missouri Learning Standards.

Effects of Poverty on Achievement in the United States

Poverty plays a role in the ranking of students on mathematics tests in the US (Barshay, 2020). The US would rank near the top on PISA if the scores of students living in poverty were isolated (Lubell, 2019). There are a few factors that cause the mathematics achievement gap on standardized tests, the psychology of children in poverty and their brain development (Barshay, 2020). Stabilizing measures need to be found to correct for both background and poor schooling for the US to close the achievement gap (Lubell, 2019).

Poverty affects brain development and one's readiness to learn. Living in poverty causes increased stress and achievement gaps in children (Jensen, 2008). In addition, stress affects the brain's ability to function (Phang, 2017) and toxic stress, or long-term stress, can change the brain's chemistry and formation. Increases in the amount of the stress hormone cortisol lead to mood changes and memory changes. Not only is a hungry child unable to focus on what they are studying, but their brain is also less likely to remember what they hear because high cortisol weakens the brain structure. Increased cortisol and the inability to focus contribute to the cognitive gaps mentioned by Jensen (2008). Cognitive gaps form as early as the sensorimotor stage, before formal schooling starts (Ojase, 2008). A child living in poverty does not have the same opportunities or exposure to learning before kindergarten compared to their more affluent peers (Phang, 2017). As a result, poor students often enter school academically behind their

peers. Further, children who lived in poverty during their early years, graduate high school 30% less often than those who did not live in poverty until later in life (Morrissey, 2020). Quality and affordable early childhood education can correct these gaps by assisting in the identification of learning disabilities earlier, giving teachers and parents the tools needed to start working on interventions before kindergarten even starts. The achievement gap, Flores (2013) asserted, is really an opportunity gap that starts almost at birth.

Nearly everyone in the United States has access to free schooling, but it is inequitable schooling (Hall, 2015). Attending a high poverty school, one where more than 50% of students receive free and reduced lunch, lowers mathematics scores in all student groups (Carnoy & Garcia, 2017). In 2013, more than 40% of Black and Hispanic students attended high poverty schools. In contrast, their White peers are more likely to go to wealthier schools and have more access to computers. Teachers who emphasize reasoning, problem solving, and who show simulations to better help students understand concepts, are more likely to work at wealthier schools (Flores, 2013). One way to break the poverty cycle is by investing in making the schooling system equitable across the US (Primi et al., 2020). Public schools depend on the community's tax base for their revenue and schools in wealthier areas have a greater revenue to buy materials and pay teachers (Flores, 2013). Schools that serve a larger percentage of low SES students have fewer experienced teachers. Teacher efficacy has the greatest effect on student achievement (Hattie, 2015) and, as a result, teachers with greater experience move to higher paying districts. In contrast, poorer schools are often filled with new teachers or teachers who have been released from other districts (Flores, 2013). Therefore, students with the greatest needs are taught by novice teachers, furthering the achievement gap (Garcia & Weiss, 2019).

Achievement Gap by the Numbers

The US suffers from an achievement gap in not only mathematics, but in all subject areas, based on standardized test data. There is a clear achievement gap in both race and low SES students (Dynarski et al., 2017). A closing of these gaps needs to be achieved to help all students have an equitable chance at success in the future (Egalite, 2016). Black and low SES students are less likely to attend schools that have personal computers with teachers who are less likely to teach using technology (Flores, 2013). According to Wagner (2015), low mathematics scores on standardized tests correlates with struggles in career and wealth in the future. The US needs to find ways to ensure all students are given access to education from an early age. Students need to have access to quality educators and interventions starting in early childhood and money needs to be given to poorer schools to help them gain the resources needed to ensure all students in the US have equal opportunities (Flores, 2013).

The performance gap based on race in standardized tests is shrinking, but it is still very troublesome and the difference in scores shows inequities in education (Carnoy & Garcia, 2017). For example, Black and Hispanic students score two to three years behind their White peers on standardized tests (Amadeo, 2022). The research on National Assessment of Educational Progress (NAEP) found that Black 12th graders scored the same as White eighth graders (Flores, 2013). By eighth grade, 91% of Black students and 87% of Hispanic students were not proficient in mathematics, based on NAEP data. The gap is greater in extended response questions on the NAEP, with minority students scoring 32% lower than their peers. Students of all ethnicities and SES groups scored nearly equal on multiple choice questions.

One in five students currently live in poverty (Russ, 2020). Students living in poverty or who are deemed low SES, based on free and reduced lunch status, show gaps in achievement on

standardized tests (Garcia & Weiss, 2020). By third grade, students in the low SES group score .84 standard deviation points behind their peers on average (Dynarski et al., 2017). The achievement gap between SES levels is twice as large as the race achievement gap (Russ, 2020) and has grown in the last 25 years (Dynarski et al., 2017). The US could correct the effects of poverty in our education system by creating an equitable education system and increasing mathematics achievement (Lubell, 2019).

The standardized tests show the gaps but fail to show the reasons why they exist. The quality of teachers was discussed prior, but there is also a difference related to how teachers perceive different students. Black students, for example, are more likely to be pushed out of the harder mathematic tracks due to false assumptions by teachers (Flores, 2013). Teachers often give White students the benefit of the doubt and promote them to harder classes, while their minority counterparts aren't afforded the same. The test given to decide the tracking of students can be biased as well. According to Amadeo (2022), states with better economies have better mathematics scores in general. Student achievement in mathematics is a predictor of their achievement as adults. The younger the age at which the US closes this gap, the better chance for success all students have (Sheffield, 2014).

Impact of Low Mathematics Achievement and Positive Correlations

Early numeric scores are a more important predictor than early reading and socio-emotional skills on later academic success (Ansari, 2015). Elementary mathematics scores are often tied to income as an adult (Egalite, 2016). Therefore, mathematics education at the high school level is tied to positive wage attainment in a student’s future. These three facts make it imperative that students have access to quality mathematics education at an early age. Interventions need to be received to close any gaps upon entering elementary school and

equitable education, asserts Jensen (2008), is the best way to break the cycle of generational poverty.

Students who score in the lowest 10% entering kindergarten have a 70% chance of staying in the lowest 10% for the next five years (Clark, 2014). Forty-eight percent of fourth graders in the US are deemed to be at a Basic level in mathematics when analyzing state tests. Interventions at an early age help to prevent students from staying at low achieving levels. The earlier students catch up to their peers, the less likely they are to feel the mathematics anxiety that accompanies failure (Morrissey, 2020).

Breaking the Poverty Cycle

Research exists on strategies to improve mathematics scores. Jansen (2017), for example, cites the importance of noticing misconceptions early and beginning interventions immediately. The earlier interventions start the less gap there is academically. To support this, Boaler (2015) stated that memorization needs to be less of a focus with teachers. Focus, according to Boaler, needs to be placed on the processes behind the concepts. Clark (2014) asserted mathematics instruction and interventions need to be sequential and scaffolded day to day. Richards (2020) asserted states need to expand the mathematics curricula in high school to include courses on data and coding. Finally, Primi et al. (2020) suggested mathematics anxiety needs to be addressed to avoid negative self-perception in students.

For interventions to be effective, they need to be broken down into small steps that can be scaffolded as the students gain mastery of the previous skill. Lower achieving students require mathematics instruction that is taught sequentially and builds day to day. Therefore, interventions must be concrete and engaging. Tier two and tier three interventions need to be supplemental and need to be given in addition to the instruction that takes place in the classroom.

Technology is a useful tool, identified by Venezky (2018), to help aid with differentiation for students that need either intervention or enrichment. Further, group sizes for interventions need to be small and focused, highlighting one skill at a time (Clark, 2014). Finally, for interventions to have the greatest effect on mathematics score increases, educators must consider one-on-one assistance (Primi et al., 2020).

Students need to master concepts instead of just repeating back the basic answers (Burns, 2007). Therefore, lessons should not focus on memorization in early elementary, as high achieving mathematics students typically rely on number sense instead of memorization (Boaler, 2015). Memorization instead of focus on concepts equates to lower achievement (Samara & Clements, 2009). Frequent assessments, both formal and informal are needed to ensure mastery before building on the next skill (Clark, 2014). Discussions about mathematical concepts must occur daily, during which students are encouraged to explain their reasoning and the processes they used to solve problems (Burns, 2007). Discussions allow teachers to determine if a student is blindly memorizing skills or if the student truly understands the concept. In addition, vocabulary needs to be pre-taught at the beginning of the lesson to ensure understanding throughout.

