Mindful Approaches, Transforming Hearts: Cultivating Elementary Students' Positive Mathematics Identity Development Through an Equity-Based Morning Mathematics Club

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MINDFUL APPROACHES, TRANSFORMING HEARTS: CULTIVATING ELEMENTARY STUDENTS' POSITIVE MATHEMATICS IDENTITY DEVELOPMENT THROUGH AN EQUITY-BASED MORNING MATHEMATICS CLUB

by

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ABSTRACT

This dissertation examines how third through fifth-grade students' mathematics identities developed through a strengths-based mathematics club focused on equitable teaching practices. In this study, theories of Communities of Practice (Wenger, 1998) and Figured Worlds (Holland et al., 1998) were combined with recommendations from *Catalyzing Change* (NCTM, 2020) and equity-based practices (Aguirre et al., 2013) to promote students' positive mathematics identity development. Students with positive mathematics identities have increased mathematics engagement and achievement, and are more likely to seek careers in STEM. Mathematics identities are developed through and influenced by various sociocultural, personal, and educational factors. Incorporating evidence from student surveys, teacher interviews, student reflections, and reflexive journaling, this qualitative action research study demonstrates how students' mathematics identities developed in response to an equity-based and strengths-oriented mathematics Community of Practice. Findings support that the selection and implementation of tasks that promoted the joy, beauty, and wonder of mathematics and incorporated equitable teaching practices within this Community of Practice influenced a positive shift in students' mathematics identities. Implications and recommendations for policy and practice, my school and district, and future research are discussed.

In honor of my mom, whose love has surrounded me always.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER ONE: INTRODUCTION

Background

In 2020, the National Council of Teachers of Mathematics (NCTM) published *Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations* as part of the *Catalyzing Change* series. Through this book, they propose four key recommendations to help ensure that every child develops a strong foundation in mathematics, which can set them on a path toward continued success in mathematics throughout their lives. Recommendations include (1) broadening the purposes of learning mathematics, (2) creating equitable structures in mathematics, (3) implementing equitable mathematics instruction, and (4) developing deep mathematics understanding (NCTM, 2020). As I work to "catalyze change" in my school and district, these recommendations remain at the forefront of my research. Specifically, my study will center on a theme undergirding the *Catalyzing Change* series: student mathematics identity.

Statement of Problem

Student engagement is essential to students' success in mathematics. *Catalyzing Change* (NCTM, 2020) emphasizes the need for children to be "doers of mathematics," meaning that students do the sense-making and reasoning in the mathematics classroom. Student engagement is a known predictor of academic achievement and consists of behavioral (on-task, compliance), emotional (attitudes, interest, values), and cognitive (effort) engagement (Fredricks et al., 2004). However, based on data collected by the principal during observations at the start of the 2022-23 school year at Larkspur Elementary School (LES) (pseudonym), less than half of the students regularly participated in classroom mathematics discussions.

One avenue to address student engagement at LES is through intentionally developing students' positive mathematics identities. Research has shown that interventions focused on developing students' mathematics identities through the use of collaboration on interesting and complex tasks have led to greater engagement in the subject (Cribbs et al., 2015; Nasir & de Royston, 2013), a feeling of belonging in the community of mathematics doers (Boaler, 1999), advancement to higher levels of mathematics (Boaler & Staples, 2008), increased aspirations to careers in STEM (Cass et al., 2011; Cribbs et al., 2021; Godwin et al., 2020), ability to apply mathematics to situations outside of school (Boaler, 1999, 2002), and increased achievement in mathematics (Cobb et al., 2009; Fernández et al., 2022). However, it is essential to note that these studies focused on students in secondary grades, and the interventions took place during their school-day classroom mathematics instruction. This current study explores what can be done to promote positive mathematics identity among upper elementary students, particularly outside the mathematics classroom.

Students' mathematics identities are formed within "Figured Worlds" (Holland et al., 1998), which are socially constructed realities that shape how individuals understand and interpret the world around them. For many students, the Figured World in which they experience mathematics involves memorizing and repeating facts and procedures (Dysarz, 2018). There is little opportunity for students to engage with one another in complex mathematical thinking because their Figured World has diluted mathematics down to a routine they must follow on their own, step-by-step. However, it does not have to be this way. A Figured World can consist of a Community of Practice (Wenger, 1998) in which students work collaboratively toward a common goal and are presented with complex and interesting tasks that are relevant to students' lived experiences. In a Community of Practice, learners improve their skills in an area of interest as they work together and build their collective identities (Wenger-Trayner & Wenger-Trayner, 2015). While district and school initiatives may limit the autonomy teachers have to adjust the curriculum, an opportunity for developing students' mathematics identities through a Figured World that engages students as a Community of Practice is still viable through meetings outside of school hours (Graven, 2011; Gulemetova et al., 2022; Lampen & Brodie, 2020; Turner et al., 2013). Thus, this study uses a morning mathematics club as an intervention by creating a Figured World in which students engage in a Community of Practice focused on collaboratively solving complex and interesting mathematics tasks in an equity-based environment that capitalizes on students' mathematical strengths. In this study, I curated a curriculum for the Mindful Approaches, Transforming Hearts (MATH) Club and analyzed how participation in this club influenced students' mathematics identities. The MATH in "MATH Club" stands for Mindful Approaches, Transforming Hearts because this club aims to use specific and carefully selected tasks and practices to cultivate the development of students' positive mathematics identities.

Organizational Context

LES is a Title I school within the Delphinium County School District (DCSD) (pseudonym). The mission of LES is to collaborate with families and the community to establish diverse and enriching paths that guide students toward success. The school's vision is to secure a promising and successful future for every student.

