Mathematics Education: Teacher Perceptions of a Mathematical Mindset as an Instructional and Curricular Tool in the Sixth-Grade Classroom

Jenna M. Hoing
B.A., Benedictine College, 2015
M.S., Western Governors University, 2017

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Harold B. Frye
Harold B. Frye, Ed.D.
Major Advisor

Denis Yoder
Denis Yoder, Ed.D.

Mark Schmidt
Mark Schmidt, Ed.D.

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Abstract

Since colonial times, different mathematics curricula and instructional approaches have been implemented in the American education system, with the goal of improved student achievement. Psychology became part of the discussion on mathematics teaching and learning in the 1940s and 1950s, and with it the push for data-based decisions (Furr, 1996). Psychology continued to be a factor in educational decisions through the publication of this study in 2023. With the new concern surrounding pandemic related learning loss, educational decision makers require resources and ideologies with strong foundations in data (Berry, 2020). This study examines one such ideology with a focus on two research question: (1) What were teachers' experiences with the mathematical mindset approach as a new curricular and instructional tool for 6th-grade math? (2) What were teachers' perceptions of the effectiveness of the mathematical mindset approach as part of the new 6th-grade mathematics curriculum?

This study had a qualitative, phenomenological design, with data gathered from teacher interviews. The setting of the study was a district in an affluent section of a metropolitan area near Kansas City. The district, referred to as District Z, changed their curriculum and instructional practice for sixth and seventh-grade math based on Boaler's mathematical mindset approach (District math coordinator, personal communication, September 17, 2020). Boaler's approach involved developing a growth mindset culture, considering the nature of mathematics when planning instruction, allowing productive struggle, focusing on connections and patterns, and utilizing meaningful assessments (Boaler, 2015). This study focused on the sixth-grade classroom. Participants were solicited from the pool of District Z's sixth-grade general education mathematics

teachers, special education teachers, and gifted facilitators. The list District Z provided totaled 55 educators. Six educators agreed to participate in the study, including two general education teachers, two special education teachers, and two gifted facilitators. Each interview was conducted in a semi-structured format consisting of eight interview questions, and each participant was interviewed individually. Transcripts from the interviews were analyzed in respect to the two research questions.

The data analysis is organized to address each of the two research questions. The analysis for the first research question resulted in one difference and three similarities. Teachers' experiences with mathematical mindset differed based on their role in the school. Commonalities in teacher experience were increased student engagement, a new focus on visual mathematics, and a hands-on approach to learning. The analysis for the second research question showed the participants found the implementation of mathematical mindset as effective, and specifically noted impact on student attitude towards mathematics, engagement, and academic performance.

Dedication

This dissertation is dedicated to Cookie, who sat by me through every night class and work session.

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I want to sincerely thank my advisor, Dr. Harold Frye, and my research analyst, Dr. Peg Waterman. Their support made this possible, and I am eternally grateful. I am also appreciative of the members of Cohort 24. Over the course of our doctoral journey, I had the opportunity to work and collaborate with an incredible group of educators.

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Chapter 1

Introduction

Mathematics curriculum and instruction are highly debated topics in America. The decades-long fight over what should be taught, and how, was coined 'math wars' in the 1990s (Schoenfeld, 2004). In their study on educational philosophy and mathematics reform, Davidson and Mitchell (2008) stated as "We believe that true reform will reflect changing perceptions in mathematics education along with changes in American culture and its expectations of mathematics education" (p. 1). Boaler (2018) described the prevalent and damaging mindset many have held in relation to mathematics learning, "the idea that some people are born with a 'math brain' and some are not, and that high achievement is only available to some students" (p. 1). Boaler went on to explain that this perception continues to hold learners back on a daily basis, particularly female and non-white students. Modern mathematics education reform involves a shifting of perceptions, in addition to the curricular and instructional changes.

Background

Despite frequent changes to mathematics standards, curriculum, and instructional approaches, a concern persists about "low achievement and low participation" in mathematics (Dowker, Sarkar, & Looi, 2016, p. 1). With this concern in mind, educational leaders in a large school district in a suburban area of Kansas decided to re-evaluate the way mathematics education was presented for kindergarten through twelfth-grade (K-12) students. The district mathematics coordinator used Boaler's 2015 research on mathematical mindset as a starting point when enlisting a team of teachers to revise the sixth and seventh-grade mathematics curriculum, and when developing the associated professional learning (District math coordinator, personal communication, September 17, 2020). Boaler's research, founded on Dweck's 2006 work on growth mindset, has been focused on actionable steps for educators looking to provide more effective and equitable mathematics education (Boaler, 2015).

Boaler published her book, *Mathematical Mindsets*, in 2015. She co-wrote and published the sixth-grade resource book *Mindset Mathematics: Visualizing and Investigating Big Ideas* in 2019 (Boaler, Munson, & Williams, 2019). These resource books have also been published for kindergarten through eighth grade (Boaler, 2018).

While the research has been available for five years, implementing ideas from these playbooks for changing instruction required a commitment to altering how math had been taught for years. As outlined and explained in Chapter 2, schools have adopted new mathematics curriculum and programs repeatedly in attempts to increase achievement (Woodward, 2004). The study reported here was designed to explore teachers' experiences with the new sixth-grade curriculum and instructional strategies, and the perceived effectiveness for mathematics students.

According to the researcher's personal communication with District Z's math coordinator on September 17, 2020, District Z distributed their new sixth grade mathematics scope and sequence for the fall of 2020. A new unit, unit 0, was included at that time. Unit 0 was composed of videos and activities created by Boaler, that explicitly taught mathematical mindset and the science of how the brain learns. When investigating teachers' experiences, an important consideration lies in the timing of the change. Due to the COVID-19 pandemic, school buildings were closed for the final quarter of the previous school year (spring 2020). District Z ended the year in a virtual learning mode, where all classes were held via Zoom. The fall 2020 semester started in the same learning mode. Throughout the first semester of implementation, these schools experienced virtual learning, hybrid learning (when half the students were in the classroom while the other half attended via Zoom), and full in-person learning (District math coordinator, personal communication, September 17, 2020).

Statement of the Problem

The question of how children should learn mathematics is often discussed as educators and policymakers look to improve mathematics achievement for students across the United States. Despite shifts in curriculum, instruction, and standards over the years, low achievement and inequity plague the mathematics classroom (Woodward, 2004). Boaler, a professor at Stanford University, and her team conducted and published research on the benefits of a mathematical mindset. This approach uses brain research to make recommendations for math learning. Boaler's recommendations are categorized under the following five ideas: growth mindset culture, nature of mathematics, challenge and struggle, connections and collaborations, and assessment (Boaler, 2015). Growth mindset culture is based on Carol Dweck's research on mindset, and the impact of growth mindset on students' academic achievement. Boaler (2015) stated that the nature of mathematics refers to the idea that mathematics is unlike other school subjects, in that the subject is "a cultural phenomenon: a set of ideas, connections, and relationships that we can use to make sense of the real world" (p. 23). A hallmark of growth mindset is the acceptance of mistakes, and the understanding that mistakes are an important step in the learning process (Dweck, 2006). Consequently, Boaler emphasized the need for challenging classroom opportunities and productive struggle (Boaler, 2015). Boaler asked educators to refocus on the core of mathematics: patterns. Mathematics is a "subject of visual images, creativity and connections, and is filled with uncertainty" (Boaler, 2015, p. 22). Boaler argued that school mathematics has split from real mathematics. Similarly, Boaler articulated the need for an increased focus on connections. The pathways to connections between areas of mathematics lie in collaborative interactions with varied-ability peers (Boaler, 2015). Finally, Boaler argued that the American education system measures what is easy, rather than assessing the most important aspects of mathematics (Boaler, 2015).

Through these recommendations, Boaler has called for an overhaul of both what is taught in mathematics classrooms, and how it is taught. Exploring the impact these practices have across a large school district may provide necessary information to aid in addressing classroom performance and equity. Boaler and her group of researchers have published studies on the impact of the mathematical mindset approach when implemented at summer camps and individual schools. There is not yet a study focused on a district-wide shift. School districts need access to these data when considering expending significant resources on material acquisition and professional development for teachers.

Purpose of the Study

The purpose of this study was to explore teacher experiences with a district-wide shift to sixth-grade math instruction based on Boaler's mathematical mindset approach. This shift included introducing a new instructional approach, along with modified curriculum to include explicit instruction in mindset and the science of how the brain learns. The study was designed to examine teachers' experiences, along with their perceptions of the effectiveness of a mathematical mindset approach in the mathematics classroom.

Significance of the Study

The significance of this study is the contribution it makes to decision making in the school district involved, along with other districts looking to improve the mathematical instruction provided to K-12 students. This study could help school districts determine if Boaler's resources and recommendations are worth an overhaul of their current practices. No other research has been published as of this date on the implementation of these resources and suggested practices, beyond isolated studies performed by Boaler's team.

The results of the study may be used to make changes to curricular and instructional expectations, assessment, or professional development for subsequent school years. With the world-wide Coronavirus pandemic, and the introduction of virtual learning options, the district will not be able to rely on district-wide achievement measures as they have in the past. These qualitative data will help the district evaluate the new curriculum and plan potential changes.

Delimitations

Bloomberg and Volpe (2019) defined delimitations as initial choices made by the researcher, for the purpose of narrowing the scope of the study. Delimitations differ from the limitations described in Chapter 3, as they are specific and intentional choices, while limitations are constraints that flow from the research design. The delimitations applied in this study were chosen to allow the researcher a comprehensive view of teacher experiences and perceptions of the effectiveness of the new curriculum. Interviews were restricted to teachers within one large public-school district in Kansas. To understand the effectiveness of the curriculum for all students, special education teachers and gifted facilitators were interviewed in addition to sixth-grade general education teachers. First-year teachers were excluded from the interviews, as they did not have experience with previous curricula to compare experiences and efficacy. While the sixth and seventh grade curricula were revised and implemented at the same time, the researcher chose to focus on teachers at one grade level, sixth grade. Sixth grade was chosen because the researcher previously taught sixth grade in the school district, and co-taught mathematics classes using the previous curriculum. This background was useful when developing interview questions.