The order in which mathematics is taught matters. Number sense, or how to work with numbers and what numbers represent, should be the focus of the first few years of elementary school (Clark, 2014). After number sense, students should move into number combinations and fact families and eventually cover problem solving skills in the upper elementary grades. Teachers need to teach students the relationships between different numbers, demonstrating how to break them apart and build new numbers to ensure numeric competency (Boaler, 2015). In addition, classes, according to Richards (2020), should focus on problem solving in the upper

elementary grades, with teachers modeling different approaches to looking at a problem. Further, teachers must provide instruction in the zone of proximal development (Suranata, 2018). Because the timeline of instruction is important, skills need to be taught systematically and sequentially to achieve success.

Mathematics achievement can change a person's trajectory in life and help break the cycle of poverty (Jensen, 2017). There are things on which the US can focus to improve mathematics achievement for all students. Mathematics interventions need to be started as early as possible to catch students up to their peers (Clark, 2014). Burns (2007) asserted all students need to gain a deep understanding and mastery of mathematical concepts and procedures before moving on to the next skill. Mathematical skills need to be taught in a sequential order that allows for scaffolding and building on previous knowledge (Richards, 2020) and brain research needs to be considered when deciding the order in which to teach mathematics concepts. Additionally, the US needs to broaden the idea of mathematics classes to include classes focused on data and coding (Richards, 2020). Teachers must begin to address mathematics anxiety and teach students strategies to cope with anxieties (Gearty, 2022). Because mathematics education can help alleviate poverty by giving students the skills they need to be economically stable in their future. The education system in the US needs to ensure all students are given the foundational mathematics skills to be prepared for careers (Richards, 2020).

Conclusion

Mathematics education needs to be researched to find the best methods to teach elementary mathematics. Currently, the US allows each school district to teach mathematics how they feel is best for their students. There is no predetermined pedagogical method or curriculum mandated from state to state or even from county to county. The U.S. scores behind other

countries on national mathematics tests (Desilver, 2020). Students in elementary schools are taught mathematics in the United States using either the Strand Method, the Spiral Method, or the Blended Method. Teachers need to be trained on brain development and learning theories to best teach mathematics to students (McLeod, 2023). There is a gap in achievement on mathematics standardized tests between Lower SES and minority students (Garcia, 2020). Research needs to be done to find the best pedagogy to close this achievement gap.

Chapter III: Methodology

Overview

The purpose of the present study was to determine if the Strand Method of instruction, the Spiral Method of instruction, or the Blended Method produced the best results for fifth grade students, in Saint Louis County, on the Missouri Assessment Program Mathematics Test (MAPMT). The secondary purpose was to determine if any of the three aforementioned pedagogies equated to better test scores for minority or low socioeconomic (SES) students. The final purpose was to determine if any of the pedagogies promoted equal growth among all populations. The results of the present study could help determine the most effective pedagogy to utilize with mathematics for elementary students. Chapter III presents the research design, the variables, the research questions and hypotheses, as well as data-collection and analysis procedures.

Research Design

The researcher conducted a descriptive research study. A descriptive study is one that looks to explain what is happening in a situation (Creswell, 2002). For the current study, the researcher explained what is currently happening with the MAPMT scores of fifth graders. The researcher identified overall trends and differences in the scores. While a descriptive study can explain what is happening, it cannot answer the why it is happening. The researcher determined whether a link existed between the type of pedagogy received in elementary school and standardized test scores on the MAPMT in fifth grade. The variables were not manipulated by the researcher, meaning a descriptive study was most appropriate. The researcher analyzed the data, looking for patterns and trends, to determine whether a link existed. The researcher could not control what texts were used by different districts, meaning the sample sizes for the different

pedagogies differed. A non-experimental descriptive causal study was chosen because it allowed for different sample sizes. (Price et al., 2015). A descriptive study allowed the researcher to compare the categorical independent variable with a numerical dependent variable of test score on the fifth grade MAPMT.

Population and Sample

The researcher examined scores for the overall fifth grade population in Saint Louis County Public Schools. Data was collected from every public school within the Saint Louis County boundaries. The data was separated into subcategories for Black students and students from low SES. The achievement gaps between subgroups and overall population were also examined. Fifth grade test scores were used because fifth grade is the final year of elementary school and districts in Missouri often switch texts and pedagogies in middle school. Due to the interference of Covid-19 in the education system, the researcher used data from the 2018–2019 school year.

The first limitation of the present study was the sample, which only accounted for students attending public schools in Saint Louis County. The MAPMT is mandatory for public schools in Missouri. Though some charter and private schools use the test, it is only universally used among traditional public-school districts. Therefore, the researcher chose not to include the data from charter or private schools. The researcher chose the population of Saint Louis County as a representation of other urban school districts throughout Missouri. The present study is also limited because some tests were deemed “Level Not Determined” (LND) and those tests were not represented in the state data. An LND is given to students who did not complete the test.

The present study did not warrant an Institutional Review Board review. The test scores were reported on the Missouri Department of Education page and considered archival data. The

page did not list students' names, only the school attended. Students were not personally identified and digitally categorized by their self-reported racial identity. Students were further categorized as low SES if they qualified for free or reduced lunch. Consent from students or their parents was not needed because the information used for the present research was public.

Instrument

The tool used to collect data was the fifth grade MAPMT. The current test was developed in 2018 (DRC, 2019). Missouri began the Assessment Program in 1993 after the passage of the Missouri Outstanding Schools Act, which required a statewide test to measure achievement of students. Missouri based the first version of the test on the Missouri Learning Standards. The MAPMT test was a grade span test, testing mathematical ability at the end of the third, seventh and eleventh grades. In 2001, the No Child Left Behind Act (NCLB) forced Missouri to move to grade level tests. NCLB also forced states to use four proficiency categories: Below Basic, Basic, Proficient and Advanced. Missouri still utilizes those categories in reporting data. In the Spring of 2015, Missouri moved the test completely online. In 2016, Missouri adopted the Missouri Learning Standards and began development of the newest MAPMT, which was first administered in 2018. The 2018 administration was considered a trial and school scores did not count towards Annual Yearly Progress (AYP). Spring 2019 was the first year scores counted towards their AYP using the current version of the MAPMT.

The MAPMT is administered in April or May of each year to elementary students in grades three through five. The fifth-grade mathematics test is broken into three sections. Two sections are multiple choice or single answer questions and one section is constructed response. Students are scored in four categories. A Below Basic rating is a score of 250–376 points. A Basic rating equates to a score of 377–409 points. A Proficient rating is given to students scoring

between 410–434. An Advanced rating is any score above 435. All students in Missouri are required to take this test with few exceptions.

The fifth grade MAPMT is divided into three sections and four subtests. The questions in each section are a mix of questions from each subtest. The questions are then sorted into subtests for scoring purposes. The four subtest areas for fifth grade are number sense and operations in base ten, number sense and operation in fractions, relationships and algebraic thinking and geometry, and finally, measurement, data, and statistics. The scores from these four subtests are tabulated for an overall scale score. The overall scale score is used to determine the student's overall achievement level of Advanced, Proficient, Basic, or Below Basic.

These four subtests are given over the course of three different testing sections. Together, the three sections take about two and a half hours to complete. The first two testing sections consist of multiple-choice questions, selected response questions and technology enhanced questions. The technology enhanced questions require students to use computer-based mathematical tools, such as rulers or protractors. The third and fourth section are performance events. Performance events require constructed responses to multi-step, real-world problems.

The first two sections are scored by a computer. The performance events are scored by a group of scorers trained on a scoring rubric. The state gathers teachers from throughout the state to act as the scorers each year and scorers are trained over the course of a few days and are given practice tests to score before conducting actual scoring. Each section is included in the overall scale score for both the subtests and the overall test. The overall scale score determines the categorical level of the student.

The MAPMT is administered utilizing scripted directions to help ensure standard administration across the state. The state sends test examiners to check randomly chosen proctors

to ensure the test maintains validity in the way it is administered. Any individual who administers the test also must complete training to help ensure administration fidelity. Districts also have a validation checklist to verify that testing measures were followed correctly.

The MAPMT is administered on a secure testing platform called Insight. Insight locks other tools and windows on the computer so that students cannot access other things while on the testing site. Questions on the MAPMT are field tested prior to use. Each year, new questions are tested at each grade level and, if they are determined valid, are added to the question bank for subsequent tests.