The 2022-23 school year was a significant transition for LES, with around half of the teachers, the principal, and many administrative team members departing from the school. The new principal came from a nearby middle school and brought a mathematics and science coach, a multi-tiered systems of support (MTSS) coach, a behavior specialist, and a reading coach to replace the administrative staff that moved with the former principal. While most teaching positions were filled, a few were left vacant for the entire school year and needed substitute teachers. During the 2023-24 school year, there were no vacant K-5 classes. However, approximately 45% of classroom teachers were new to the school that year after another year of high turnover. The school lacked a sense of coherence due to approximately 75% of the staff being new to the school during the 2022-23 or 2023-24 school year. However, this scenario provided an opportunity to build conceptual coherence in this school and a new school culture that recognizes the importance of the recommendations presented in the *Catalyzing Change* (NCTM, 2020) series.

Transitions were not only occurring at LES. The entire state of Florida felt a shift in the 2022-23 school year with a new set of standards, the Benchmarks for Excellent Student Thinking (B.E.S.T.), and a new standardized test, the Florida Assessment of Student Thinking (FAST). The DCSD mathematics program specialists had limited time to prepare the curriculum resources and unit assessments due to the change in standards, so growing pains were also felt within the district regarding curriculum. Teachers sometimes shared a sentiment that the materials presented were not always engaging or relevant to students, and the scope and sequence were not always logical.

As mentioned previously, there is a need for greater student engagement in mathematics at LES. By promoting students' positive mathematics identities through experiences of collaboration on complex and interesting tasks, students are more likely to regularly engage in mathematics (Boaler & Greeno, 2000; Cribbs et al., 2015; Nasir & de Royston, 2013).

Theoretical and Conceptual Frameworks

The goal of MATH Club is to promote students' positive mathematics identities. I seek to accomplish this by combining the theories of Communities of Practice (Wenger, 1998) and Figured Worlds (Holland et al., 1998) with recommendations from *Catalyzing Change* (NCTM, 2020) and Aguirre et al.'s (2013) equity-based practices.

Wenger (1998) describes a "Community of Practice" as a group of people who share a common interest or goal and engage in ongoing interactions to develop shared practices and knowledge. Holland et al. (1998) describe "Figured Worlds" as socially constructed realities that shape how individuals understand and interpret the world around them. MATH Club will embody a Community of Practice and a Figured World because it is a group of students who engage in mathematics discourse and practice together to make sense of the world around them.

Catalyzing Change (NCTM, 2020) emphasizes broadening the purposes of learning mathematics, including the need to promote joy, wonder, and beauty in mathematics, as well as equitable mathematics instruction. It highlights the importance of nurturing curiosity, embracing cultural connections, and providing equitable opportunities for all students. Aguirre and colleagues (2013) describe five equity-based practices for increasing mathematics understanding and promoting positive mathematics identity in students. These practices include "going deep with mathematics, leveraging multiple mathematics competencies, affirming mathematics learners' identities, challenging spaces of marginality, and drawing on multiple resources of knowledge" (Aguirre et al., 2013, p. 43). I combine these frameworks to inform and guide instructional choices for MATH Club. These theoretical and conceptual frameworks undergird my work as I form and facilitate MATH Club and are discussed in more detail in the following chapter.

Significance of Study

This study benefits LES, the greater DCSD district, and the broader mathematics education community. There are benefits to LES for several reasons. Understanding how students mathematics identities are developed may lead to pedagogical changes in how mathematics is taught across all classrooms and the initiatives we promote at our school. Impacting students' mathematics identities now could lead to larger-scale changes in how the school community views mathematics in the future and the collective identity of our students. This can lead to greater student engagement in mathematics, more equitable learning opportunities across classes, and increased mathematics achievement.

This study also benefits the mathematics education community, as there is a need for more studies on elementary students' mathematics identity development. It also provides an avenue through which mathematics identity can be studied outside the regular school-day classroom. Examining how out-of-school mathematics learning opportunities can impact mathematics identity and how those impacts can positively influence in-school mathematics learning experiences are essential.

Purpose of Study

Through this study, I explore how participation in a mathematics club based on equitable teaching practices, interesting and challenging mathematics tasks, collaboration, and the affirming experience of success promote the development of positive student mathematics identities.

Research Question

Through this study, I sought to answer the question: How does my facilitation of a strengths-based mathematics club focused on equitable teaching practices influence the development of upper elementary students' mathematics identities?

Key Terms

Affirming: "encourages students to see themselves as confident problem solvers who can make valuable mathematical contributions" (Aguirre et al., 2013, p. 46).

Conceptual-based mathematics classrooms: classrooms in which mathematics is taught through student-centered instruction facilitated by the teacher. The focus is on collaborative problem-solving, with an emphasis on the process of making sense of mathematics.

Communities of Practice: "groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis" (Wenger et al., 2002, p. 4).

Figured World: “a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others. Each is a simplified world populated by a set of agents… who engage in a limited range of meaningful acts or changes of state… as moved by a specific set of forces…” (Holland et al., 1998, p. 52).

Lived experiences: “what an experience is like for a person and how the person recognizes and interprets the self-experienced experience” (Björk et al., 2005)

Low-pressure mathematics environment: a time and space with low stakes regarding a student’s mathematics proficiency and speed.

Mathematical agency: “the ability to participate and perform effectively in mathematical contexts” (Aguirre et al., 2013, p. 16).

Mathematics identity: “the set of beliefs that one has about who one is with respect to mathematics and its corresponding activities. An identity is dependent on what it means to do mathematics in a given context; as such, it is individually and collectively defined. Identities include ways of talking/acting/being as well as how others position one with respect to mathematics” (Bishop, 2012, p. 41).