Assumptions

Lundberg and Irby (2008) described the importance and influence of assumptions on a research study, "Specifically, delineation of assumptions provides a basis for formulating research questions or stating hypothesis and for interpreting data results from the study; and the assumptions provide meaning to the conclusions and lend support to these recommendations" (p. 135). This study was based on the following assumptions: (a) the selected teachers implemented the revised math curriculum with fidelity; (b) the selected teachers' responses to interview questions accurately reflect their experiences and their perceptions of curriculum efficacy.

Research Questions

According to Bloomberg and Volpe (2019), research questions are tied to a study's purpose and assist readers in clearly understanding the direction and scope of the study. This qualitative study was designed to focus on the following two research questions:

RQ1. What were teachers' experiences with the mathematics mindset approach as a new curricular and instructional tool for sixth-grade math?

RQ2. What were teachers' perceptions of the effectiveness of the mathematical mindset approach as part of the new sixth-grade math curriculum?

Definition of Terms

The definitions of five terms integral to the research study are provided in this section to ensure clarity for readers. Flake (2017) wrote that "The definition of instruction and curriculum is subjective. Both curriculum and instruction may take on different meanings based on the purpose or interpretation whether political, social, or educational" (p. 1). To avoid misconceptions regarding these terms, both are defined below.

Curriculum. Flake (2017) described curriculum as what is being taught. In the context of this study, the term covers the school district's standards for sixth-grade mathematics classes. Curriculum also includes the prioritization and sequencing of mathematical skills.

Instruction. According to Flake (2017), instruction refers to how content is taught. Instruction includes the teaching method and specific activities used with learners.

Growth Mindset. Dweck (2006a) defined growth mindset as the belief that a person's qualities, including intelligence, are malleable and therefore able to be developed.

Fixed Mindset. As defined in Dweck's (2006a) book, a fixed mindset is the belief that a person's qualities, including intelligence, are unalterable.

Mathematical Mindset. Jo Boaler coined the phrase mathematical mindset, referencing a growth mindset specific to mathematics learning. An individual has a mathematical mindset if they believe they can achieve highly in mathematics, as opposed to the belief that individuals are either born with or without the ability to succeed in mathematics (Boaler, 2015). The term mathematical mindset also encompasses Boaler's philosophy for instruction in mathematics classrooms. When a mathematical mindset approach is being implemented in the classroom, the curricular and instructional decisions are being made through the lens of building and supporting the students' growth mindsets.

Organization of the Study

This study is organized in five chapters. Chapter 1 included the introduction, background, statement of the problem, purpose of the study, significance of the study, delimitations, assumptions, research questions, and the definition of terms. Chapter 2 includes a review of literature surrounding the history of mathematics education in the United States, along with mindset research. Chapter 3 covers the methodology for the study, including research design, setting, sampling procedures, instruments, data collection procedures, data analysis and synthesis, reliability and trustworthiness, researcher's role, and limitations of the study. Chapter 4 contains an explanation of the results of the study. The final chapter presents a summary of the findings, findings related to literature, and conclusions. The conclusions are ordered by implications for action, recommendations for future research, and concluding remarks.

Chapter 2

Review of the Literature

The studies over the implementation and effectiveness of Mathematical Mindset in the classroom are currently limited to the research team who developed the approach and resources. Chapter 2 provides an overview of the history of mathematics education in the United States, starting in colonial times. The original mindset research and Boaler's mathematical mindset research are also covered in this chapter.

History of Mathematics Education in the United States

The first part of the literature review will be an overview of mathematics education in America since colonial times. The section is divided into four subsections: 17th and 18th centuries, 19th century, 20th century, and years 2000 to 2022. The focuses within each subsection are the changes to what mathematics skills children were taught, how children were taught, and the driving forces behind those changes.

17th and 18th centuries. Colonial education was provided in three main locations: dame schools, grammar schools, and town schools. The purpose of grammar schools was to prepare boys for university, so the instructional focus was on classical subjects and religion (Willoughby, 1967). Dame schools were run by women in their homes, and provided basic reading, writing, and arithmetic for the middle class (Gelbrich, 1999). Town schools aimed to train clerks, and originally focused on writing and arithmetic (Willoughby, 1967). However, strong puritan influences led to the replacement of mathematics learning with more religion and reading (Furr, 1996). Mathematics was only taught in towns that had commercial interest (Willoughby, 1967).

Religion was a major focus of colonial education. Consequently, a greater value was placed on reading and writing than on mathematics.

Mathematical learning focused on the four rules (addition, subtraction, multiplication, and division), fractions, and proportions (Swett, 1900). In colonial times, mathematics was taught primarily through the 'rule method.' According to Furr (1996), the rule method was a strategy "in which a particular rule for a particular problem was presented, memorized, and then drilled" (p. 3). Furr (1996) also pointed out the flaws in this method, "What most students learned under such instruction was how to follow examples. Very rarely did they understand an operation" (p. 3).

During colonial times, the purpose of colleges was to prepare ministers. Harvard University led the movement to include more mathematics learning in colonial schools. In 1726, Harvard hired the first mathematics professor in America, and added arithmetic proficiency requirements for applicants. These new requirements led to the inclusion of arithmetic in American secondary schools (Willoughby, 1967).

19th century. More children gained access to public education during the 19th century, through the Common School movement. While not yet compulsory, wider access to education was provided based on the idea that political stability and social harmony depended on a more educated populace (Haarlow & Wagoner, n.d.). The number of children taught arithmetic rose with the Common School movement. At this time, a few privileged boys began learning algebra and geometry. Girls were still not included in mathematics learning (Furr, 1996).

In 1820, Harvard began requiring algebra, with other colleges following their lead. This led to algebra being taught in American schools. In 1844, Harvard began requiring geometry. This led to a similar adoption by other colleges, and consequently, the addition of geometry to the curriculum in secondary schools. Arithmetic was taught first, followed by algebra, and then geometry (Willoughby, 1967).

A problem with the increased focus on arithmetic, and the addition of algebra and geometry, was a shortage of teachers who were trained in mathematics. One-room schoolhouses were the norm for most American boys. One teacher instructed a group of students in grades one through eight, covering reading, writing, history, geography, and arithmetic (Kegley, 1947). The lack of teacher training led to an incomplete understanding of mathematics, and therefore ineffective teaching methods. The rule method was still standard practice.

There was no focus on pedagogy in mathematics teaching until 1821, when Warren Colburn published *First Lessons in Arithmetic on the Plan of Pestalozzi, with Some Improvements* (Furr, 1996). Colburn's ideas were based on the work of the Swiss philosopher, Pestalozzi. This shift in instruction prioritized connections to students' experiences, and progression from familiar topics to new information (Colburn, 1821). Additionally, Colburn was an advocate for mathematics as a mental discipline, rather than just preparation for everyday calculations. Colburn (1821) recognized that practical utility was the primary consideration in the learning of mathematics.

In an 1830 speech to the American Institute of Instruction, Warren Colburn argued for a new approach to mathematics. He mentioned the lack of mathematical education for girls, the need to start mathematics instruction at a younger age, and the need for reasoning rather than memorization and drill (Bidwell & Clason, 1970). Colburn's book was used in schools and homes. Monroe (1912) reported that by 1856, 50,000 copies were used yearly in Great Britain, while 100,000 were used yearly in the United States. Unlike the rule method, Colburn's system began with practical problems and the use of manipulatives while students gained an understanding of the operation. Only then were abstract numbers and signs introduced, allowing students to develop general principles (Colburn, 1821; Furr, 1996).

According to Bidwell and Clason (1970), the difference in mathematical instructional approaches was tied to the perceived purpose. When mathematics was taught only for daily application, the rule method allowed students to gain the skills needed to participate in commerce. When a secondary purpose of mental discipline emerged, a need for deeper understanding and reasoning followed (Bidwell & Clason, 1970).

The public did not immediately commit to the switch to mathematics as a mental discipline. While there was an increase of students attending secondary school, there was pushback on mathematics learning for the sake of intellectual value (Cooper, 2017). Many schools continued to focus on social utility, and drill continued to dominate instruction. These disagreements extended to the overall role of American schools. Some believed the role of schools was to prepare students for college, while others believed the role was to prepare students for trade jobs (Bidwell & Clason, 1970; Cooper, 2017).

Due to the differing views on the role of American schools, "the National Education Association appointed the Committee of Ten on Secondary Studies in 1892 in order to standardize school curriculum" (Cooper, 2017, p. 6). The committee recommended a system similar to what is seen in America today. Overall, twelve years of education are needed, split into elementary (eight years) and secondary (four years). The recommendations also contained a progression of mathematics topics for high school. Algebra should be taught first, followed by Geometry, Algebra 2 and Geometry 2, and finally Trigonometry and Higher Algebra (Cooper, 2017). The study of algebra was to be continued during the time when geometry was taught. Willoughby (1967) and Furr (1996) described the failure of this component of the committee's recommendations. In most schools where the parallel courses were tried, teachers still taught algebra and geometry as though there were no connection between the two; furthermore, many teachers preferred one of the subjects over the other. Consequently, while many of the other recommendations of the committee were incorporated into the mathematics curriculum of the nation, the parallel courses in algebra and geometry were dropped by most schools (Furr, 1996). Ultimately, the committee sided with those who believed the purpose of American schools was to prepare students for college. The committee also emphasized a need for better teacher training (Cooper, 2017).

Curriculum in American schools shifted with college requirements. This presented an issue as more American colleges were established, and entrance requirements were inconsistent. In 1900, the College Entrance Examination Board was founded for the purpose of organizing educational standards (Cooper, 2017). The development of common college standards impacted secondary school curriculums, which would align with the new standardized college entrance requirements (Cooper, 2017).