The state of Missouri requires the test publisher, Departmental Research Committee (DRC), run validity tests each year. DRC sampled 34,936 fifth grade MAPMTs in 2019 (DRC, 2019). The 2019 Mathematics Missouri Assessment Program fifth grade test was given a Cronbach's coefficient alpha score of .94. The Standard Error of Mean for the 2019 fifth grade mathematics test was a 2.92.

To gather mathematics teacher emails, the researcher used a listserv of mathematics teachers that belonged to a mathematics cohort. The researcher then created a table and shared the table with all districts in Saint Louis County to fill in the mathematics text they utilized during the 2018–2019 school year for elementary students. Two districts did not respond to the table, so the researcher called the districts and filled in the text over the phone.

Variables

The independent variable was the method of instruction used to teach mathematics to the students. There are three different categories of instruction. The Spiral Method introduces many concepts at once and the teacher cycles through the concepts, in a pattern, over time. The Strand Method focuses on teaching one concept until mastery and then moves on to subsequent

concepts. The third category is the Blended Method. Districts using the Blended model typically do a Spiral Method review at the beginning of class, followed by a Strand Method lesson for the main lesson.

The dependent variables are scores on the MAPMT. The researcher examined the scores for each teaching pedagogy. The Missouri Department of Elementary and Secondary Education reports each district's scores, not each school. Therefore, each district was given equal weight for the purpose of the present study. The scores were then broken down into subgroups for each pedagogy. The researcher examined scores for minority students and low SES students. The achievement gap between each subpopulation and the overall population were also studied.

Research Questions and Hypotheses

The following research questions and hypothesis were examined in the present study:

1. Is there a link between mathematics pedagogy (Spiral, Strand, or Blended Method) and overall fifth grade test scores on the Missouri Assessment Program Mathematics Test?

The null hypothesis stated that no difference existed for the overall fifth grade population between the three different mathematics pedagogies. The alternative hypothesis stated difference existed for the overall fifth grade population between the three mathematics pedagogies.

2. Is there a link between mathematics pedagogy (Spiral, Strand, or Blended Method) and low SES student achievement on the Missouri Assessment Program Mathematics Test?

The null hypothesis stated that no difference existed for low SES students between the three different mathematics pedagogies. The alternative hypothesis stated a difference existed for low SES students between the three mathematics pedagogies.

3. Is there a link between mathematics pedagogy (Spiral, Strand, or Blended Method) and Black student achievement on the Missouri Assessment Program Mathematics Test?

The null hypothesis stated no difference existed for Black students between the three mathematics pedagogies. The alternative hypothesis stated a difference existed for Black students between the three mathematics pedagogies.

4. Do any of the three pedagogies help close the achievement gap between the overall population performance and that of low SES students?

The null hypothesis stated the pedagogies showed no difference in achievement between the overall population and low SES scores on the fifth grade Missouri Assessment Program Mathematics Test. The alternate hypothesis stated there was a difference between low SES students and the overall population.

5. Do any of the three pedagogies help close the achievement gap between the overall population performance and that of Black students?

The null hypothesis stated there was no difference between the overall population and Black student's scores on the fifth grade Missouri Assessment Program Mathematics Test. The alternate hypothesis stated a difference existed between Black students and the overall population using one of the three pedagogies.

The null hypothesis for questions one through three was that the mean of all samples was equal:

$H0: \mu 1 = \mu 2 = \mu 3\ldots = \mu k$

The alternate hypothesis for questions one through three was that the means of at least two pedagogies showed a statistically significant difference:

$HA: \mu 1 \neq \mu 2$ and/or $\mu 1 \neq \mu 3$ and/or $\mu 2 \neq \mu 3$ …. $\mu 1 \neq \mu k$

The researcher hypothesized that the Blended Method would show the highest test scores for all students in questions one through three. The researcher believed the blend of the Spiral Review would prevent students from forgetting previously taught concepts, and the Strand Method for core instruction would allow students mastery before moving on.

The final two research questions asked if any of the three pedagogies helped close the achievement gap between the overall population performance and that of low SES and Black students. The researcher predicted the Blended Method of teaching would be the most effective in closing the achievement gap. The researcher believed utilizing both methods of instruction was better to reach all learners. Specifically, the Spiral Review would help fill gaps in students' mathematics education and the Strand Method, for daily instruction, would ensure all students were not only exposed to, but mastered all concepts. The combination of both methods would ensure high achievement for all groups.

Data Collection

The Missouri Assessment Program administers testing to all Saint Louis County School Districts in the spring of each year. The testing window for the 2018–2019 school year was April 1, 2019 to May 24, 2019. The mathematics portion of the test for fifth graders is divided into three sections. Districts choose how to divide the three sections of the test within the testing window. Districts typically offer one section each day, although sections may be combined.

All fifth graders in Saint Louis County schools are required to take the MAPMT, with few exceptions. Special School District students are allowed to take a different version of the test called the MAP-Alternate (MAP-A). Those students are counted in the overall data for their grade level. Rarely, a student will receive a Level Not Determined (LND) Score. This occurs when a student encounters a problem that prevents them from testing in the correct or

standardized manner. Examples of this include a student illness or a student who moved during the testing window. In addition, a student who was caught cheating on the test would also receive a LND. Finally, students who were miscoded and given wrong accommodations, according to their Individual Education Plan (IEP), would also receive an LND. LND is calculated as an uncompleted test. The LND does not count toward the percentage in any of the four categories. This means that the percentages for the scores of a district with an LND do not add up to 100. For example, in a school district with 100 students, two of whom score LND, that district's percentages, when added up from the four categories (Below Basic, Basic, Proficient, and Advanced), would only add up to 98%. This is shown on the state's webpage with an asterisk.

The state collects the data and assembles a scoring team to grade the Performance Event section of the test during the summer. Scores are then computed together from all three sessions and the data is broken into each subtest category. School districts usually receive their data in late August or early September. The state combines the data for each district and posts the percentage of students at each achievement level, for each district, on the state website. The overall breakdown of scores for each grade are given and the scores are broken down into subgroups of Black students and low SES students and posted on the Missouri Department of Elementary and Secondary Education websites.

Data Analysis

The researcher contacted the school districts in Saint Louis County to determine which elementary mathematics textbook series was used for the 2018 and 2019 school year. The researcher used this information to determine which pedagogy the district used to teach mathematics. Different texts utilized different pedagogies and only one, *Bridges*, used the Blended Method. The researcher pulled the MAPMT data from the state website for each district.

The data for each district's fifth grade were collected. The data were broken into Black and low SES students for each district.

The data were analyzed using a comparison of mean scores on the MAPMT. The researcher compared the means for each pedagogy in each category (Below Basic, Basic, Proficient and Advanced). The researcher ranked which pedagogy showed the highest achievement for each subgroup. Difference was determined for each category and each pedagogy to make comparisons. The researcher looked for trends in the data to determine which pedagogy resulted in higher achievement on the fifth grade MAPMT. A descriptive study was chosen due to the limited number of districts in Saint Louis County. Saint Louis County is made up of 22 districts, a sample too small to use ANOVA. Neighboring districts could have been added to the present study, but their inclusion would have skewed the demographics and been a misrepresentation of the overall Missouri population. The closest county to Saint Louis, Saint Charles County is rural and predominately White.

Conclusion

The researcher conducted a causal study to determine links between mathematics pedagogy and performance on the fifth-grade mathematics test scores on the MAPMT. The researcher predicted the present study would find the Blended Method of instruction had the greatest positive effect on student achievement. The researcher asserted this method would increase achievement for minority students and low SES students. The goal was to determine which pedagogy would help mathematics achievement and to create more well researched mathematics instruction across Saint Louis County.

Chapter IV: Finding and Analysis

Introduction

The researcher conducted the present study to determine if there was a link between mathematics pedagogy and performance on the Missouri Assessment Program Fifth Grade Mathematics Test (MAPMT). The researcher collected data from the 22 public school districts located in Saint Louis County, Missouri. Each district was polled to see which text was used during the 2018-2019 school year to determine pedagogy. Textbook companies were contacted to determine with which pedagogy to label their respective text. The data from the 2019 fifth grade MAPMT was then examined to determine trends. The researcher took the mean score from the Missouri Department of Elementary and Secondary Education's webpage for each category (Below Basic, Basic, Proficient and Advanced) and entered that into a data table. Districts were separated by pedagogy. When collecting data, *Math in Focus'* numbers did not align with the other Strand Method data. Therefore, the researcher isolated the *Math in Focus* data. The mean scores for each pedagogy and *Math in Focus* were calculated. Data for low socioeconomic students (SES) and Black populations were also collected. The researcher chose these two populations given the availability of the data. The mean for each category was determined and compared.