Traditional mathematics classroom: classrooms in which mathematics is taught through teacher-led direct instruction. The focus is often on memorizing and performing steps and procedures to solve mathematics problems. Emphasis is often placed on mathematical speed and accuracy.

CHAPTER TWO: REVIEW OF RESEARCH

In this literature review, I synthesize and critique the research and scholarship on mathematics identity. Although studies on mathematics identity have examined the impact of mathematics identity on student achievement, few studies have explored how upper elementary students' mathematics identities develop through successful experiences with challenging mathematics tasks. As such, this literature review provides additional insight into the potential impact of an affirming, low-pressure environment in which students can be successful with complex and interesting mathematics tasks on student mathematics identity. The theoretical frameworks for this study include Communities of Practice (Wenger, 1998) and Figured Worlds (Holland et al., 1998), with conceptual frameworks focusing on recommendations from *Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations* (NCTM, 2020) and *The Impact of Identity in K-8 Mathematics Learning and Teaching: Rethinking Equity-Based Practices* (Aguirre et al., 2013). This study analyzes how interesting and challenging mathematics tasks affect students' mathematics identities and engagement. In addition, although numerous studies related to mathematics identity have identified interventions teachers can use in their classroom to promote positive mathematics identity, little attention has been paid to how interventions outside the classroom impact students' mathematics identities. I address this issue by exploring how a mathematics club that meets outside school hours impacts positive mathematics identity development.

This study investigates how participation in MATH Club, a Community of Practice that incorporates equitable teaching practices and promotes the joy, beauty, and wonder of mathematics, influences the development of student mathematics identity. My research question is, how does my facilitation of a strengths-based mathematics club focused on equitable teaching practices influence the development of students' mathematics identities?

Chapter Two is organized across five sections. I start with a section on mathematics identity, exploring how identity has been defined, operationalized, and categorized in the research, the purposes for developing students' mathematics identity, and the factors that shape the formation of students' mathematics identity. The second section explores mathematics clubs, including the benefits of mathematics clubs and the findings of mathematics clubs that have focused on promoting positive mathematics identity in students. The third section describes this study's theoretical framework, including Wenger's (1998) Communities of Practice and Holland and colleagues' (1998) Figured Worlds. The fourth section details the conceptual framework guiding this study, including recommendations from *Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations* (NCTM, 2020) and *The Impact of Identity in K-8 Mathematics Learning and Teaching: Rethinking Equity-Based Practices* (Aguirre et al., 2013). The fifth and final section summarizes and concludes the literature review.

Literature Search Procedures

An exhaustive search was conducted to gather scholarly literature on mathematics identity. This search was conducted through the University of Central Florida (UCF) virtual library. The UCF virtual library provided access to extensive literature from various databases, including EBSCOhost, JSTOR, and ProQuest. The focus of this study was to explore the impact of MATH Club on students' development of positive mathematics identity. Search terms were formulated to align with mathematics identity and mathematics club, which are detailed in Table 1.

Table 1: Constructs and Related Search Terms

Construct	Boolean Search String
Mathematics identity	"mathematics identity"; "math identity"; "mathematical identity"; "mathematics identities"; "math identities"; "mathematical identities"
Mathematics clubs	"mathematics club"; "math club"
Mathematics identity and mathematics clubs	"mathematics identity" *and* "mathematics club"; "mathematics identity" *and* "math club"; "math identity" *and* "mathematics club"; "math identity" *and* "math club"; "mathematical identity" *and* "mathematics club"; "mathematical identity" *and* "math club"

My search generated several articles that needed to be excluded from this review to maintain focus on the topic of students' mathematics identity. First, articles about science identity, engineering identity, or other domains of identity unrelated to mathematics were excluded. Second, studies addressing the mathematical concept of "identity," such as trigonometric identities, were excluded as they did not align with the type of identity being studied. Additionally, articles exploring identity as a construct, such as gender identity, in relation to mathematics were excluded as they were not studying mathematics identity. Last, articles that were about mathematics teacher identity were excluded, as the focus of this study is on mathematics learner identity. By applying these exclusion criteria, the literature search was refined to include only articles that directly addressed the topic of this study.

Mathematics Identity

In this section, I seek to provide an overview of mathematics identity, including defining it and exploring why it matters, the factors that impact it, and intersectionality.

Defining Mathematics Identity

Mathematics identity is a complex and multifaceted construct encompassing various elements and is influenced by many factors (Bishop, 2012; Darragh, 2016; Radovic et al., 2018). Originating with research on the broader topic of identity in the early-to-mid twentieth century (Erikson, 1959; Mead, 1913), mathematics identity emerged as a topic of interest in the late 1990s and early 2000s (Boaler, 1999, 2002; Lerman, 2000) and has continued to bloom as a topic worthy of study today (Darragh, 2016). Gutiérrez (2009) names identity as one of the four key dimensions of equity. Researchers have defined mathematics identity in a variety of ways and have identified several operationalizations (Darragh, 2016), dimensions (Radovic et al., 2018), and categorizations (Radovic et al., 2018) of mathematics identity that aid the community in making sense of the construct.

Definitions of Mathematics Identity

Researchers have defined mathematics identity in different ways; however, many common themes exist among their definitions. By examining the contributions of various researchers, we can gain a comprehensive understanding of how mathematics identity is defined in the literature. Common themes include engagement and participation, beliefs and views, socio-cultural influences, and context.

Engagement and active participation in mathematics-related activities are critical aspects of identity formation (Black et al., 2010; Wenger, 1998). According to Wenger, identity is composed of engagement, imagination, and alignment. Engagement refers to active involvement and participation in collaborative mathematics activities. Black and colleagues (2010) further emphasize that one's identity arises from active participation in mathematics activities focused on specific objectives.