20th century. In America's post World War 1 era, an anti-intellectual movement threatened the inclusion of mathematics in schools (Furr, 1996). This uncertainty led to the formation of the National Council of Teachers of Mathematics (NCTM), originally a part of the National Education Association (NCTM, 2021). The council's first president, Charles M. Austin, described the organization's purpose:

> First, it will at all times keep the values and interests of mathematics before the educational world. Instead of continual criticism at educational meetings, we intend to present constructive programs by friends of mathematics. We prefer that curriculum studies and reforms and adjustments come from the teachers of mathematics rather than from educational reformers. (NCTM, 2021, p. 9)

In 1921, NCTM acquired *Mathematics Teacher*, a publication started in 1908. The publication allowed for mathematics teachers to share activities and pedagogical strategies. NCTM is the world's largest mathematics educational organization in 2021, and *Mathematics Teacher* is one of the most celebrated mathematics publications (NCTM, 2021).

During the 1920s, psychologist E. L. Thorndike conducted research regarding pedagogy of mathematics (Furr, 1996). In his publication, *Psychology of Arithmetic*, Thorndike advocated for arithmetic without reasoning, and extensive practice of isolated skills (Thorndike, 1924). Thorndike said he believed mathematics should only be learned for practical purposes.

With the passing of the Fair Labor Standards Act of 1938, child labor was limited, increasing participation in school (Furr, 1996). The discipline of mathematics was being taught to more students than ever. However, the debate surrounding how and why mathematics should be taught continued. In 1925, William Kilpatrick published *Foundations of Method*, which would become the textbook for teacher preparation courses in America (Cooper, 2017). Kilpatrick argued against the idea of mathematics as a mental discipline and promoted drill and rote memorization (Kilpatrick, 1925).

Myron Rosskopf, a mathematician and professor of mathematics, criticized Thorndike and promoted the use of mathematics for teaching reasoning skills (Furr, 1996). Rosskopf's obituary in the New York Times (1973) noted that he was "one of the few mathematicians in this country engaged in research in Piagetian cognitive development theory in mathematical learning" (p. 1).

After World War 2, psychology became foundational to the mathematics reform movement. In addition to Piaget, the work of John Dewey, BF Skinner, and Max Wertheimer were considered (Furr, 1996). Laboratory schools were opened in the twentieth century to experiment with curricula. Carnegie Corporation's Eight-Year Study compared the outcomes of the experimental schools with the traditional schools. The study concluded that traditional college preparatory programs were not the only effective method for educating college bound students. In fact, students from the most experimental schools earned the highest marks (Kridel, n.d.). Despite the findings, most schools in America continued with the traditional college preparatory curriculum (Tyler, 1986).

During this post-war time, the U.S. government began expressing the importance of mathematics to national defense, "World War 2 marked the start of the U.S. government's interest in math education due to the lack of mathematical skills of incoming officers" (Cooper, 2017, p. 10). The NCTM (2021) presented new recommendations to address the military's difficulty finding candidates with adequate mathematical competency (Furr, 1996). Algebra, geometry, and trigonometry were the minimum expectation (NCTM, 2021).

In 1916, the Mathematical Association of America formed the National Committee on Mathematics Requirements (NCMR) (Department of the Interior, Bureau of Education, 1921). The committee published a preliminary report that year. In 1923, the committee published a final report, entitled *The Reorganization of Mathematics in Secondary Education*, addressing what mathematics should be taught in junior high and senior high schools (Butler, 1951; Department of the Interior, Bureau of Education, 1921; Zitarelli, 2015). Additionally, the reports addressed "the status of disciplinary values, of experimental courses in mathematics, of standardized tests in mathematics, and of the training of teachers of mathematics" (Butler, 1951, p. 91). The report impacted curricula for middle and high schools, mathematics textbooks, and most books regarding the teaching of secondary mathematics written during the rest of the twentieth century (Butler, 1951).

The NCMR (1922) report stated that the aims of mathematics education fall under three categories: practical, disciplinary, and cultural. The practical aim involves learning arithmetic used in daily life. The disciplinary aim relates to mental training, and the creation of mental habits that can be transferred to new problems and situations. The cultural aim includes appreciation for geometry in nature, and an appreciation for the power of mathematics. The National Committee of Mathematics Requirements (1922) summarized the overall purpose of mathematics learning in their report:

> The primary purposes of the teaching of mathematics should be to develop those powers of understanding and of analyzing relations of quantity and space which

> are necessary to an insight into and control over our environment and an appreciation of the progress of civilization in its various aspects, and to develop those habits of thought and action which will make these powers effective in the life of the individual. (p. 9)

The NCMR (1922) recommended assisting students in developing their abilities to understand and apply processes and ideas, rather than rote drill and memorization. The report detailed the importance of integrating mathematical subjects, rather than continuing traditional separation of single subject classes. In terms of content, the NCMR recommended a curriculum for all students to complete by the end of ninth grade. The curriculum was organized under seven subjects: arithmetic, intuitive geometry, algebra, numerical trigonometry, demonstrative geometry, history and biography, and optional topics. Each subject was followed by standards, describing the specific skills and ideas teachers should focus on. The report included five potential sequences for students to cover all areas in a three-year span. Similarly, topics and sequences were published for the remainder of high school years (NCMR, 1922). The document also included pedagogical suggestions and rationale.

Another section of the NCMR report focused on teacher training. NCMR emphasized the importance of qualified teachers, comparing American educators to their more thoroughly trained European counterparts. The committee went further, describing an ideal mathematics teacher as not only being adequately trained in the content, but also one displaying a genuine enthusiasm, specific personality attributes, and mastery of the psychology of the learning process (NCMR, 1922).

Change was not instantaneous after the publication of the NCMR report, due to the "Great Depression and the inertia of maintaining traditional educational practices" (Zitarelli, 2015, p. 12). However, the 1950s were a time of change. There was a push to teach more mathematics before college, to start learning math at a younger age, and a need for mathematics skills due to the new technology in the job market (Furr, 1996).

According to Furr (1996), the launching of Sputnik shifted public perception of the purpose of mathematics education. Better science and mathematics education became a matter of public interest. The 1958 National Defense Education Act provided funding for the development of teaching mathematics. In that same year, the School Mathematics Study Group was formed and funded by the National Science Foundation to develop textbooks (Furr, 1996). In 1959, modern mathematics was added to the secondary mathematics curriculum. Modern mathematics included linear programming and probability (Furr, 1996).

The 1950s and 1960s were characterized by the New Math movement (Furr, 1996). Despite the name, new ideas were not being taught. New Math involved shifting the instructional emphasis. Mathematical topics were reordered for better sequencing. Advanced ideas were introduced earlier, set theory was introduced, and a greater focus was placed on "formal logic, applications, and manipulatives for analytical induction" (Furr, 1996, p. 12). During this time, calculus was first introduced at the high school level. New Math was a continuation of ongoing changes including the introduction of newly discovered mathematics topics and the pushing of subjects to younger students. With these changes, there was a need for specialized math teachers at all levels of

American schools. The need led to a rise in professional development for teachers, through conferences, workshops, and courses (Furr, 1996).

During the 1960s and 1970s, America saw a slight dip in standardized test scores. In reaction, many pushed for back-to-basics programs that utilized rule and drill without application. Additionally, tougher accountability standards were put in place (Furr, 1996). In 1980, NCTM released *An Agenda for Action*, recommending a focus on problem solving, and encouraging the use of manipulatives (Cooper, 2017).

In 1983, *A Nation at Risk* caused a public frenzy with the findings that students were not ready for college level mathematics (Cooper, 2017). This led to increased standardized assessments and more difficult textbooks. In 1987, the NCTM developed the *Curriculum and Evaluation for School Mathematics*, a document to aid in evaluating mathematics curricula. After revision in 1988, and publication in 1989, this would become the NCTM standards. The standards were split into three levels: Kindergarten to fourth grade, fifth through eighth grade, and ninth through twelfth grade (Cooper, 2017). The publication called for the use of manipulatives and calculators. By 1997, most states adopted similar mathematics standards.

In 1997, the NCTM criticized California's mathematics standards (Cooper, 2017). Due to the large population in the state, California's standards impacted the work of textbook developers. This affected what was available to the rest of the country. In 2000, NCTM released a revision of the 1989 standards, *Principles and Standards for School Mathematics* (Cooper, 2017). However, disagreements about standards continued.

2000 to 2022 Congress passed the No Child Left Behind Act in 2001, and the law was signed in 2002 (Cooper, 2017). The basis for the legislation was that the United States was behind other countries in academic achievements. The law aimed to address the achievement gap seen in different populations, including English language learners, students from low socio-economical families, and students of ethnic minorities. States were required to administer yearly tests in reading and math for grades three through eight. The federal government expected to see adequate progress by the 2013-2014 school year (Cooper, 2017).

According to Cooper (2017), The No Child Left Behind Act resulted in an increase in data, higher school accountability for the subgroups previously mentioned, and a requirement for highly qualified teachers. However, many schools did not make adequate yearly progress, leading to a decrease in teacher morale (Cooper, 2017). Additionally, the increase in standardized testing is a component still debated.

In 2009, the U.S. Department of Education started the Race to the Top program. Through the American Recovery and Reinvestment Act, $4.35 billion was allocated to support schools in implementing more rigorous standards, better assessments, and better data systems, along with providing support for increased teacher effectiveness and resources for interventions (Cooper, 2009; 2017). To receive funding, states were required to adopt common K-12 standards and common assessments.

One option for standard adoption was the Common Core State Standards, introduced in 2010. The purpose of the new standards was college and career readiness for ELA and mathematics. The common core standards were met with great resistance from the public (Cooper, 2017). As of 2021, 41 states and the District of Colombia had adopted the Common Core State Standards (Common Core State Standards Initiative, n.d.). In 2015, the Every Student Succeeds Act was passed, requiring states to test all students in math and reading. While there were some federal regulations, individual states were in control of their testing and accountability systems (Cooper, 2017).