Research Participants

Saint Louis County consists of 22 different districts. The districts utilized for the present study were categorized alphabetically: Affton, Bayless, Brentwood, Clayton, Ferguson-Florissant, Fox, Hancock Place, Hazelwood, Jennings, Kirkwood, Ladue, Lindbergh, Maplewood/ Richmond Heights, Mehlville, Normandy, Parkway, Pattonville, Ritenour, Riverview Gardens, Rockwood, University City and Webster Groves. Every student that was in

fifth grade was in one of these 22 districts during the 2018–2019 school year was a participant in the present study.

Districts varied in size. The smallest district included a single elementary school while the largest included 18 elementary schools. Since Missouri only reports the mean for each category (e.g., Below Basic, Basic, Proficient, Advanced) for each district, each is weighted equally. The researcher, to ensure anonymity of each district, removed district names and instead assigned each district a random letter. Districts were grouped by the type of pedagogy utilized.

The Data

The fifth grade MAPMT data were collected and placed into data tables. The tables display the type of pedagogy each district utilized and the mean test score for each category (e.g., Below Basic, Basic, Proficient, Advanced). Further, the table contains the overall population, the Black population, and the low SES population. The * signifies students who scored a Level Not Determined (LND) or students whose tests were invalidated. An LND is any test that was invalidated by the state. The label could be assigned if a student was sick and did not complete the test, if a student was caught cheating, or if required test modifications were not followed. A category with an * does not add up to 100 because not all students were counted. The * equals zero in calculations.

Blended Method of Teaching

Table 1 represents districts that utilized the Blended Method of teaching. The first column is the district symbolized by a letter. The achievement categories and test populations comprise the labels across the top row of the table. The bottom row displays the mean score for each category for each population. The Blended Method is defined as a district utilizing a program that asserts itself as blended or districts utilizing two different programs, one Spiral and

one Strand. Saint Louis County had three districts in 2019 that utilized the Blended Method of teaching. The top row of the table lists the populations for each score. The overall population had the fewest students not meeting standards (75%), a combination of the Below Basic mean and the Basic mean for the overall population. The overall population also had the most students meeting standards (23%) when compared to the two subpopulations. Black students had the fewest students meeting the state's expectations on the fifth grade MAPMT (5%) and the largest number below grade level (88%). The students from low SES homes fell in the middle for both meeting expectations (83%) and falling below state expectations (15%). A difference of 9.7 was found for Below Basic and a 2.9 difference was found between Basic. The closest similarity of scores was in the Basic category. The difference within the Proficient category was 10.5 and the difference within Advanced category was 7.6. The Blended Method ranking of students performing Proficient and Advanced put the overall population in first place with a mean of 23.5 The low SES population ranked second with an overall mean of 15.7, and the Black population ranked third with a mean of 5.4% of students scoring Proficient or Advanced.

Table 1
Data Table for Blended Method of Teaching Mean Scores

District	Overall Population				Black Population				Lower SES Population			
	BB	Basic	Prof.	Adv	BB	Basic	Prof.	Adv.	BB	Basic	Prof.	Adv.
Mean for Each District												
A.	28.9	36.6	19.1	15.5	47.4	36.8	*	*	41.7	36.1	13.9	8.3
B.	32.8	31.2	20.5	15.6	41.7	41.7	8.3	8.3	40.3	34.7	19.4	5.6
C.	73.2	23.7	*	*	74.9	21.9	*	*	73.2	23.7	*	*
Overall Mean for Blended Method												
	44.9	30.5	13.2	10.3	54.6	33.4	2.7	2.7	51.7	31.5	11.1	4.6

Note. BB=Below Basic. * = Level Not Determined.

Spiral Method of Teaching

Table 2 represents districts that utilized the Spiral Method of teaching. The first column is the district symbolized by a letter. The achievement categories and test populations run across the top. The bottom row displays the mean score for each category for each population. The Spiral Method had 53% of students falling below the state's expectations. Black students and students from low SES scored close to equally with nearly the same percentage scoring below grade level (74% and 71% respectively). The difference for Below Basic was 16.9 and the difference within Basic was 6.4. The difference within the Proficient category was 9.9 and the difference within the Advanced category was 16.2. The ranking for the Spiral Method puts the overall population in first, with 48.3% of students meeting or exceeding expectations. The low SES population ranked second, with 25.3% of students meeting or exceeding expectations. The Black population ranked third with 23.3% meeting or exceeding expectations.

Table 2
Data Table for the Spiral Method of Teaching Mean Scores

District	Overall Population				Black Population				Lower SES Population			
	BB	Basic	Prof.	Adv	BB	Basic	Prof.	Adv.	BB	Basic	Prof.	Adv.
					Mean for Each District							
D.	21.7	32.5	32.5	13.3	24.1	27.6	34.5	13.8	21.7	32.5	32.5	13.3
E.	18.2	36.8	27.2	17.8	36.5	46.0	15.9	1.6	30.6	42.7	18.0	8.7
F.	5.6	31.5	18.5	44.4	25.0	43.8	18.8	12.5	14.3	38.1	23.8	23.8
G.	11.8	28.3	32.6	27.3	37.8	56.8	2.7	2.7	35.1	51.4	10.8	2.7
H.	39.6	36.8	17.6	6.0	43.4	37.2	15.3	4.1	45.8	35.3	14.8	4.1
I.	11.3	27.0	31.6	30.1	34.8	47.8	10.9	6.5	36.4	43.6	12.7	7.3
J.	33.4	36.2	19.6	10.9	46.0	33.3	15.3	5.3	33.4	36.2	19.6	10.9
K.	32.8	31.2	20.5	15.6	41.7	41.7	8.3	8.3	40.3	34.7	19.4	5.6
					Overall Mean for Spiral Method							
	20.9	32.5	26.4	21.9	37.5	36.5	17.6	5.7	32.4	38.9	16.5	8.8

Note. BB=Below Basic. * = Level Not Determined.

Strand Method Data

Table 3 represents districts that utilized the Strand Method of teaching. The achievement categories run across the top with population classification. The left-hand column includes a letter representing each of the eleven districts that utilized the Strand Method representing half of the districts polled. The mean for each category is displayed along the bottom row. Fifty seven percent of students in the overall population scored below the state's expectations. The Black population had the largest percentage of students who did not meet expectations (81%). The low SES category fell in the middle with 75.6% below expectations. The difference for Below Basic

was 21.8 and the difference for Basic was 4.3. The difference for Proficient was 11.1 and the Advanced group had a difference of 16.0. The overall population scored the highest and the Black Population scored lowest. The overall population using the Strand Method ranked first with 42% of students who met or exceeded the state's expectations. The low SES population came in second with 24.4% who met expectations. The Black population ranked third with the fewest students who met expectations (15%).

Table 3

Data Table for the Strand Method of Teaching Mean Scores

District	Overall Population				Black Population				Lower SES Population			
	BB	Basic	Prof.	Adv	BB	Basic	Prof.	Adv.	BB	Basic	Prof.	Adv.
					Mean for Each District							
L.	65.3	28.9	5.0	0.8	65.6	26.7	4.9	0.8	65.3	28.9	5.0	0.8
M.	41.6	36.3	15.9	6.2	45.7	38.7	12.9	2.7	41.6	36.3	15.9	6.2
N.	15.0	28.9	25.7	30.4	66.7	16.7	8.3	8.3	27.3	44.3	10.2	18.2
O.	6.4	17.5	29.5	46.7	26.1	34.8	21.7	17.4	28.2	43.6	18.0	10.3
P.	14.0	21.8	24.4	39.9	45.8	41.7	*	*	41.4	27.6	20.7	10.3
Q.	26.5	29.6	24.8	19.2	44.1	32.9	13.8	9.2	37.1	31.9	20.5	10.5
R.	14.4	28.4	29.2	28.1	52.1	34.5	10.1	3.4	43.4	31.1	17.5	8.1
S.	53.7	32.5	9.7	4.1	55.8	35.2	8.3	2.6	53.7	32.5	9.7	4.1
T.	17.3	36.8	28.0	17.9	40.0	40.0	*	*	25.6	43.2	19.1	12.1
U.	16.6	23.6	24.1	35.7	47.0	30.1	14.9	8.0	41.3	34.3	13.0	11.4
V.	42.1	37.7	18.4	1.8	41.8	36.2	18.2	1.8	42.1	37.7	18.4	1.8
					Overall Mean for Strand Method							
	26.4	29.2	21.3	20.9	48.2	33.5	10.2	4.9	40.6	35.5	15.2	8.5

Note. BB=Below Basic. * = Level Not Determined.