Core to the development of a mathematics identity are the beliefs and perspectives one holds about oneself as a learner and the nature of mathematics. Students' beliefs and views of themselves determine whether they consider themselves insiders or outsiders of the mathematics community (Boaler & Greeno, 2000; Gee, 2001) and are often based on what they believe about their ability to do mathematics (Aguirre et al., 2013; Bishop, 2012; Martin, 2000). Students tell stories about who they are in relation to mathematics (Sfard & Prusak, 2005) based on reflections on themselves and the nature of mathematics (Black et al., 2010; Solomon, 2009; Wenger, 1998).

The sociocultural context in which individuals operate greatly influences their mathematics identity. Scholars highlight how sociohistorical, communal, educational, and individual factors impact identity formation. Martin (2000) suggests that these factors encompass the broader societal, cultural, and educational contexts that shape individuals' beliefs about ability, importance, constraints, opportunities, and motivation in mathematics. Darragh and Radovic (2020) emphasize that mathematics identity is formed socioculturally through interactions with others, the environmental context, and how individuals are seen and treated in relation to mathematics. The ways in which students participate in mathematics are also shaped by sociocultural influences (Black et al., 2010).

The mathematics community and contextual factors within which individuals engage with mathematics strongly impact their mathematics identity. Individuals develop their mathematics identities through interactions with the mathematics community, including teachers, peers, parents and families, and anyone with whom they share mathematics contexts. The expectations, norms, and treatment within this community shape individuals' sense of belonging, positioning, and self-perception in relation to mathematics (Bishop, 2012; Darragh & Radovic, 2020) and can change based on the situation (Aguirre et al., 2013).

Students' mathematics identities are composed of and defined by how they engage and participate in mathematics, their beliefs and views about themselves as mathematicians and mathematics in general, socio-cultural influences, and the context within which they are exposed to mathematics. With an understanding of mathematics identity and its definition, the next section explores how mathematics identity has been operationalized in the literature.

Operationalizations of Mathematics Identity

Mathematics identity has been operationalized in various ways. Darragh (2016) identified and defined five ways mathematics identity has been operationalized in the literature. These are not harshly delineated and frequently intersect with each other, and authors often opt to integrate ideas from various perspectives. The five operationalizations include participative, narrative, discursive, psychoanalytic, and performative viewpoints of mathematics identity.

Participative mathematics identity refers to understanding mathematics identity as actively constructed through an individual's active engagement and involvement in various social mathematics practices and activities (Darragh, 2016). For example, Boaler and Greeno (2000) studied students in a traditional mathematics classroom compared to students in a more conceptual-based mathematics classroom. Students in the conceptual-based mathematics class developed attitudes consistent with positive mathematics identity. In contrast, students in the traditional classroom were more likely to leave the field and express distaste for mathematics. Mathematics identity was operationalized in this case by the opportunities students had to collaborate on complex mathematics tasks.

Narrative mathematics identity involves the idea that individuals construct their sense of self through storytelling and creating coherent narratives about their experiences with mathematics, integrating past encounters and future aspirations (Darragh, 2016). Sfard and Prusak (2005) describe identities as stories about people that are "reifying, endorsable, and significant," (p. 16) and these stories can be told by the person themselves, about the person to the person, or about the person to someone else. These stories are not windows into discovering identities; the stories themselves are identities.

Discursive mathematics identity emphasizes the role of language and discourse in shaping mathematics identity. It highlights how individuals negotiate and communicate their identities through language, discourse, and social interactions (Darragh, 2016). Bishop (2012) studied discourse between two students who worked as partners in a mathematics classroom and identified five moves that situated one student as mathematically competent and the other as inferior. This study operationalized mathematics identity through the discourse between the two students.

The psychoanalytic view of mathematics identity suggests that identity is formed through conscious and unconscious processes influenced by sociocultural constructs such as gender, race, social class, and power (Darragh, 2016). For instance, in a study of Black college students studying mathematics or engineering, participants emphasized their engagement in stereotype management to maintain their racial and mathematics or engineering identities (McGee & Martin, 2011).

Performative mathematics identity is viewed as how individuals actively perform and express their identities through behavior, gestures, and symbolic acts, contributing to the ongoing construction of their identities (Darragh, 2016). This is the preferred operationalization of Darragh (2016), who likens identity to an action rather than an acquisition.

These five operationalizations of mathematics identity describe how mathematics identity is studied and discussed in the literature. However, there are other ways to describe the literature on mathematics identity, including Radovic et al.'s (2018) dimensions and categorizations of mathematics identity.

Dimensions of Mathematics Identity

Radovic and colleagues (2018) described three dimensions found in research on mathematics identity that illustrate distinctive characteristics of the construct. These dimensions are not studied in isolation; instead, multiple dimensions tend to be considered when researching mathematics identity. They describe "a subjective/social dimension, a representational/enacted dimension, and a change/stability dimension" (Radovic et al., 2018, p. 26).

According to Radovic et al. (2018), when researchers emphasized the subjective understanding of identity, or how individuals personally understand themselves, they explored various senses and experiences. These explorations of sensations emphasized that identity is profoundly personal and private, tied to our individual experiences. When researchers accentuated the social dimension of identity, they described it as a result of our interactions with others and the influence of discourse. In this perspective, identity is something that is enacted and recognized within social contexts by other people. These dimensions are often studied together. When Heyd-Metzuyanim and Sfard (2012) examined how students identify themselves during mathematics activities, they studied four seventh-grade students working in a peer group outside of school. They examined the subjective and social dimensions of identity through how the students positioned and described one another and themselves throughout the discourse.