Mindset Research

Research has shown that growth mindset culture has a positive impact on mathematics achievement. Dweck and Licht (1980) first hypothesized that female students' disbelief in malleable intelligence was the cause of the gender gap in academic achievement, particularly in mathematics. In 1984, Licht and Dweck published the results of a study examining how students react to simple and confusing tasks, in relation to students' views of their own intelligence. Girls who considered themselves intelligent were debilitated by the confusing tasks at much higher rates than boys who considered themselves intelligent (Licht & Dweck, 1984). Dweck (2006a) later termed an individual's belief that their intelligence was immoveable, regardless of their efforts or education a fixed mindset, while the belief that one can change their intelligence was labeled growth mindset. When girls with fixed mindsets encountered difficult tasks, they questioned their intelligence, thereby lowering their confidence and academic achievement (Dweck, 2006b).

Good, Aronson, and Inzlicht (2003) conducted a study that involved teaching a group of students that their intelligence was not fixed, but rather something they could change through learning. Information on the science of how the brain works was included in the instruction for the intervention group. At the end of the school year, the researchers compared the state math assessment scores for the intervention and control groups. In the control group, female students continued to score below their male peers. However, the gender gap disappeared for the students who received the growth mindset intervention. All students in the intervention group made progress on the test, but the progress was most significant for female students (Good et al., 2003).

In 2018, Degol, Wang, Zhang, and Allerton conducted a longitudinal study looking at how mindset and gender intersect in relation to mathematics achievement for 1,449 high school students. The researchers conducted surveys in the fall to measure students' mindsets, motivational beliefs, and STEM (science, technology, engineering, and mathematics) career aspirations. The study showed that students with growth mindsets also had high expectations for their performance in mathematics and achieved well in the classroom. Students with fixed mindsets had lower expectations for their classroom performance. However, male students with fixed mindsets showed higher expectations than female students with fixed mindsets. Achievement in the classroom was correlated with students' expectations, showing that female students were subject to more significant negative consequences of having a fixed mindset. The researchers concluded that the results support growth mindset as an important component of the education for all students, with particular importance for female students in the mathematics classroom (Degol et al., 2018). Historically, research has shown that a focus on growth mindset positively impacts student achievement and promotes equity.

Jo Boaler, a professor and researcher at Stanford University researched the brain and mathematics learning. Stemming from Dweck's research, Boaler's model for how to best approach mathematics learning in the classroom is referred to as mathematical mindset. Boaler's research findings led to recommended practices, activities, and considerations for mathematics teachers. Boaler emphasized the importance of struggle and learning from mistakes. She encouraged the use of open, visual mathematic tasks. Boaler (2016) also listed six strategies for increasing equity in the mathematics classroom.

1) Offer all students high-level content.
2) Work to change ideas about who can achieve in mathematics.
3) Encourage students to think deeply about mathematics.
4) Teach students to work together.
5) Give girls and students of color additional encouragement to learn math and science.
6) Eliminate (or at least change the nature of) homework. (pp. 102-107)

Finally, Boaler recommended avoiding ability grouping, and provided suggestions for assessing students in a way that aligns with the growth mindset culture.

Boaler, a team of graduate students, and Stanford researchers conducted a study through a summer mathematics intervention camp in 2021 (Boaler et al., 2021). This study was the first to examine the impact of a "mathematical mindset teaching approach" in addition to the explicit instruction of growth mindset (Boaler et al., 2021, p. 1). The camp was taught in 10 school districts in the United States. Through a mixed methods approach, the researchers used pre and post assessments, along with changes to grade point averages, to gather quantitative data on the effectiveness of the instruction. The researchers reported that "Both measures showed that a mathematical mindset approach to teaching significantly improves students' mathematical achievement, and changes students' beliefs about themselves and their approach to learning" (Boaler et al., 2021, p.

1). Teacher interviews were used to gain insight into how students changed over the course of the intervention camp. The analysis of the qualitative data highlighted "the need to bring about shifts in students' mindsets through a changed approach to mathematics teaching and learning" (Boaler et al., 2021, p. 1).

Summary

The reviewed research illustrates America's history of changing the mathematics curriculum and instruction for school-aged children. Since the founding of the nation, the purpose of mathematics education has been debated. For some, the main purpose was everyday utility, while others considered mathematics learning part of mental training. More recently, mathematics learning has been identified as a matter of national importance. The 'how' of mathematics learning shifts with the perceived purpose. Throughout history, instruction has oscillated between rote memorization to exploration and inquiry-based tasks. The final section of the chapter focused on Carol Dweck's mindset research, and Jo Boaler's extension of mindset into the learning of mathematics. These researchers use modern neuroscience to make recommendations for today's mathematics classrooms.

Chapter 3 covers the methods for addressing the study's research questions. The sections in the chapter are research design, setting, sampling procedures, instruments, data collection procedures, data analysis and synthesis, reliability and trustworthiness, researcher's role, limitations. Chapter 3 ends with a summary of the study's methods.

Chapter 3

Methods

The purpose of this study was to explore teacher experiences and their perception of the effectiveness of the mathematical mindset approach as a curricular and instructional tool in the sixth-grade mathematics classroom. This chapter describes the research design, setting, sampling procedures, instruments, and procedures used for data collection. The processes for selecting participants and conducting interviews is provided. Methods for ensuring reliability and trustworthiness are included, along with the researcher's role. Additionally, data analysis and synthesis are described, along with the study's limitations.

Research Design

In order to examine the perceptions and experiences of mathematics educators, a qualitative research design was followed. According to Lunenburg and Irby (2008), "Qualitative research emphasizes understanding by closely examining people's words, actions, and records" (p. 89). Additionally, Creswell and Creswell (2018) stated, "If a concept or phenomenon needs to be explored and understood because little research has been done on it or because it involves an understudied sample, then it merits a qualitative approach" (p. 19).

Lunenburg and Irby (2008) identified four types of qualitative research designs: phenomenological, case study, ethnographic, and grounded theory. Creswell and Creswell (2018) described phenomenological research as:

> a design of inquiry coming from philosophy and psychology in which the researcher describes the lived experiences of individuals about a phenomenon as

> described by participants. This description culminates in the essence of the experiences for several individuals who have all experienced the same phenomena. (p. 13)

This study falls in the phenomenological research design category because the purpose was to examine and describe the experiences of teachers undergoing the phenomenon of the implementation of a new mathematics curricular and instructional tool. The researcher utilized interviews as the method of data collection for this phenomenological study. According to Lunenburg & Irby (2008), "The interview, both factual and meaningful, seeks to describe the meanings of central themes in the life world of the subjects" (p. 91). The interviews were conducted in a semi-structured format, with open-ended questions and follow-up questions as needed, to deepen the understanding of participants' experiences and perceptions. According to Bloomberg and Volpe (2019), semi-structured interviews allow the researcher to "facilitate a more focused exploration" (p. 193).

Setting

School District Z is located in an affluent section of a metropolitan area. According to the 2020 U.S. Census report, the area served by District Z includes a population of approximately 130,000, with a median income of approximately $121,000 and 3.3% of the population reported under the poverty line. The racial makeup of the area is 80% white, 11% Asian, 4% Hispanic, 3% black, and 2% individuals of two or more races (U.S. Census Bureau, 2020). District Z oversees 21 elementary schools, nine middle schools, and five high schools. The district reported early-childhood through twelfth- grade enrollment of 22,421 learners, and a graduation rate of 95.9%.

Additionally, the district reported employment of 1,888 certified staff members, 1,328 classified staff members, and 108 administrators, with 73% of teaching staff having a master's degree or higher (District Overview/Demographics, n.d.). In District Z, middle schools serve students in Grades 6 through 8. The participants come from five of the nine middle schools.

Sampling Procedures

The participants in this study were chosen with purpose. Bloomberg and Volpe (2019) described the logic of purposeful sampling as "selecting information-rich cases, with the objective of yielding insight and understanding the phenomenon under investigation" (p. 186). Participants were chosen based on the grade level taught, area of specialty, and years of experience. Sixth-grade mathematics teachers, special education teachers, and gifted facilitators were considered for the study, as each had the opportunity to observe students' growth in mathematics over the school year. First year teachers were not considered for the study, because it would not be possible for them to consider the effectiveness of the curriculum and instruction beyond the 2021-2022 school year.

Instruments

The interview questions were developed by the researcher and reviewed by a panel of mathematics experts, including the school district's mathematics coordinator, one college mathematics professor, and one university mathematics education professor. Lunenburg and Irby (2008) stated that questions about the present should precede questions about the past or future. Questions about the 2021-2022 school year's math instruction were asked before questions regarding previous years' instruction.

The first three interview questions are focused on teachers' experiences with the new instructional approach. These questions addressed the first research question of the study.

RQ1. What were teachers' experiences with the mathematical mindset approach as a new curricular and instructional tool for sixth-grade math?

1. Describe your experience learning about the use of the mathematical mindset approach in the classroom.
2. Describe your experience implementing the mathematical mindset approach in the classroom.
3. How does your experience with the 2021-2022 curriculum compare to your experiences with past curricula?

The second set of five interview questions are focused on the perceived effectiveness of the new instructional and curricular approach. These questions addressed the second research question of the study.

RQ2. What were teachers' perceptions of the effectiveness of the mathematical mindset approach as part of the new sixth-grade math curriculum?

1. Describe the effectiveness of instruction rooted in the mathematical mindset approach.
2. Describe the effect the content of the new sixth grade math curriculum has had on student learning.
3. Describe the effect of teaching mathematical mindset on student academic success.

a) What impact have you noticed within specific subgroups? (gender, race, IEP or gifted services)

4. What impact have the mathematical mindset activities had on student attitude towards mathematics?

   a. Follow-up: What additional impact have you observed, if any, other than academics?

5. How does the effectiveness of the mathematical mindset approach compare to past instructional movements (new math, project-based learning, etc.)?

Data Collection Procedures

Before collecting data, a research proposal was submitted and approved by District Z (Appendix A). This approval was received on September 23, 2021. Upon district approval of the research proposal, a research proposal was submitted to the Baker University Institutional Review Board (IRB). The proposal was approved on June 2, 2022 (Appendix B). Following District Z and Baker's approval of the research proposal, a central office employee from District Z provided the names and email addresses for sixth-grade math teachers, special education teachers, and gifted facilitators. An email was sent to the group explaining the purpose and process of the study and requesting their participation (Appendix C). The email also included information on informed consent along with the researcher's email in case of additional questions. At the request of the school district, the email also included a statement clarifying that the study was through Baker University, and not associated with District Z.