Analysis of Research Questions

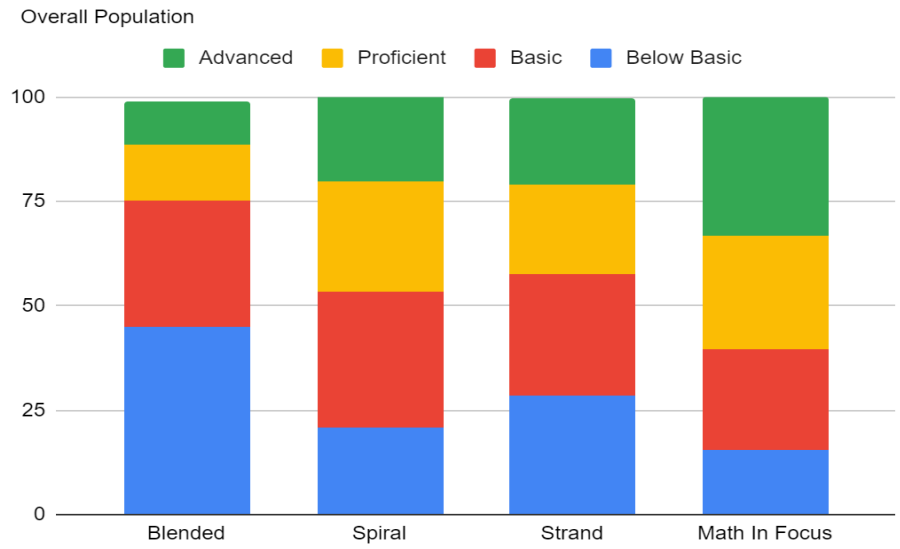
The researcher relied on a descriptive analysis to compare the different pedagogies. A t-test was not performed because there were more than two variables (JMP Statistical Discovery, 2023). An ANOVA was not utilized because the sample size consisted of 22 districts. In order to find statistical significance between the three different populations the researcher would have needed a sample size larger than the 22 districts available. The five research questions are answered using figures to represent the data. In addition, Figure 4 presents the overall means showing a representation of how the different pedagogies perform for the total population.

Research Question 1

Is there a link between mathematics pedagogy (Spiral, Strand, or Blended Method) and overall test scores on the fifth grade Missouri Assessment Program Mathematics Test?

The null hypothesis is that there is no difference for the overall fifth grade population between the three mathematics pedagogies. The alternative hypothesis is that there is difference for the overall fifth grade population between the three mathematics pedagogies.

Figure 4:
Graph of Overall Fifth Grade Population Mathematics Scores on the MAPMT



The Blended Method ranked last for student scores. Forty-four-point nine percent of students scored Below Basic and 30.5% scored Basic using the Blended Method. Twenty-three-point five percent of students met or exceeded expectations using the Blended Method. The Strand Method scored similarly to the Spiral Method for the overall population. Fifty-seven-point six percent comprised the mean percentage of students scoring Basic or Below Basic with the Strand Method. Forty-two-point four percent comprised the mean percentage of students who met or exceeded expectations using the Strand Method. The Strand Method ranked third for student achievement. The Spiral Method equated to a mean of 53.4% of students that were either Basic or Below Basic. Forty-six point six was the mean percentage of students who met or exceeded expectations using the Spiral Method. This data placed the Spiral Method in second place for overall student achievement. Districts that used the Strand Method textbook, *Math in Focus,* had the best results. Thirty-nine-point six percent of students using *Math in Focus* scored Basic or Below Basic. In addition, 64% of students using *Math in Focus* met or exceeded expectations. Range of scores varied by 35.8 points for Below Basic and Basic, with the Blended Method totaling 75.4% and *Math in Focus* totaling 39.6%. The range for students who met expectations was 16.1 points with *Math in Focus* having the highest number and the Blended Method with the fewest. Overall, *Math in Focus* was the best teaching method for fifth grade mathematics students.

Research Question 2

Is there a link between mathematics pedagogy (Spiral, Strand, or Blended Method) and low SES student achievement on the Missouri Assessment Program Mathematics Test?

The null hypothesis was that there was no difference for low SES students between the four mathematics pedagogies. The alternative hypothesis was that there was a difference for low SES students between the three mathematics pedagogies.

Figure 5

Graph of Lower SES Fifth Grade Population Mathematics Scores on the MAPMT

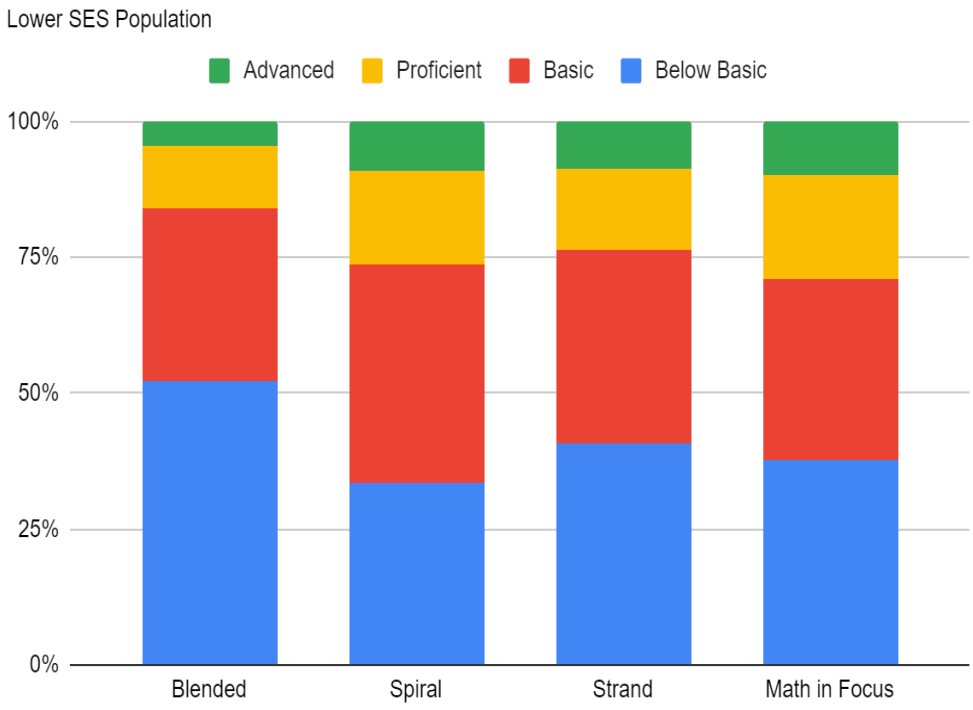


Figure 5 reflects data attributable to Research Question 2. The Blended Method ranked last for low SES student scores. Eighty-three percent of students using the Blended Method scored Below Basic or Basic. Fifteen-point seven percent of students met or exceeded expectations using the Blended Method. The Strand Method ranked third for low SES student achievement. The mean percentage of students who scored Basic or Below Basic was 67.1% with the Strand Method. Twenty-five-point three percent was the mean percentage of students who met or exceeded expectations using the Strand Method. The Spiral Method had a mean of 71.3% of students that were either Basic or Below Basic. Twenty-three point seven equated to

the mean percent of students who met or exceeded expectations using the Spiral Method. This data places the Spiral Method in second place for low SES student achievement. Districts that used the *Math in Focus* had the best results. Seventy-one percent of students who used *Math in Focus* scored Basic or Below Basic. Twenty-eight-point nine percent of students who used *Math in Focus* met or exceeded expectations. The range of scores varied by 12 points for Below Basic and Basic, with the Blended Method totaling 83% and *Math in Focus* totaling 71%. *Math in Focus* and the Spiral Method varied by .3%. The range for students meeting expectations was 13.2 points with *Math in Focus* scoring the highest number and the Blended Method scoring the least. Overall, *Math in Focus* was the best teaching pedagogy for fifth grade low SES mathematics students.