Radovic et al. (2018) explain that in the representational dimension, identity is seen as shaped by the way individuals talk about themselves and the stories they tell. It is all about the discourses and narratives that describe who people are. Cobb and colleagues (2009) explored the representational dimension when they created and examined a method of analyzing mathematics identity by studying students from two classes, one traditional and one focused on conceptual understanding, and interviewed them to understand students' narratives about themselves in relation to mathematics. The enacted dimension sees identity as something that comes to life through our actions without needing words to define it. It emphasizes active engagement as a critical factor in constructing and expressing identity. For example, in a study of English Language Learners' participation in mathematics discourse, Turner et al. (2013) considered how students engaged in discursive actions conveying mathematical agency to describe students' identity development.

Radovic and colleagues (2018) discuss that the dimension of change/stability emphasizes how identity transformation is described and understood. In most studies, researchers see identity as something that grows and evolves, which means it can change. Even in the few studies where researchers describe mathematics identity as consistent and unchanging, they still recognize that change is possible.

The dimensions of mathematics identity describe characteristics of literature on the topic, with multiple dimensions noted in each study. These dimensions of mathematics identity are combined to form various categorizations of studies on mathematics identity.

Categorization of Studies on Mathematics Identity

Utilizing the dimensions of mathematics identity described previously, Radovic et al. (2018) developed categories within which research on mathematics identity can be further defined. These categories focus on one or more of the dimensions of mathematics identity mentioned above and share similar operationalizations and methodologies for studying the construct. The five categories are "identities as individual attributes, identities as narratives, identities as a relationship with a specific practice, identities as ways of acting, and identities as afforded and constrained by local practices" (Radovic et al., 2018, p. 28).

According to Radovic et al. (2018), studies that consider identities as individual attributes focus on the subjective dimension of identity. These studies emphasize individual attributes and self-perceptions, often investigating under the representational dimension through surveys. While acknowledging the social world's influence, these studies treat individuals and their social context as separate entities. These studies tend to recognize the malleable nature of identities, exploring how they may change under certain circumstances but not necessarily exploring how that change happens.

Radovic and colleagues (2018) describe studies focusing on the representational dimension under a second category of identities as narratives. These studies emphasize the role of social and cultural factors in molding the individual narratives of mathematics learners, highlighting the social dimension of identity. Narratives are perceived as active constructions of identity rather than a tool for reflecting notions about one's identity (Sfard & Prusak, 2005). While these studies recognize the interconnectedness of the social and subjective dimensions, there are variations in how much importance is given to each. With narratives encompassing elements from the past, present, and future, these studies focus heavily on the idea of change in identities.

The third type of study described by Radovic et al. (2018) emphasizes how identities are defined by individuals' relationship with a specific mathematical practice, highlighting the subjective and representational aspects. Researchers in this category mainly use interviews, narratives, and surveys, with some complementing the data with observations during practice. They consider subjective and social features as intertwined in individuals' identities. Identities are seen as a sense of belonging or form of membership that cannot be understood without considering the collective practice. These studies focus on the situated nature of meaning construction and define identity development as a negotiation of meanings within a specific practice. The student's relationship with the practice is the main focus of any narrative data collection. Unlike narrative studies, these studies place less emphasis on the notion of change over time and the process of identity formation.

Studies that focus on viewing mathematics identities as enacted behaviors are under the category of identities as ways of acting (Radovic et al., 2018). This category considers identity a dynamic and negotiated process that emerges through moment-to-moment interactions. These studies analyze observed interactions as the primary unit of analysis to provide a detailed understanding of students' enacted identities. They explore how individuals position themselves in relation to others during discourse and how individuals participate. These studies bridge the gap between subjective and social dimensions of identity and highlight the significance of change and the developmental process of identity through interactions.

The final category described by Radovic and colleagues (2018) is identities shaped by specific local practices. These studies focus on the spaces and opportunities provided for students to develop, express, or embody particular identities. These studies do not prioritize the subjective aspect of mathematics identity in their approach but instead emphasize contextual factors and how they influence the range of available identities. Researchers in this category tend to combine multiple data sources to gain insights into how these practices operate and the identities they facilitate.

These five categorizations of studies on mathematics identity help to better understand the literature and various ways of viewing and studying mathematics identity. With an understanding of the definitions, operationalizations, dimensions, and categorizations of mathematics identity that currently exist in the literature, the following section moves into the purpose of studying and building students' mathematics identities.

Why Mathematics Identity Matters

The significance of mathematics identity cannot be understated. In this section, I delve into three domains influenced by students' mathematics identity: engagement within the mathematics classroom, mathematics achievement, and students' inclination toward STEM careers.

Engagement

Student engagement is an essential ingredient in mathematics classrooms. Catalyzing Change (NCTM, 2020) emphasizes the need for children to be "doers of mathematics," meaning that students do the sense-making and reasoning in the mathematics classroom. Student engagement is a known predictor of academic achievement (Fredricks et al., 2004). A positive mathematics identity serves as a catalyst for increased engagement in the mathematics classroom. Boaler and Greeno (2000) found that when students' mathematics identities were nurtured through classroom experiences that included collaboration and complex instruction, students engaged in mathematical discussions and reasoning that did not occur for students in a more traditional classroom. A defining trait of a student with a positive mathematics identity includes an orientation toward engagement with mathematics rather than away from it (Cribbs et al., 2015). Students with a positive mathematics identity have increased motivation to engage with mathematics, and greater opportunities for engagement in mathematics increase the development of positive mathematics identities, meaning that the relationship between mathematics identity and mathematics engagement are bidirectional (Nasir & de Royston, 2013). By promoting one, we encourage the other as well. This increased engagement leads to gains in achievement.