The interview questions and consent forms (Appendix D) were sent to participants at the same time, via email, along with further details regarding the scope of the research. Providing the interview questions prior to the interviews allowed participants to reflect on their experience and the efficacy of math instruction during the most recent school year, and comparatively, previous school years. Through the email, participants were made aware that participation was voluntary, and they had the right to discontinue at any time. Dates and times for interviews were set when participants returned the consent forms.

One-on-one interviews were conducted via Zoom, a virtual meeting platform, or over the phone. Each interview was conducted individually, and each participant was interviewed one time. One interview took place during the summer of 2022, and the other five took place during the fall of the 2022-2023 school year. The researcher conducted interviews with all six participants. Microsoft Word dictation software was used to transcribe in real time, and all interviews were audio recorded. Audio files, transcription documents, and interview notes were organized in digital folders. To maintain confidentiality, no one other than the researcher had access to the files. Once all interviews were complete and transcribed, the data were member checked and then analyzed. According to Bloomberg and Volpe (2019), member checks entail “sending the transcribed interview or summaries of the researcher’s conclusions to participants for review” (p. 204). In this study, member checks were utilized after transcription, and before the researcher began investigating themes.

Data Analysis and Synthesis

According to Bloomberg and Volpe (2019), “Once you have collected your data…your next step is to manage, organize, and make sense of all the separate pieces of accumulated information” (p. 230). The interviews were transcribed verbatim using

Microsoft Office dictation software. The transcriptions were checked against the audio recordings to ensure accuracy. The transcripts were then sent to participants, to allow them to make corrections to the content of their responses. One participant sent a correction, saying the original answer to one interview question was not complete. The researcher then read through all the interview transcriptions to begin detecting common themes. The portions of each transcript associated with the first research questions were grouped, as were the portions addressing the second. The data were looked over again, in these groups, and the data were coded according to common words, phrases, and themes. Dedoose, a qualitative analysis program, was used to assist in the coding of the interview data. Creswell and Creswell (2018) described this type of open coding, "The traditional approach in the social sciences is to allow the codes to emerge during the data analysis" (p. 196). Predetermined codes were not used. The researcher developed codes only as they emerged from the participant data. Through coding, similarities and differences in participant responses were observed and analyzed with respect to the two research questions. These findings are reported in Chapter 4 and interpreted in Chapter 5.

Reliability and Trustworthiness

Bloomberg and Volpe (2019) separated trustworthiness of qualitative studies into two considerations, validity and reliability. Creswell and Creswell (2018) stated that validity in qualitative research "means that the researcher checks for the accuracy of the findings by employing certain procedures (p. 199). Bloomberg and Volpe described validity as follows, "If research is valid, it clearly reflects the world being described" (p. 202). Bloomberg and Volpe (2019) identified member checking and audit trails as processes for increasing validity. Bloomberg and Volpe (2019) went on to note that using member checks "entails sending the transcribed interviews or summaries of the interviews of the researcher's conclusions to participants for review" (p. 204). To address validity as defined above, member checking was employed to allow participants to review and make corrections to the interview transcripts, to ensure the data being analyzed were an accurate reflection of the participants' experiences and perceptions. The audit trail created by the recordings and manuscripts along with detailed steps regarding data collection and analysis allowed for greater validity. The third method for addressing validity was the involvement of an expert panel to review and provide feedback on the interview questions prior to the beginning of the interview process. The expert panel included the mathematics coordinator for District Z, one college mathematics professor, and one university mathematics education professor.

Creswell and Creswell (2018) wrote that "qualitative reliability indicates the researcher's approach is consistent among different projects" (p. 199). Bloomberg and Volpe (2019) described reliability as follows, "If work is reliable, then two researchers studying the same phenomenon will come up with compatible observations" (p. 202). For a study to achieve reliability, as defined above, the researcher must limit personal bias. A procedure for reducing potential for the researcher to introduce bias was personal reflexivity. According to Lunenburg and Irby (2008), personal reflexivity "involves reflecting upon the ways in which our own values, experiences, interests, beliefs, political commitments, wider aims in life, and social identities have shaped the research" (p. 104). The interviewer reflected on these potential factors prior to beginning interviews, self-monitored during interviews, and conducted post-interview and post-analysis reflections to minimize personal bias, and therefore strengthen reliability.

Researcher's Role

The role of the researcher in a qualitative study is to present the perceptions and experiences of the participants without personal bias (Bloomberg & Volpe, 2019; Creswell & Creswell, 2008). As noted above, the researcher engaged in personal reflexivity in order to present the experiences and perceptions of the participants, with limited bias. This reflexivity is vital for qualitative research, as explained by Patnaik (2013), "As compared to the quantitative method's straightforward claim to objectivity, qualitative research has often been labeled as impressionistic, anecdotal, and influenced by researcher's bias" (p. 2). The researcher selected introspection as the process of reflexivity, further explained by Patnaik (2013) below:

> Introspective reflexivity – This involves consciousness of the self by the researcher in order to understand how one's own experiential location might influence the choice of subject, methodology and themes. The researcher is both, the documenter of events as well as co-constructor on account of being present at the creation of the reality. By choosing to frame certain aspects and not merely mirror events the researcher determines the reader's perspective. Introspective reflexivity acknowledges that the researcher's experiences, attitudes and emotions will affect engagement with the participants and subsequent analysis of data. Introspective reflexivity is an attempt to maintain research focus by bracketing biases and attitudes of the researcher in order to minimize, if not prevent, their influence on the research process. (p. 9)

Three stages of reflection were listed in the previous section: pre-interview, during interview, and post-interview. A reflective journal was used by the researcher as a tool for introspection during the post-interview stage. Observations were noted after each interview prior to checking the transcripts.

The researcher had taught special education in District Z for six years, two of which were at the sixth-grade level. During those two years, the researcher also co-taught general education math classes. Additionally, the researcher has a Master's Degree in Mathematics Education, with a focus on Grades 5 through 12. At the time of the interviews, the researcher worked in a high school in District Z, teaching special education. No personal or professional relationships existed between the researcher and the participants. The researcher took care to leave personal experiences and perceptions from teaching sixth-grade mathematics out of the interview process and analyses of the interview data.

Limitations

Bloomberg and Volpe (2019) described limitations as "external conditions that restrict or constrain the study's scope or may affect the outcome" (p. 185). One limitation of the study was that the first school year with the new curriculum was atypical, with the COVID-19 pandemic causing frequent changes in learning modes. Students had periods of the school year when they attended class in person for half of the week, and other periods when they received all instruction remotely. This was the first time that teachers and students experienced the different learning modes. With these novel challenges, it was potentially difficult for participants to isolate the impact of curricular or instructional changes from pandemic related factors. Another limitation was the small number of individuals who volunteered for interviews. The end of the school year is a difficult time to ask teachers to take on additional activities, and the end of the school year during a pandemic was especially difficult. There is potential bias in only exploring the perceptions of teachers who were willing to participate in this study. For example, teachers who had a positive experience with the new mathematics curriculum may have been more likely to agree to participate.

Summary

Chapter 3 included information on the qualitative research design, teacher sampling procedures, development of interview questions and alignment to research questions, data analysis and synthesis methods, and reliability and trustworthiness. The researcher's role was described, including the process of introspective reflexivity. Chapter 4 covers the study's results.

Chapter 4

Results

This qualitative study was designed to explore teachers' experiences with the mathematical mindset approach to teaching mathematics, along with their perceptions of the effectiveness of the approach as a curricular and instructional tool in the sixth-grade mathematics classroom. The researcher contacted all sixth-grade mathematics teachers, special education teachers, and gifted facilitators in District Z. From that population, two mathematics teachers, two special education teachers, and two gifted facilitators agreed to participate in the study. Interviews were conducted with each of the six participants.

The researcher uploaded each transcript to the Dedoose software to aide in coding and analyzing the data. A code application table from the Dedoose analysis can be found in Appendix E. Thirty-seven codes were identified while repeatedly reading through the interview transcripts. The Dedoose program then categorically recorded the highlighted data related to each code, allowing for comparison among participant responses. The code application table shows the prevalence of each code within each participant's transcript, along with the total number of links to each code, across all transcripts. The table also includes the total number of times a part of a participant's transcript was linked to a code. This data allowed the researcher to view discrepancies in the references to each participant. The major themes identified from the qualitative data are described in detail in the section below.

Findings

The findings in this section are organized by the two research questions. The findings under Research Question 1, which addressed teachers' experiences with mathematical mindset, are organized by one clear difference among participants' responses: teacher introduction and training on the mathematical mindset model, and one common theme: student engagement. Under the umbrella of student engagement, the participants identified two common practices impacting engagement: visual mathematics and hands-on learning. The findings under Research Question 2, which addressed teachers' perceptions of the effectiveness of Mathematical Mindset, are organized by in dividual participant. Participants reported a shared perception of overall effectiveness, including a positive impact on student attitude towards mathematics as well as academic performance. The following two sections contain the results of the qualitative data analysis of the teachers' responses for each finding.

Participant 1, a math teacher, is referenced most frequently in the discussion of findings, as this teacher provided the lengthiest and most in-depth responses to the interview questions. The other math teacher, Participant 2, and one special education teacher, Participant 3 provided responses of similar volume and depth. Any disparity in reference between Participants 1 and 2 stems from Participant 1's experience including the general population of students, versus Participant 2's experience that was limited to the sub-group of students in special education. Of the three remaining participants, Participant 4, a gifted facilitator, provided the most data in response to the interview questions. Participants 5 and 6 offered the shortest responses to the questions, and both shared their limited experience with mathematical mindsets as part of their daily teaching role. Participant 5, a gifted facilitator, was not able to answer some of the questions due to the small number of gifted students enrolled in the grade-level math class. Participant responses also were varied in length and content, possibly due to factors such as their position in the school and their teaching experience.