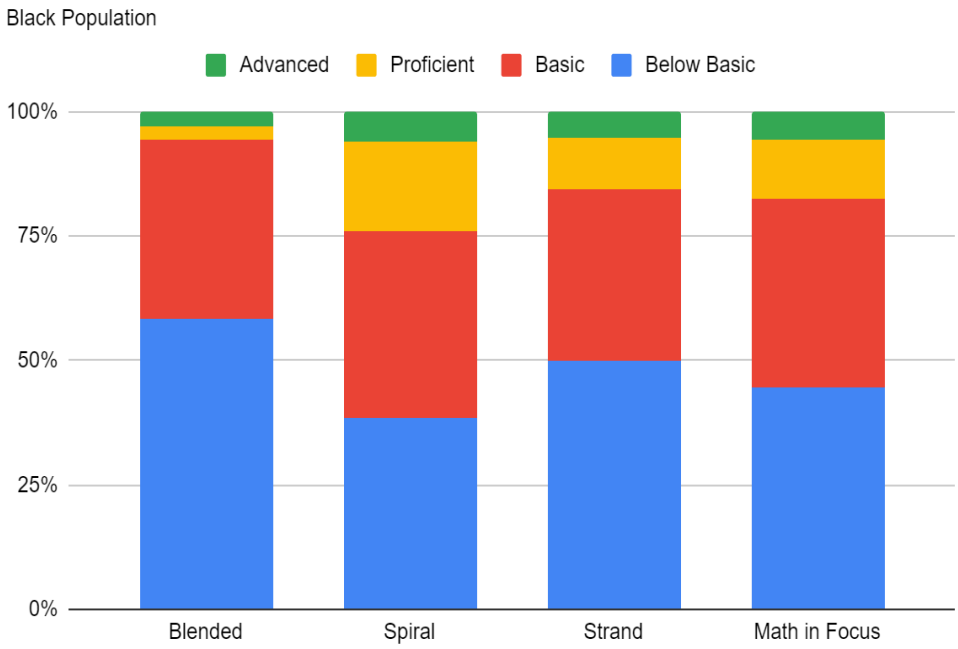
Research Question 3

Is there a link between mathematics pedagogy (Spiral, Strand, or Blended Method) and Black student achievement on the Missouri Assessment Program Mathematics Test?

The null hypothesis was that there was no difference for Black students between the four mathematics pedagogies. The alternative hypothesis was that there was a difference for Black students between the three mathematics pedagogies.

Figure 6

Graph of Black Fifth Grade Population Mathematics Scores on the MAPMT



The Blended Method ranked last for Black student scores. Eighty-eight percent of students who used the Blended Method scored Below Basic or Basic. Five-point four percent of students met or exceeded expectations using the Blended Method. The Strand Method ranked third for Black student achievement. Eighty-one-point seven percent was the mean percentage of students who scored Basic or Below Basic with the Strand Method. Fifteen-point one percent was the mean percentage of students who met or exceeded expectations using the Strand Method. *Math in Focus* had a mean of 77.9% of students that ranked either Basic or Below Basic. Sixteen-point six was the mean percent of students who met or exceeded expectations using *Math in Focus*. This data placed *Math in Focus* in second place for Black student achievement. Districts using the Spiral Method had the best results for Black students. Seventy-four percent of students who used the Spiral Method scored Basic or Below Basic. Twenty-three-

point three percent of students who used the Spiral Method met or exceeded expectations. The range of scores varied by 14 for Below Basic and Basic, with the Blended Method totaling 88% and the Spiral Method totaling 74%. The range for students meeting expectations was 17.9 points with the Spiral Method scoring the highest and the Blended Method scoring the least. Overall, the Spiral Method was the best teaching method for fifth grade Black mathematics students.

Research Question 4

Do any of the three pedagogies help close the achievement gap between the overall population performance and that of low SES students?

The null hypothesis was that no pedagogy would have low SES students and overall population equally scored in all subgroups. The alternative hypothesis was that there would be a pedagogy that had the low SES population and the overall population scoring equally in all categories.

Figure 7

Mean of Overall Population Compared to Mean of Low SES Students

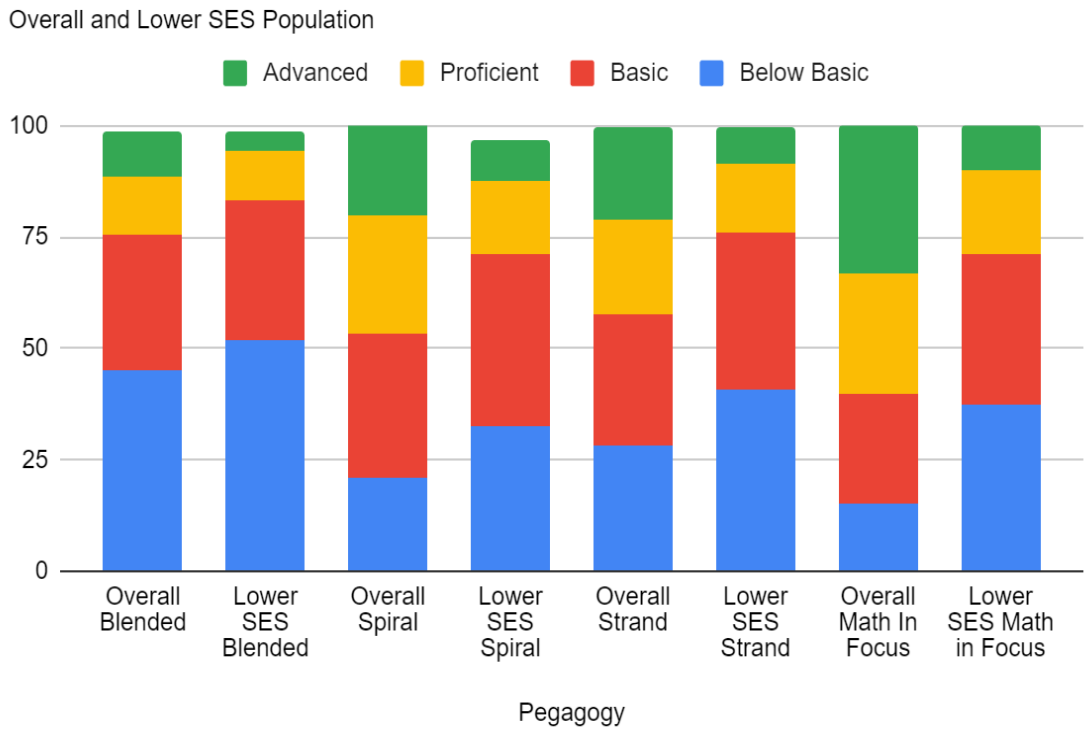


Figure 7 shows the comparison of mean scores of the overall population compared to mean scores of the low SES population. No pedagogy closed the achievement gap completely. Each pedagogy showed variation in how the overall population scored when compared to how the low SES population scored. The Blended Method showed the most commonalities in scores. The Blended Method had the fewest students who scored Proficient and Advanced, but the mean number of students in each category were the most closely matched to the low SES students. The mean number of overall students who scored Basic for the Blended Method was 30.5%, and for the low SES population the mean was 31.5%, a range of one. Proficient scores were also close with the overall population mean at 13.2% and the low SES population mean at 11.1%. The range for Proficient scores was 2.1 using the Blended Method. The overall difference in the

Below Basic category for the three pedagogies was 36.4 points. The low SES Blended Method reported 51.7% of students in Below Basic with the *Math in Focus* overall population with the fewest (15.3%). The Basic category had a range of 14.6 points. Low SES Spiral reported 38.9% whereas the *Math in Focus* overall population was the lowest with 24.3%. The Proficient category had a difference of 15.8 points. Overall population with *Math in Focus* reported the highest with 26.9% students scoring Proficient. Low SES Blended reported the fewest students scoring Proficient with 11.1%. The Advanced category had a difference of 28.8 points. Overall, the *Math in Focus* population scored Advanced at 33.4% and the low SES population with the Blended Method scored 4.6% Advanced. While no single pedagogy closed the gap, the Blended Method had the most similarities and the *Math in Focus* group had the greatest difference. Finally, *Math in Focus* had the largest percentage of low SES students score Proficient and Advanced.