Achievement

Positive mathematics identity influences students' mathematics achievement. Even when accounting for various factors that could influence student performance, Fernández and colleagues (2022) found that students with positive mathematics identities tend to achieve higher levels of success in mathematics. They emphasize that mathematics identity is best cultivated through mathematics reform pedagogy that engages students in collaborative practice on complex mathematics tasks, which has been shown to lead to increased student achievement in mathematics (Bargagliotti et al., 2017; Budak, 2015; Krupa & Confrey, 2017). When educators foster students' mathematics identities, they impact student mathematics achievement as well, which opens opportunities for students' future career aspirations.

Aspirations Toward STEM

Following the COVID-19 pandemic, the United States is facing a shortage in the workforce, particularly in the fields of science, technology, engineering, and mathematics (STEM), as the demand has increased by almost 34% in the last ten years (Boggs et al., 2022). Female, Black, and Latinx professionals are also underrepresented in STEM careers (Boggs et al., 2022). Students with a negative mathematics identity are unlikely to pursue careers in STEM, with mathematics being the gatekeeper

(Douglas & Attewell, 2017) preventing them from pursuing lucrative career options. Students are more likely to pursue careers in STEM fields when they have positive mathematics identities (Cass et al., 2011; Cribbs et al., 2021; Godwin et al., 2020). When educators know what factors play a role in students' mathematics identity formation, they can foster students' positive mathematics identities and impact the future of STEM.

Mathematics identity is an essential component of student engagement, student achievement, and students' future aspirations. In the next section, I discuss factors influencing students' mathematics identity.

Factors Influencing Mathematics Identity

Understanding why mathematics identity matters leads us to question how we can positively influence students' mathematics identity. Mathematics identity is formed throughout a student's life. It is malleable (Radovic et al., 2018) and influenced by various factors. These factors fall under the umbrella of three main categories – sociocultural, personal, and educational - which I explore further in the following sections.

Sociocultural Factors

Sociocultural factors influencing mathematics identity are those in place due to societal stereotypes and prejudices, as well as inequitable systems and structures within school mathematics (Chen & Horn, 2022; Flores, 2007; McGee & Martin, 2011). These factors are broad-reaching and can be difficult for individual teachers to influence; however, they are factors that should be recognized and that any intervention on student mathematics identity should seek to address. The race, gender, and socioeconomic class of a student has an impact on their mathematics identity.

Students' racial identity can influence the development of a positive mathematics identity. McGee and Martin (2011) describe how Black students have faced systemic challenges, including inferior education, limited resources, stereotypes, and biased discussions about achievement gaps. There is an opportunity gap, rather than an achievement gap, due to inequalities in schools that limit Black and Latinx students' access to high-quality mathematics instruction and resources (Flores, 2007). These obstacles have hindered their academic success and perpetuated negative perceptions of their intellectual abilities. Practices meant to address the so-called achievement gap for Black and Latinx students end up perpetuating negative narratives, disregarding the malleability of student identity, reinforcing stereotypes of inferiority, and suppressing alternative perspectives (Gutiérrez, 2013).

Positive mathematics identity can also be impacted by gender. Portrayals of mathematics as masculine and mathematicians as men influence individuals' perceptions and beliefs about mathematics. People's perceptions of mathematics often align closely with pop culture representations, shaping their understanding of who can do mathematics (Epstein et al., 2010). The perception of mathematics as masculine poses challenges for girls and women to feel skilled and at ease with the subject, affecting their participation and performance in mathematics (Mendick, 2005).

Socioeconomic status is a third sociocultural factor that plays a role in mathematics identity development. Students who live in poverty often academically underperform peers who live in higher socioeconomic areas when it comes to mathematics (Flores, 2007). Low-income students tend to arrive at school without sufficient knowledge of mathematical skills (Galindo & Sonnenschein, 2015). When students are working to develop their mathematics skills and position themselves as less able compared to their peers, it does not contribute toward the development of a positive mathematics identity.

Students' sociocultural backgrounds, including race, gender, and class, play a role in developing their mathematics identities. Beyond sociocultural factors, students also have personal factors that influence their mathematics identities.

Personal Factors

Personal elements play an essential role in shaping an individual's mathematics identity. This section delves into the multifaceted aspects that influence one's mathematical identity formation. Within this exploration, I examine key dimensions such as purposes and goals for doing mathematics, beliefs about mathematics, perceived competence, authority and positioning, and the role of affirmation in fostering a positive mathematics identity.

The reasons students have for engaging in mathematics can influence their mathematics identities. For example, Black and colleagues (2010) analyzed the narratives of two students, Lee and Mary, who each have a "leading activity" that influences their motivation for doing mathematics. Lee initially feels frustrated and lacks a clear goal, while Mary's motive is tied to her engineering dream. Lee develops a new motive to study psychology and is motivated to get good grades in mathematics to earn a degree. At the same time, Mary's motivation is hinged on the understanding that mathematics underpins the work she wants to do in engineering. These motives shape their engagement with mathematics and how they see themselves as mathematicians.

How students see mathematics and mathematicians impacts the development of their mathematics identity. Epstein and colleagues (2010) explain how the media portrays mathematicians as loners, obsessed, and socially awkward, and mathematics is seen as challenging and dubious. They found that young people's perceptions of mathematicians aligned with these stereotypes, associating them with geekiness and nerdiness. However, those interviewed who were choosing to study mathematics distanced themselves from these images. When students do not see themselves as looking or behaving like mathematicians seen in popular culture, particularly when those are their only references, it can be difficult to identify themselves as mathematicians.