Finding 1: Teachers' experiences with mathematical mindset. The results described in this section relate to the first research question, "What were teachers' experiences with the mathematical mindset approach as a new curricular and instructional tool for sixth-grade math?" Three interview prompts were used to address the first research question, "Describe your experience learning about the use of the mathematical mindset approach in the classroom.", "Describe your experience implementing the mathematical mindset approach in the classroom.", and "How does your experience with the 2021-2022 curriculum compare to your experiences with past curricula?" Differences in participant responses were observed with regard to learning about the mathematical mindset approach. A common theme of increased student engagement was noted, in addition to an emphasis on the specific practices of visual mathematics and hands-on learning.

Participants 1 and 2 learned about the mathematical mindset approach through district planning meetings, professional learning sessions, and school-community events. Participant 1, a math teacher, was introduced to the mathematical mindset approach through district-run professional learning. This participant described the opportunity to play with mathematics through visual pieces, "We started off with the geometry and just looking at nets and playing with nets and building nets and cutting nets and looking at nets that didn't work." Participant 1 identified one of the purposes of the learning session to be "helping teachers to become more of facilitators rather than standing at the front of the room, being the instructional piece." The activities mirrored the goal of having students "explore things and learn on their own." Participant 2, also a math teacher, began interacting with the mathematical mindset approach early, as part of a district math team. This participant described professional learning along with community involvement:

> You had adults in a room with string, trying to make a 3D shape, working together. I did that for a parent night last year one time, where we did building shapes and they just had a loop of yarn…and they had to try to make 2D and 3D shapes with a team of four people.

Both math teachers had opportunities to explore resources and experience the instructional approach prior to full implementation.

Participant 3, a special education teacher, brought experience from her time as a general education elementary school teacher. Of her previous experience, this participant recalled:

> The curriculum we were using at that time was really big into the mindset piece and doing a lot of the process part. And so that's how we started every unit was with those kinds of lessons where it was more exploratory. And they were working out, maybe like trying to attack a real-world problem… and then we come back and connect. We go back and we learn the basic parts that we needed to know, and then we go back and connect it to the original problem.

Participant 3 was the only participant who had experience with the mathematical mindset approach prior to District Z's initiative. Participant 6, the other special education teacher in the study, was introduced to mathematical mindset when they received resource books and saw the implementation in a District Z co-taught mathematics class. Unlike the mathematics teachers, special education teachers did not participate in professional learning focusing on mathematical mindset. Similarly, Participants 4 and 5, the gifted facilitators, reported that they did not initially receive training or information on mathematical mindset. The experience for the gifted facilitators was limited, as a majority of their students were on an accelerated path for mathematics. Therefore, when their students arrive at the middle school for sixth grade, they were typically enrolled in math classes above the sixth-grade level.

Participant 4 shared that the year after the mathematical mindset approach was implemented in sixth-grade classrooms, gifted facilitators did receive training where they were able to experience activities based in mathematical mindset. The participant then tried some of the activities in the gifted classroom to see how students who were performing between grade-level and accelerated-level mathematics would respond. Additionally, Participant 4 assisted in a district math night that was held for all elementary and middle school communities. Mathematical mindset-based activities were facilitated at that event.

The common theme from the participants' reported experiences with mathematical mindset was increased student engagement. Visual mathematics and hands-on learning were repeatedly identified as elements of the mathematical mindset approach that contributed to the increased engagement. As described in the Chapter 1 background section, District Z distributed their new sixth grade mathematics scope and sequence for the fall of 2020, including a new unit 0 focused on explicit instruction on mathematical mindset and the science of how the brain learns (District math coordinator, personal communication, September 17, 2020). The majority of references related to the first research question came from the mathematics and special education teachers, as those four participants reported being in the sixth-grade mathematics classrooms on a daily basis. Both gifted facilitators reported that they were not in the classroom for implementation.

Participant 2 shared that engagement was a goal established in the initial district math team meetings. This participant explained that the changes in the classroom, including the use of unit 0, increased student engagement. To start lessons, students used manipulatives and visually played with mathematical concepts. Participant 2 described the hybrid mode of learning as a dream because the smaller in-person group was able to open up a lot more, "They were able to have a lot of math talking. I think with this curriculum, it really tries to encourage kids to talk to each other about what they notice." Participant 1 shared that instead of jumping in to teach a new skill right away, the big ideas became the starting points for each unit. Students were given materials to explore and play with related to the big ideas. From there, subsequent lessons related new skills to what was learned through the earlier exploration.

When starting the year in the virtual learning mode, Participant 2 focused on the engagement and visual elements that are foundational to the mathematical mindset approach to instruction, "I tried to work with things that would work with mathematical mindset or my overall feeling of OK, let me get something engaging. Let me get something visual. Let me get something kids like." Participant 1 explained that the schools prepared materials for students to use while attending Zoom classes, and therefore this participant did not feel that students were at a disadvantage by not being in person for the instruction, "They were definitely exposed to mathematical mindset at home." With the materials available to all students, regardless of learning mode, a hands-on approach was utilized.

As a special education teacher, Participant 6 found the math-talking component more difficult when students were not in person, "When kids were at home they couldn't get with a partner and talk about things…I think it was really hard when the kids were at home because you just couldn't do some of those activities." Participant 3 had a different experience when implementing the new curriculum, facilitating "more exploratory type lessons that were designed to be difficult for students, so that they can learn what it feels like to struggle." The classes watched videos that emphasized that there is more than one way to solve a problem. Participant 1 also mentioned going over "different kinds of problem-solving skills, communication skills, things that kids don't consider math." For her specific population of students on IEPs, Participant 1 focused instruction on metacognition, "thinking about thinking, thinking about how to attack a problem, how to solve a problem, not just follow the procedure." To engage students during virtual learning, this participant made videos where they modeled with think-alouds, "I was thinking aloud, talking aloud, going through the steps to help them visualize what the problem meant." Participant 1 shared that students in her co-taught math classes were still able to participate in the mathematical communication piece through breakout rooms in Zoom. This participant finished the description of her implementation experience by sharing the impact mathematical mindset had on her own thinking,

> I never really thought I was that good at math, even though I took accelerated courses through high school. So, it wasn't until I was teaching it, then I was like

> oh, this is why we do this. Like, this is how multiplication works. And the curriculum taught me that through the mindset pieces.

When asked about the new district scope and sequence, including the new Unit 0, the participants reported that while the overall concepts taught in the sixth-grade classroom stayed largely the same, the approaches and activities differed with the introduction of the mathematical mindset approach. Participant 1 identified a more creative and visual side of mathematics after the change. Participant 2 emphasized the new curriculum's ease of engagement compared to the past curriculum. This participant also mentioned the benefit of this engagement when students were given standardized tests early in the school year. According to Participant 2, sixth-grade students in District Z participate in standardized mathematics and reading assessments in the fall and spring. Each test was taken over multiple days. Recently, due to a change in state requirements, students also took a reading screening test in the first weeks of the school year. Participant 2 reported that engaging students in learning during the weeks dominated by standardized testing was particularly difficult. The participant reported that the new Unit 0 allowed for higher engagement during that time. Participant 3 mentioned an increased focus on process over final answers. Participant 4 expressed that shift in instructional practice was difficult for her gifted students, as they were typically looking for the right answer, and to work as quickly as they can. Additionally, this participant said that the students in the gifted program see mathematics as a competition to see who can get the highest score or the most correct answers. According to Participant 4, the shift makes the instruction seem less like math to students because they are used to seeing mathematics as checking a box for a new skill. The shift in mindset for this population was reported as a challenge that will take multiple years to address.

Finding 2: Teachers' perceptions of effectiveness. The results described in this section relate to the second research question, "What are teachers' perceptions of the effectiveness of the mathematical mindset approach as part of the new sixth-grade math curriculum?" The fourth, fifth, and sixth interview prompts focused on the effects of implementing the mathematical mindset approach in the classroom, including perceived effectiveness of instruction, observations of effects on daily classroom learning, effects on academic achievement, effects on student attitude towards mathematics, and perceived effectiveness of instruction compared to past instructional movements. The most recent instructional strategy implemented within District Z was to bring project-based learning to the mathematics classrooms, so some participants compared the two. Participant responses overlapped these areas, for example, sharing how students' attitudes were affected and how those effects went on to impact academic achievement.

The responses described in this section were from participants 1, 2, 3, 4, and 6. Participant 5 shared that they could not speak to the effectiveness of the mathematical mindset approach because the participant is not in the mathematics classroom, and their students are almost all in accelerated math courses and did not receive the grade-level mathematics instruction. Responses from participants 1 through 5 are described in numerical order.

Participant 1 noted increased energy levels and engagement, across ability levels:

> I remember one of my lower [achieving] students came into my room and she was like ‘Are we doing those nets? Are we doing those nets?’ And she just loved the cutting and building and taping and making, the creative part.

Participant 1 also reported observing higher energy when students worked in collaborative groups, working on hands-on tasks, “It’s loud, it’s energetic, and I think the learning is as high and they’re engaged.” Participant 1 also described the effects on academic performance, along with a comparison to previous instructional approaches:

> I think my math scores have gone up. I know it’s hard to compare previous years to current years, but I feel that I can go through my standards a bit more efficiently because of the understanding that they have with mathematical mindsets. I feel that in the eight years that I’ve taught math, that I’ve actually gone through all the required standards for the year, and that’s been kind of a first…Assessments were better, student understanding was better.

Participant 1 said the mathematical mindset approach was more impactful than previous instructional movements due to the visual component, and what is now known about how that impacts the brain, “I think it’s been more impactful. Again, there is kind of a math-art connection… Kids really love to see the math, to understand the math, to create the math.” The participant noted that while project-based learning brought in real-world application, the visual piece was lacking,

> I think with project-based learning, that was kind of, it was bringing in more of the real-world aspect. But I think a lot of our current curriculum is very real world. I don’t think that was ever an issue. But I think the visual understanding of math was never there.