Research Question 5

Do any of the three pedagogies help close the gap in achievement between the overall population performance and that of Black students?

The null hypothesis was that no pedagogy would have Black students and overall population equally scored in all subgroups. The alternative hypothesis was that there would be a pedagogy that had the Black population and the overall population scoring equally in all categories.

Figure 8:

Mean of Overall Population Compared to Mean of Black Population

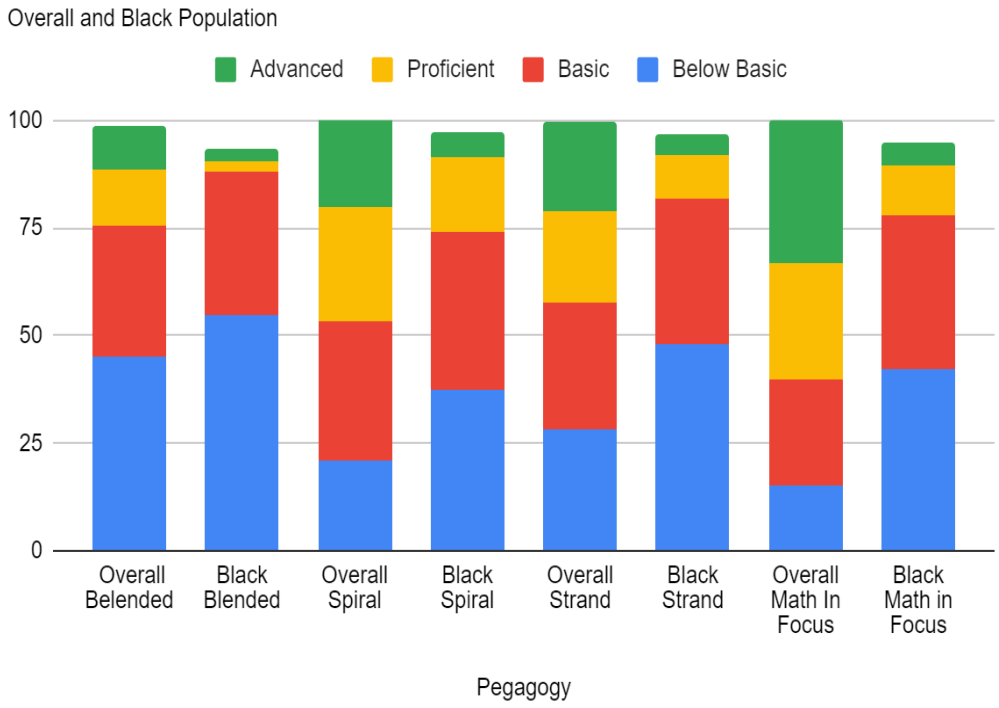


Figure 8 reflects the comparison of mean scores of the overall population to mean scores of the Black population. No pedagogy closed the achievement for Black students. Within each pedagogy Black students scored lower than the overall population. The Black students using the Blended Method had 54.6% of students in Below Basic with the *Math in Focus* overall population having the fewest (15.3%). The Below Basic category had a range of 39.3 points and Basic category had a range of 12.2. Black students using the Spiral Method had a mean of 36.5% in the Basic category whereas the *Math in Focus* overall population was the lowest with 24.3%. The Proficient category had a difference of 24.4 points. The overall population using *Math in Focus* had the highest with 26.9% and low SES Blended had the fewest with 2.7%. The Advanced category had a difference of 30.7 points. Overall, the *Math in Focus* population scored

33.4% and Black population Blended Method scored 2.7%. Black students had the most students achieve Proficient and Advanced when taught using the Spiral Method.

Conclusion

The researcher conducted a descriptive comparative study to look for a link between mathematics pedagogies and scores on the fifth grade MAPMT. The five research questions were answered using the data collected. Results reflected large differences in the mean scores of students for the different populations using the different pedagogies. Questions Four and Five were analyzed and presented using bar graphs, comparing the different mean scores for each test category. The *Math in Focus* pedagogy had the greatest percentage of students who met or exceeded the state's expectations on the MAPMT. Black students achieved best using the Spiral Method. Low SES students performed best using the *Math in Focus*. No pedagogy tested closed the achievement gap. The Blended Method of instruction produced similar scores for the overall population and low SES students, but the scores were lower than other pedagogies.

Chapter V: Conclusions and Discussion

Introduction

Mathematics test scores in the United States fall behind those of other countries (Garcia, 2020). This is primarily due to the way mathematics is taught in the US. In other countries, mathematics is broken down into a few specific concepts each year with students allowed to master concepts before moving on (Venezky, 2018). The Missouri standards hold fifth graders responsible for 32 mathematical concepts (DRC, 2019). Students with this number of concepts to master in a year gain little more than surface-level understanding. Early mathematics skills, correlated to future earnings, makes it imperative that educators understand the best way for students in the US to learn mathematics.

The researcher conducted a descriptive study on mathematics pedagogy in Saint Louis County Public Schools, finding the pedagogy that led to the most success for the overall fifth grade population in 2019, as well as the low socioeconomic status (SES) student population and the Black population. A difference was found in the three pedagogies, indicating a clear preferred pedagogy for each group. Previous research aligned with the results found in the present study. There are practical implications for how the present study impacts the P–20 education. Given the data available, there were limitations to the present study. Further studies could deepen the understanding of how mathematics education might be adjusted to ensure maximum growth and achievement for all students.

Summary of Study

The researcher studied fifth grade mathematics pedagogy in the 22 Saint Louis County public school districts. The researcher then examined scores on the fifth grade Missouri Assessment Program Mathematics Test (MAPMT) for each district. A descriptive study was

conducted to determine whether pedagogy affected fifth grade MAPMT. The texts were broken into three different pedagogies, Blended Method, Spiral Method, and Strand Method. The textbook, *Math in Focus,* was examined independently. *Math in Focus* utilizes the Strand Method of teaching but focuses on fewer concepts each year, spending the entirety of the first semester on numbers 1–20 whereas other Strand Method texts look at numbers 1–20, time, and geometry in kindergarten. The test scores that were analyzed came from every fifth grader in Saint Louis County public schools during the 2018–2019 school year. These were examined in three groups: overall population, low SES student population, and Black population. The researcher chose those populations because the Missouri Department of Elementary and Secondary Education isolates those groups, making them available on their webpage. A difference was found among the different pedagogies. Black students scored best utilizing the Spiral Method of teaching, whereas the overall population and low SES student population had the highest test scores when utilizing the textbook *Math in Focus,* which follows the Strand Method.

Conclusions of Study

The present study found a correlation between pedagogy and scores on the fifth grade MAPMT in 2019. The fewest students achieved Proficient and Advanced using the Blended Method. The Black population scored the worst of the three groups using the Blended Method, with only 5.4% of students achieving Proficient and Advanced. The low SES group scored 15.7% Proficient and Advanced using the Blended Method. The overall population scored 23.5% Proficient and Advanced utilizing the Blended Method. The Blended Method was ranked fourth for all populations. The Black population scored best when utilizing the Spiral Method. Twenty-three-point three percent scored Proficient and Advanced. The textbook *Math in Focus* ranked

first for both the overall population and the low SES student population, with 60.3% of students scored Proficient and Advanced. Twenty-eight-point nine percent of the low SES students scored Proficient and Advanced utilizing *Math in Focus*. *Math in Focus* ranked second for the Black population, 16.6% of students scored Proficient and Advanced. The Spiral Method ranked second for the overall population (48.3%) and the low SES student population (25.3%). The Strand Method ranked third for all groups. Black students scored 15.1% Proficient and Advanced utilizing the Strand Method, the low SES population scored 23.7% Proficient and Advanced utilizing the Strand Method, and the overall population scored 42.2% Proficient and Advanced utilizing the Strand Method. Therefore, the data shows a clear link between mathematics pedagogy and achievement for Saint Louis County's fifth grade students on the fifth grade 2019 MAPMT.

Relationship of Conclusions to Other Research

The findings of the present study were similar to prior research. The achievement gap has been discussed in prior research in Chapter II and the same disparity was found in MAPMT data from 2019. The fact that *Math in Focus* was found to be the best program for the overall population fits with what brain research says about learning development. In addition, the structure of *Math in Focus* supports research that speaks to teaching fewer mathematics concepts for longer periods of time. The researcher's findings in the present study expand on current research.