Self-efficacy in mathematics, or lack thereof, can contribute to students' mathematics identities. According to Bandura (1997), the motivation to act is reduced when people lack confidence in the effectiveness of their actions to produce desired outcomes and prevent undesirable ones. When applied to mathematics, one could say that the motivation to do mathematics is reduced when a student lacks confidence in the effectiveness of their mathematics skills to produce correct answers and prevent incorrect ones. Cribbs et al. (2015) found that students' strong belief in their mathematical abilities is associated with a higher interest in mathematics and a perception that others also view them as capable. Interest in mathematics and the perceived recognition of teachers, peers, and family are positive self-perceptions that directly influence students' mathematics identities.

Students' mathematics identities are impacted by students' positioning and sense of authority in the mathematics classroom. Langer-Osuna (2017) describes how shared intellectual authority between teachers and students in collaborative mathematics classrooms impacts sense-making opportunities, fostering ownership of ideas, greater understanding, and identification with mathematics. The construction and distribution of intellectual authority among students influences mathematics learning and the development of mathematics identities. For example, Bishop (2012) studied two girls, Teri and Bonnie, who were friends and worked as partners in mathematics class. Teri, positioning herself as the "smart one," employed strategies to assert her mathematical knowledge, often disregarding Bonnie's ideas and controlling the dynamics of their participation. In contrast, Bonnie embraced her identity as the "dumb one," relying on more passive behaviors and deferring decision-making to others. This mutually reinforcing pattern perpetuates the belief that Bonnie is not proficient in mathematics. How students are positioned in relation to their peers and their sense of authority impacts their mathematics identity development.

External recognition of mathematics ability is among the most significant predictors of positive mathematics identity (Cribbs et al., 2015). Students seen as "mathematics people" by teachers, peers, and family members are more likely to identify positively with mathematics. Sfard and Prusak (2005) emphasize that mathematics identity is made up of significant, reifying, and endorsable narratives – with the endorsable part being key here. The perceived acceptance of others and the agreement that one is a "doer of mathematics" are important components in students' mathematics identity development.

Students' personal factors, including purposes and goals for doing mathematics, beliefs about mathematics, perceived competence, authority and positioning, and affirmation they may or may not receive, play a role in the formation of their positive mathematics identities. There are also educational factors that contribute to students' mathematics identities.

Educational Factors

Educational factors impacting student mathematics identity are the factors that teachers and school systems have the greatest opportunity to influence. Many of these factors lead to the improvement of the personal factors explored in the previous section. Educational factors to explore include equitable teaching, ability grouping, and pressure.

In *Catalyzing Change* (NCTM, 2020), equitable mathematics teaching is described as utilizing NCTM's (2014) eight effective teaching practices while fostering students' mathematical identity and agency. It is underpinned by the belief that every child possesses inherent mathematical competence and can actively participate in mathematics. The eight effective teaching practices outlined by NCTM include that teachers should "establish mathematics goals to focus learning, implement tasks that promote reasoning and problem solving, use and connect mathematical representations, facilitate meaningful mathematical discourse, pose purposeful questions, build procedural fluency from conceptual understanding, support productive struggle in learning mathematics, and elicit and use evidence of student thinking" (NCTM, 2014, p. 9). Boaler (2002) found that in traditional classrooms, students adopted a passive "received knowing" stance, leading to a dislike for mathematics and a conflict with their desired identities as freethinkers. Teachers' pedagogical practices influenced their rejection. In contrast, discussion-oriented classes fostered active learning and understanding, aligning with students' identities and fostering continued engagement. Identity played a crucial role, as students with similar test scores developed contrasting relationships with mathematics. Passive reception of knowledge made mathematics unappealing, while active contribution allowed students to identify with mathematics. Cobb and colleagues (2009) studied students who attended a "regular" algebra class and a design experiment class. In the "regular" algebra class, the teacher ascribed to more traditional teaching methods, and students were limited by their obligation to produce correct answers using the methods prescribed by the teacher. This resulted in frustration and disengagement with mathematics. However, in the design experiment class, students analyzed data to gain insights and felt a sense of agency. They believed in their ability to contribute and shape meanings.

Ability grouping in mathematics shapes students' mathematical identities. Academic data are used to segregate and marginalize students based on performance at both the class and small-group levels (Knoester & Au, 2015). This leads to discriminatory practices where only the highest-achieving students receive challenging tasks (McGillicuddy & Devine, 2018). Meanwhile, less effective learning opportunities, such as direct instruction on basic skills, are provided for students who do not perform well (McGillicuddy & Devine, 2020). This further widens the mathematics performance gap among students (Lleras & Rangel, 2009). Hodgen and Marks (2009) studied students in a classroom who were grouped by ability. They found that with limited movement between the groups, students identify themselves and others based on their ability group. This mindset is common in elementary schools, with a focus on labels such as low/middle/high, red/yellow/green, or below/on/above. These labels focus on groups of students collectively and overlook individual learning paths and continuums. Labels and levels are not only talked about by teachers, but students notice which groups they are in and which groups their peers are in, reinforcing ideas about who students are in relation to mathematics (McGillicuddy &

Devine, 2018, 2020). Students in the “lower-ability” groups do not perceive that they have the same mathematical identities available to them as the students in the “higher-ability” groups (Hodgen & Marks, 2009). Ability grouping does not promote the development of positive mathematics identities for all students.

Excessive academic pressure can also impact students’ mathematics identities. When there is a focus on students mastering mathematics concepts quickly, and students need more time to grapple with the concepts, it can leave them feeling as though they are less capable mathematically. Boylan and Povey (2009) analyzed the story of a student, Louise, who speaks about her mathematics experiences. Louise talks about the dread she would feel when she had to compete orally against peers to give the correct answer to a multiplication fact. She discusses how she had to weigh herself against other students, identifying herself and her peers as “good” or “bad” at mathematics. When she would go home, the pressure would continue with her parents physically and verbally responding to her lack of memorization of the times tables. Rather than being able to focus on learning and doing mathematics, she was inundated with the negative pressure that came her way with mathematics. Approximately one-third of students experience mathematics anxiety when faced with timed testing, blocking access to mathematics facts stored in their working memory (Boaler, 2016). This anxiety-inducing experience causes students to lose interest in mathematics and to identify as nonmathematical.