The effects on student learning Participant 2 reported were a developed understanding that mistakes were okay and the ability to find peers to collaborate with. Participant 2 went on to explain that the mathematical mindset approach positively impacts academic performance when the teacher provides a process or strategy to go back to,

> They're feeling might be good about math…the biggest or the hardest thing I see is transferring the knowledge. Like the engagement is there. The excitement is there. They're having fun… When it comes to transferring that knowledge sometimes into an algorithm or proving how you got the solution you did, my challenge is OK, I've gotta make sure at some point that they are using a correct method…They may have discovered how to solve it or what to do, but have I taught them a process or strategy that they can come back to?

Participant 2 went on to stress that students, particularly students on IEPs, need consistent processes in order apply their learning to new situations, including when showing mastery on an assessment.

Participant 2 reported that the biggest effect on student attitude was an increase in confidence despite mistakes:

> We watch[ed] some of the Jo Boaler little clips…where she talked about the brain being a muscle and how your brain is growing. You wouldn't just lift a three-pound weight all the time. You gotta make sure you are working on some things that are hard… So I feel they've had a better confidence with it and maybe it's just my reassurance. I always tell them the pencil's got an eraser for a reason. And if you make a mistake, that's OK.

Participant 2 explained that the mathematical mindset approach is more effective than the dated drill and kill method. This participant also noted the respected research base for the new approach, along with the ease of materials when compared to previous curriculum adoptions and instructional movements.

Participant 3 noted that the low floor, high ceiling tasks helped her students because they were able to see that everyone was struggling. According to NRICH, a "collaboration between the Faculties of Mathematics and Education at the University of Cambridge" (NRICH, 2019, p. 1), low floor, high ceiling tasks are activities that are accessible for all learners and have the capacity to be extended to high levels for individual learners. The realization led to an increase in confidence and "created a culture in the classroom where it was okay not to know stuff." Participant 3 described another effect on her students' attitudes:

> The other part too was, I think it helped them because they think in different ways. Maybe they think visually and so they are problem solving in a visual way, and this gave them the allowance to say it's okay if you don't solve it the same way the teacher did. You know, as long as your process makes sense and you got the same answer, then you're okay.

Participant 3 described the impact on academic performance for her group of students receiving special education services:

> I think it indirectly improves their performance. As in, it helped them build confidence and have more of an open mind and so that allowed them to try more, participate more, and be more engaged, which then increased their performance. We talked a lot last year about on a test, if you're really stuck, at least just show

> your work and try, and you could get partial credit for attempting the problem, for showing some understanding even if you don't arrive at the right answer at the end. Giving that permission to the kids made it more likely for them to get it right, because they were trying versus just saying 'This is too hard, I'm not gonna get it right, I'm not even gonna try.'

Participant 4 observed some frustration from gifted students who were unused to having to work at something quality. Specifically, this participant saw those students as lacking grit. With the mathematical mindset approach, and specifically low floor, high ceiling tasks, participant 4 noticed higher academic comprehension, increased student perseverance, and more access points to mathematics. Participant 4 also observed the following, regarding the effect of mathematical mindset in her school:

> Because of how it's been utilized, a lot of times it's like a Friday activity, so it feels like an enrichment and not the mainstream math. I think kids still think of it as extra rather than actually what math is… But I do think that it improves character and access to math.

Participant 4 saw the implementation of the mathematical mindset approach as more complete than past instructional movements because the district involved the community through school math nights, "Other movements tend to be more teacher only and can get lost by the time they are applied in the classroom."

When asked about the effects of the mathematical mindset approach on academic performance, Participant 6 shared that there was a positive impact for some students,

> Well, you know, that's a hard one 'cause my kids are all kind of all over the place. And, you know, different groups of kids every year. You know a lot my kids on

> IEPs thrive on that manipulative part of math. Other kids who really just aren't into it, like I hate puzzles, or they hate you know trying to figure out things. They just want it black and white. It was harder for those kinds of kids. So I think it helped, but you know, I just had different kids with different learning styles.

In regard to student attitude, Participant 6 reported connections to real world experiences led to better attitudes toward mathematics learning. When comparing the mathematical mindset approach to New Math and project-based learning, Participant 6 identified collaboration as an element that pushed mathematical mindset to be more effective in the classroom, "I think the mindset helped kids just work together in groups more." Participant 6 ended the interview by sharing that they like the mathematical mindset approach and saw the good that was brought to the mathematics classrooms.

Summary

Chapter 4 detailed the results of the analysis of the qualitative data acquired from the study's six teacher interviews. The findings were organized into two groups, aligning with the two research questions. Data from the first three interview prompts were analyzed under finding 1, to view trends in teachers' experiences with the mathematical mindset approach as a curricular and instructional tool for sixth-grade math. Data from the subsequent five interview prompts were analyzed under finding 2, to gain insight into teachers' perceptions of effectiveness of the mathematical mindset approach as part of the new sixth-grade math curriculum. Chapter 5 includes a study summary, organized into the following subsections: an overview of the problem, purpose statement and research questions, review of methodology, and major findings. The chapter also contains a description of findings related to literature. Chapter 5 concludes with implications for action, recommendations for future research, and concluding remarks.

Chapter 5

Interpretation and Recommendations

This chapter begins with a study summary, including an overview of the problem, purpose statement and research questions, and major findings. The final two sections of the chapter are findings related to literature and conclusions. The conclusion includes implication for action and recommendations for future research.

Study Summary

This qualitative, phenomenological study was designed to examine teachers' experiences with the mathematical mindset model, and the perceived effectiveness of the mathematical mindset approach in the sixth-grade classroom. The study participants were sixth-grade mathematics teachers, special education teachers, and gifted facilitators. The interview questions focused on teachers' experiences learning about and implementing mathematical mindset in the classroom. Questions also focused on teachers' perceptions of the effectiveness of the mathematical mindset approach, including the impact on student attitude and academic performance, and the effectiveness compared to previous instructional movements. The changes in District Z were implemented in the fall of the 2020-2021 school year, so the different learning modes necessitated by the COVID-19 pandemic became part of the discussions.

Overview of the problem. School districts spend large amounts of time and money trying to improve student mathematical performance (Murphy & Regenstein, 2012). As previously outlined, Jo Boaler advocated for specific teaching and learning strategies, along with explicit instruction over mathematical mindset. While studies have been conducted by Boaler and her team at Stanford, there are not yet any outside studies on the mathematical mindset approach to teaching and learning mathematics. Additionally, within Boaler's pool of research, there are not studies examining a school district's adoption on the mathematical mindset approach. This lack of data poses a problem for districts deciding where to allocate their limited funds.

Purpose statement and research questions. This qualitative study had two purposes. The first purpose was to examine teachers' experiences with the mathematical mindset approach. The second purpose was to examine the perceived effectiveness of the mathematical mindset approach in the sixth-grade classroom. Data was collected through one-on-one interview with the six participants. Each interview included eight structured interview questions, with follow-up questions being asked for clarification. The study was guided by two research questions.

RQ1. What were teachers' experiences with mathematics mindset as a new curricular and instructional tool for sixth-grade math?

RQ2. What were teachers' perceptions of the effectiveness of mathematical mindset as part of the new sixth-grade math curriculum?

Review of the methodology. This qualitative, phenomenological study was designed around the two research questions listed above. A solicitation email was sent to all potential participants (Appendix C). The six teachers who responded to the solicitation email fit the criteria for the study. Teachers who chose to participate were provided details regarding informed consent and given the opportunity to ask questions of the researcher. The six teachers signed their consent and were scheduled for a one-on-one interview with the researcher. Interviews were held via Zoom or over the phone, through a semi-structured interview format. Eight interview questions were used, with follow-up questions added as needed for clarification or deeper understanding.

After each interview, the researcher checked the transcript against the audio recording to ensure accuracy of transcription. The transcripts were then sent to the participants, to check for accuracy of meaning. After the six interviews were concluded, and all participants completed their member checks, the transcripts were uploaded to the qualitative data analysis program, Dedoose. Transcripts, audio recordings, and the Dedoose program were used and stored on a password protected personal computer that could only be accessed by the researcher. The researcher used Dedoose as an aid in coding data and organizing similar themes. The code application table is included in Appendix E. The findings from the analysis were reported in Chapter 4 and are summarized below.

Major findings. The first major finding of the study relates to the first research question about teachers' experiences with mathematical mindset as an instructional and curricular tool. The participants' experiences differed based on their role in the school, their experience in previous positions, and their participation on district planning committees. Commonalities in participants' experiences included higher student engagement, a focus on visual mathematics, and hands-on learning. Teachers described their experiences implementing the new curriculum and using the new instructional approach while navigating the different learning modes caused by the COVID-19 pandemic. Differences in experiences occurred based on the time, in relation to implementation, the participants were introduced to the mathematical mindset model. The participants also had different exposure to profession learning. Mathematics teachers participate in professional learning over the mathematical mindset approach prior to implementation. Gifted facilitators participated in professional learning after implementation. Special education teachers did not participate in any professional learning over mathematical mindset.

The second major finding of the study relates to the second research question, about the perceived effectiveness of the mathematical mindset approach in the sixth-grade classroom. The data analysis over the final five interview questions showed the participants' responses reflecting a common perception of effectiveness. Five of the six teachers reported a positive shift in students' attitude toward mathematics. Two participants tied the change in attitude to academic growth. One participant attributed part of the movement's success to the district's decision to involve the community.

Findings Related to the Literature

The literature review in Chapter 2 includes a history of mathematics education in the United States since colonial times, with a focus on instructional and curricular changes. The review also contains a section over mindset research, and the research that Boaler and her Stanford team conducted during and after developing the mathematical mindset model. Numerous mindset studies were conducted following Dweck's landmark growth mindset publication in 2006, including studies focused on growth mindset in the mathematics classroom. However, growth mindset is only one component of the overall Mathematical Mindset movement. At the time of this study's publication, no studies outside of Boaler's research have been published over Mathematical Mindset as a model for approaching mathematics learning in the classroom. In fact, in the 2021 article published by Boaler and a group of graduate students and Stanford faculty, this lack of data was noted, “The approach of changing students’ ideas and changing teaching, with a mathematical mindset intervention, has not, before now, been studied” (Boaler et al., 2021, p. 3). Finding 2 aligned with the quantitative data showing student growth in mathematics resulting from Boaler’s study. Finding 1 supported Boaler’s qualitative data from the study. Teachers interviewed after the summer camp reported increased engagement during low-floor, high-ceiling tasks (Boaler et al., 2021).