Nationally a difference exists in standardized test scores between minorities and low SES students (Garcia, 2020). According to Amadeo (2022), Black and Hispanic students score two to three years behind their peers on standardized tests. The MAPMT data from Saint Louis County displayed similar disparities. The Blended Method reported a difference of 18.1 points between

the overall population and the Black population scoring Proficient and Advanced. The difference for low SES students compared to the overall population who scored Proficient and Advanced using the Blended Method was 7.8 points. The difference with the Spiral Method between the overall population and Black population was 25 points, with the Spiral Method for the overall population and the low SES population being 23 points and with the Strand Method between the overall population and the Black population being 27.1 points. The difference between the overall population and the low SES student population with the Strand Method was 18.5 points. The difference with those who utilized *Math in Focus* was the greatest, reporting a difference of 43.7 points between the Black population and the overall population. The difference for low SES students and the overall population using *Math in Focus* was 31.4 points. This result is discouraging but not surprising. The entirety of the scholarship predicted achievement difference.

Math in Focus is most closely aligned with research on brain development. Piaget asserted four main phases of brain development: sensorimotor, preoperational, concrete, and formal (Saunders & Wong, 2020). *Math in Focus* breaks each skill into three teaching phases. The first part of the lesson is concrete where students use manipulatives (Cavendish, 2022). The second part of the lesson is pictorial where students utilize pictures to solve problems. The final phase is abstract, where students are forced to visualize the answer or simply answer the problem based on recall. Orale and Uy (2018) stated the best way to gain mastery was for students to struggle, using time to work in small groups until mastery was achieved. Both the Spiral Method of instruction and the Strand Method utilize small groups to help struggling students.

The Strand Method followed the research-supported learning theories that are attributed to mathematics success. Crawford and Snider (2000) studied a fourth-grade mathematics cohort

and found that the direct approach to teaching equated to better standardized test scores. The Strand Method relies on direct instruction for the lesson portion of class. Snider (2004) found that focusing on fewer skills at early elementary grades led to mastery. *Math in Focus*, while following the Strand Method, devotes more to time on fewer skills than any of the pedagogies. Venezky (2018), found that taking skills to a higher level of understanding, as opposed to focusing on memorization and quick recall, correlated to higher test scores. The main difference between *Math in Focus* and a typical Strand Method is that a single lesson in *Math in Focus* often takes several days, allowing students time to master a skill concretely before moving on to pictorial and then to abstract thinking (Cavendish, 2022).

The findings from the present study verify previous research on mathematics education. The present study found an achievement gap for minority students. *Math in Focus*, which had the overall highest scores, was most closely tied to brain development. *Math in Focus* is also structured similarly to the research that shows fewer skills each year builds solid mathematics foundation and better standardized test scores.

Inferences from Data

The researcher predicted the Blended Method would bring the best results. The researcher was surprised to find that a Strand Method performed best for the overall population. The researcher thought the lack of Spiral would cause students to forget certain skills. Because *Math in Focus* focuses on fewer skills for longer amounts of time, the researcher believes this approach led to student success recalling skills. The perplexing finding is that no pedagogy was the clear winner for all subgroups. Black students did best with the Spiral Method of instruction. The researcher would like to study this further. This means districts would be best served to utilize different teaching methods for different groups of students. Without debate, this would be

challenging since texts typically promote a singular teaching method. One solution could be the workshop model. The workshop model allows teachers to teach the same skills utilizing different pedagogies for different groups. A requirement before adjusting pedagogy would be to study growth comparisons for the different pedagogies to determine if one teaching methodology lends itself to the best growth for all populations.

It is clear from the present study that students in Saint Louis County did not receive mathematics instruction that allowed more than half to meet or exceed the state expectations. Most students scored Below Basic or Basic on the standardized tests, so the instruction model needs to be studied and changed. A methodical and structured mathematics pedagogy needs to be implemented that allows students time for mastery. The pedagogy must be taught by teachers who are confident in their mathematics ability. In addition, the mathematics curriculum must be taught with fidelity. Mathematics time cannot be utilized to teach other subjects or rushed because the teacher does not feel confident in the lesson. Teachers must spend time with their students to understand how they learn best as well as their true ability level. Further, mathematics discussions must be a key part of each lesson to help the teacher gain understanding of how students view mathematics. Finally, mastery must be attained by all students before moving on to subsequent concepts. More research related to mathematics curriculum and pedagogy is needed.

Practical Significance and P-20 Implications

Mathematics education is a priority for districts in Saint Louis County. Fifth graders in Missouri are tested on 32 different concepts on the MAPMT (DRC, 2022). In the United States, many topics are covered each year, but not deeply. This type of teaching has led the US to score worse on international mathematics tests when compared to other countries. The present study

determined that the overall population did best when *Math in Focus* was utilized. *Math in Focus* focuses on Singapore Math, breaking learning concepts down into step-by-step procedures and methodical instruction (Cavendish, 2022). Skills are taught using the concrete, pictorial, abstract sequence allowing students to gain a deep understanding of concepts. Surprisingly, the Black population did not perform best with *Math in Focus. Math in Focus* ranked second among Black population. Black students performed better with the Spiral Method. The researcher was unable to find research with similar findings. The difference in achievement for Black students between the Spiral Method and *Math in Focus* was a difference of 6.7 points. This difference suggests that schools may need to focus on a student's learning styles as well as ability to decide how to group students for mathematics instruction.

The implications of this research for P–20 are vast. Teaching mathematics in ways that promote student success in elementary school greatly affects mathematics success in the upper grades. Students who succeed in elementary mathematics are positioned to take harder mathematics courses in high school. In turn, students, as they enter post-secondary education, will be better prepared for university mathematics courses. Further, student mathematics skills success better prepares them for careers, saving employers time and money while enhancing their employability. Mathematics education is a progression that begins in preschool. The earlier students gain a solid mathematical foundation, the more success they will achieve in adulthood.

Limitations

There were several limitations to the present study. The first limitation was sample size, which limited the degree of statistical analysis possible. Initially a correlation study was planned because Saint Louis County test scores are representative of the entire state of Missouri. Saint Louis County comprises 22 districts serving roughly 43,000 students from K–12. However,

scores were not available for individual students. As a result, the researcher was limited to analyzing group data. Twenty-two districts did not provide a sample large enough to test for significance. Another limitation was the demographic information. The researcher would have liked to look at other sub-populations, such as Asian, gender, and single parent homes but due to how Missouri disseminates information to the public, this was not possible. The final limitation was whether teachers utilized textbooks correctly. The researcher was forced to determine pedagogy based on the textbook districts stated they utilized. However, the name of the textbook did not ensure teachers utilized the textbook as directed.

Recommendations for Future Studies

Future studies would benefit from the present study data. The researcher would like to see a similar study done for middle school and high school. There is value in knowing how older students learn as well as whether K–12 grade mathematics programs prepare students for the post-secondary world. A second study could disaggregate into different demographics that are not currently available. A study examining single parent homes versus two parent homes would be informative since nearly 24 million students live in single parent homes (Casey, 2022). A study focusing on gender would be significant to determine if students should be grouped for mathematics education based on gender. Preschool access and attendance would be a study of further significance to determine correlation based on the age students begin receiving structured education. Another impactful study would be the examination of student growth from one grade to the next comparing different pedagogies. Growth comparison research using different pedagogies in combination with the current research on overall achievement, would help determine which pedagogy is the best for teaching elementary students. Researchers would be

able to compare success and growth rates of the different pedagogies to create the best educational program.

Conclusion

The goal of the present research was to begin to analyze the mathematics pedagogies in Saint Louis County. Students scored worse on mathematics standardized tests than reading standardized tests. Mathematics pedagogies need to be researched to create research-based mathematics programs that follow a logical learning progression influenced by brain development research. The present study is a beginning. *Math in Focus* led to the highest achievement for the overall population of fifth grade students in Saint Louis County, while the Spiral Method works best for the Black student population. Research needs to be done to determine which pedagogical methods lead to the most student growth. Solid mathematics foundations must begin in preschool to ensure students have the needed skills to master mathematics in higher grades. Strong mathematics foundations allow students in upper grades to take advanced mathematics courses that will help prepare them for a competitive workforce.

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