In Good et al.’s 2003 study, students who received intervention over growth mindset concepts and the neuroscience of learning improved their mathematical performance. Additionally, the study showed the gender gap disappear for the intervention group (Good et al., 2003). In a 2018 longitudinal study, Degol et al. measured mathematical achievement for high school students. They concluded that a growth mindset is an important component of education for all students. Finding 2 supports these conclusions, as participants described growth in academic achievement and attitude toward mathematics.

Conclusions

Shifts in mathematics curriculum and instruction have occurred in America since colonial times. School districts allocate resources to support these changes, hoping to improve student performance. Data is needed for school districts considering implementing mathematical mindset as a curricular and instructional tool. The experiences and perceptions provided by the participants in this study are a starting place for the collection of such data. This section includes implications for action, recommendations for future research, and concluding remarks.

Implications for action. The implications of this study relate to District Z, along with other districts considering the implementation of the mathematical mindset approach. The participants shared their personal and professional experiences with mathematical mindset as a curricular and instructional tool. While the reported experiences were mostly positive, there was a discrepancy in professional learning among positions. District Z could use the data as a tool for reflecting on professional learning. District Z could also find use in the teachers' perceived effectiveness of the mathematical mindset approach, when making curricular decisions for other grade levels.

These findings may be useful for districts looking to improve mathematical performance. At the time of publication, skill loss and increased math anxiety are widespread concerns due to the pandemic's disruption of learning (Sawchuk & Sparks, 2020). The participants experiences and their perception of effectiveness could benefit districts planning for future mathematics learning.

Recommendations for future research. Recommendations for future studies relating to the mathematical mindset model are listed below.

1. A quantitative study measuring student performance, after implementation of the mathematical mindset approach, on standardized tests such as the MAP test. Student growth in the area of mathematics could be compared to growth documented in past years.
2. A replication of this study in a different setting, specifically in a district with a lower socio-economic status. A comparison could be made to help determine if wealth is a factor in teachers' experiences and their perception of the effectiveness.

3. A replication of this study at a different grade level. A comparison could be made to determine if student age is a factor in teachers' experiences and their perception of the effectiveness.

4. A mixed methods study on the effectiveness of the mathematical mindset approach on the academic achievement and attitude towards mathematics for specific sub-groups. The sub-groups could be based on race, gender, students receiving special education services, and students identified as gifted.

5. A quantitative, longitudinal study on the impact of the mathematical mindset approach on the number of female students and students of non-Caucasian ethnicities entering STEM fields after high school.

6. A quantitative study examining the impact of the mathematical mindset approach over multiple consecutive years. The study could compare student growth over the first year to subsequent years.

7. A quantitative study examining impact of the mathematical mindset approach on different areas of mathematics. Possible sub-groups are algebra, number theory, geometry, and arithmetic.

Concluding remarks. Effective learning of mathematics prepares students for the challenges of daily life, as well as broadening career opportunities. After decades of fluctuating between ideologies, it is time to establish effective mathematics instruction in every classroom. This study provides one example of the impact curriculum and instruction based in mathematical mindset has in classrooms, in a field of limited data. With further research, the mathematical mindset approach may prove to be the tool educators need to more effectively help students find success.

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Appendices

Appendix A: Approval from School District

From: [redacted]
Sent: Thursday, September 23, 2021 11:30 AM
To: Hoing, Jenna M. <JHoing@[redacted]>
Cc: [redacted]
Subject: [redacted] Research Request - Official Approval Email

Hi, Jenna.

Thank you for taking the time to discuss your research proposal and for being willing to meet the Review Board's requests. For your records, your research proposal is approved, as long as interviews are voluntary and take place before or after contract hours. In addition, we ask that you create a statement that you will read before the interview begins, delineating the purpose of the interview is for your personal research and not affiliated with [redacted] Schools. Once you have this statement drafted, please send it my way so that I can include it in your file.

As with any research study, the following conditions must be met:

1. All identifying information needs to be anonymous; please do not use teachers' names, the school name, District, etc.
2. Teachers can opt out of the research at any time.

We are excited to see your results. Please send us a copy after your dissertation defense.
Good luck with your research!

Best,
[redacted]

Appendix B: Baker University Institutional Review Board Approval

Baker University Institutional Review Board

June 2nd, 2022

Dear Jenna Hoing and Harold Frye,

The Baker University IRB has reviewed your project application and approved this project under Expedited Status Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.
6. If this project is not completed within a year, you must renew IRB approval.

If you have any questions, please contact me at npoell@bakeru.edu or 785.594.4582.

Sincerely,

Nathan Poell, MLS
Chair, Baker University IRB

Baker University IRB Committee
Sara Crump, PhD
Nick Harris, MS
Susan Rogers, PhD

Appendix C: Email Solicitation for Voluntary Participation

Solicitation Email

Hello,

My name is Jenna Hoing and I am a student working on my EdD in Educational Leadership at Baker University. I have finished coursework and am now beginning work on my dissertation. The focus of the study will be teacher perceptions of 6th grade mathematics teaching and learning in relation to mathematical mindset.

In order to gain a fuller understanding of teacher perceptions, I am reaching out to 6th grade mathematics teachers, special education teachers, and gifted facilitators.

This email is an invitation to participate in the study. Should you agree to participate you can be assured that your personal/ identifying information will be confidential. Your participation will be anonymous to everyone but me. This study is through Baker University and is not associated with [redacted] School District. If you agree to participate, I will send the interview questions in advance for you to look over.

Thank you in advance for your consideration.

Respectfully,

Jenna Hoing

Baker University Doctoral Candidate

Special Education Teacher- Blue Valley Northwest High School

jhoing@bluevalleyk12.org or jennahoing@yahoo.com

Appendix D: Consent Form for Participation

Consent to Participate

Research Title: Mathematics Education: Teacher Perceptions of Mathematical Mindset as an Instructional and Curricular Tool in the Sixth-Grade Classroom

Researcher: Jenna Hoing

Advisor: Dr. Harold Frye

School of Education

Baker University

7301 College Blvd.

Overland Park, KS 66210

(913)-344-1220

harold.frye@bakeru.edu

My name is Jenna Hoing, a doctoral student at Baker University in Kansas and educator in Blue Valley Schools. I am conducting research on teachers' perceptions of 6th grade mathematics teaching and learning in relation to mathematical mindset.

As an interview participant, you will be asked to answer approximately 9 open ended questions relating to your perceptions, experience, and opinions concerning the instructional and curricular elements based in Mathematical Mindset. Your participation is voluntary; therefore, you may decline to answer any question at any time. Furthermore, you may terminate your participation at any time for any reason you deem necessary.

Any personal and confidential information that would be considered identifiable, such as name, building site, and position will all be kept confidential, and access will be restricted. Interview transcripts will be password protected. The researcher, university research advisor and analyst will be the only individuals with permissions to access study data and documentation.

Statement of consent to participate:

I understand that my participation in this research study is entirely voluntary. Moreover, I understand that I have the right to terminate my participation and recant any statements that I provided during this study at any time for any reason. I understand that the principal investigator can be contacted at jennahoing@yahoo.com or jhoing@bluevalleyk12.org should any questions or concerns arise or if I wish to terminate my statements and/or participation.

I have read and understand the above statement. By signing, I agree to participate in the research study. The Baker University Institutional Review Board approved this study on 6/21/2022 and will expire on 6/21/2023 unless renewal is obtained by the review board.

Participant Signature____Date________________

Appendix E: Dedoose Code Application Table

	Confidence	Engagement	PBL	Play	Questions/ facilitating	Real-World	Visual	acceleration	brain	community engagement
Participant 6	0	0	0	0	1	2	0	4	0	2
Participant 5	0	0	0	0	0	1	0	1	0	0
Participant 4	0	0	0	0	0	0	0	0	1	0
Participant 3	2	2	1	0	0	2	2	0	2	0
Participant 2	2	6	0	1	0	1	4	0	0	1
Participant 1	2	4	0	2	4	1	5	0	1	0
Totals	6	12	1	3	5	7	11	5	4	3

	connections	creative	district math team	effectiveness	enrichment/ extras	exploration	fun	groups/ student communication	hands on	high energy
Participant 6	0	0	0	1	2	1	0	0	0	0
Participant 5	0	0	0	0	0	0	1	0	0	0
Participant 4	0	0	0	0	0	0	0	1	0	0
Participant 3	0	0	0	2	0	1	0	1	0	0
Participant 2	0	0	1	0	0	0	3	3	1	0
Participant 1	1	2	0	6	0	2	4	2	4	4
Totals	1	2	1	9	2	4	8	7	5	4

	low floor-high ceiling	manipulatives	memorization/ algorithm	mistakes	participation	past and future learning	patterns	perserverence	professional learning	prove/justify
Participant 6	2	0	0	0	0	1	0	2	3	1
Participant 5	0	0	0	0	0	0	0	0	0	0
Participant 4	0	2	0	0	0	0	0	0	0	0
Participant 3	0	1	2	0	0	1	0	3	1	0
Participant 2	0	1	2	1	0	1	1	1	0	0
Participant 1	2	0	1	0	1	1	0	0	3	0
Totals	4	4	5	1	1	4	1	6	7	1

	resources	speed	standards	teacher experience	try	understanding	videos	Totals
Participant 6	1	0	0	1	1	0	0	25
Participant 5	0	0	0	1	0	0	0	4
Participant 4	1	0	0	1	0	0	0	6
Participant 3	0	0	1	1	0	0	3	28
Participant 2	0	0	0	1	0	0	1	32
Participant 1	1	2	3	2	0	2	0	62
Totals	3	2	4	7	1	2	4	0