Educational factors such as equitable teaching practices, ability grouping, and pressure influence students’ mathematics identities, whether for good or bad. Sociocultural, personal, and educational factors influence students’ mathematics identities over time.

Intersectionality

I would be remiss to discuss identity without discussing the topic of intersectionality. In the late 80s and early 90s, the theory of intersectionality came into prominence with the work of Crenshaw.

Crenshaw (1989) introduced intersectionality by illustrating discrimination that is faced by Black women, which comes from discrimination based on racism like that faced by Black men, on sexism similar to that faced by White women, and on both racism and sexism simultaneously in a way that is unique to Black women.

People identify themselves in various ways, including but not limited to race, gender, sexuality, ability, age, religion, or ethnicity (Atrey, 2019). One may experience privilege or disadvantage in any of these or other groups depending upon one's identity. Some will identify with multiple groups that face discrimination (Atrey, 2019). Intersectionality explores how multiple identities overlap, having some things in common with all who are in one group and some things in common with all who are in another group, but also separately having unique experiences as someone who belongs to both groups (Atrey, 2019; Crenshaw, 1989).

While children are developing mathematics identities, they simultaneously identify in other ways. For example, a Latinx student with a positive mathematics identity will identify as Latinx, as a person who does mathematics, and as a Latinx who does mathematics, which comes with unique experiences. McGee and Martin’s (2011) study of how Black mathematics and engineering students managed their multiple identities, described earlier in this paper, is one example of intersectionality involving mathematics identity. The students worked to overcome stereotypes involving their racial and mathematical identities and used those stereotypes as a motivating factor. Zavala (2014) studied the intersectionality of Latinx students’ racial, linguistic, and mathematics identities and the unique experiences of those students, including having trusted peers who could talk about mathematics with them in Spanish. Educators need to consider students’ multiple identities and the unique ways they experience mathematics due to those identities.

I have discussed how mathematics identity has been defined, operationalized, and categorized in the literature, the purposes behind developing students' positive mathematics identity, the factors contributing to the formation of mathematics identities, and intersectionality. In this study, I aimed to promote positive mathematics identity through a mathematics club, so it was vital to analyze the research on mathematics clubs and their benefits, particularly for the promotion of positive mathematics identity.

Mathematics Clubs

Mathematics clubs have been around for over a hundred years. It is difficult to pinpoint the first ever mathematics club; however, there is evidence of mathematics clubs existing as early as 1891 (Waterhouse, 1971). Mathematics clubs have evolved and can be found in communities and schools worldwide. Mathematics clubs are beneficial in schools for various reasons, including the development of students' positive mathematics identities.

Benefits of Mathematics Clubs

There are many reasons why mathematics clubs are started in schools. They can be helpful in stepping outside of the restraints of the traditional school structure, supporting sense-making and problem-solving, increasing engagement and enjoyment of mathematics, and promoting positive mathematics identity.

One benefit of a mathematics club is the ability to engage students in mathematics without the barriers that school structures and policies place on mathematics. During the school day, teachers face the challenge of instructing students on prescribed material while motivating disengaged students and navigating high-pressure tests and accountability measures (Horn, 2007). Outside of the classroom, these limitations dissipate, and they are free to engage students in mathematics in other ways. Through a mathematics club, specific goals can be focused on, and a curriculum can be developed that could not be used in the regular mathematics classroom (Lampen & Brodie, 2020).

Mathematics clubs that meet outside of school can support students' sense-making and problem-solving skills. Studies on mathematics clubs that focus on students' collaboration on mathematics tasks have described discursive moves that show students are working to make sense of and solve complex problems (Diez-Palomar et al., 2006; Turner et al., 2013). This involves purposeful planning, as meeting and calling it a mathematics club but not engaging students in collaborative activities would not have the same result.

When the goal of the mathematics club is to increase engagement and enjoyment in mathematics, students want to be a part of it. Prescott and Pressick-Killborn (2015) studied a lunchtime mathematics club that pre-service teachers ran. This club was voluntary and open to upper elementary students. Many students joined the club after hearing from peers that it was challenging and fun.

A few mathematics clubs have been established and studied with the goal of increasing students' positive mathematics identities. These clubs utilize many of the aforementioned benefits, such as the removal of restraints in place during the regular school day, supporting students' problem-solving and sense-making skills, and increasing enjoyment and engagement in mathematics as a pathway toward this goal.

Mathematics Clubs and Mathematics Identity

I found four studies focused on mathematics identity development through a mathematics club. Two of these studies focused on fourth- and fifth-grade students, while the other two focused on high school students.

Graven (2011) discusses the idea of mathematical abuse and compares the outcomes of some students' mathematics experiences with the outcomes of emotional abuse. She tells the story of a voluntary mathematics club she created for high school students, in which students brought whatever they wanted to work on, and she facilitated discussion between the club members. She observed students' identities shifting toward more positive directions throughout the club, as students felt a sense of belonging and could work with mathematics more collaboratively than they were afforded in their regular classrooms.

Turner et al. (2013) studied the development of fourth- and fifth-grade English learners' (ELs) mathematical agency as a path to their mathematics identity development. They studied students' positioning and discursive moves during the mathematics club. They focused on students' discursive moves, including "explaining a solution strategy, justifying an idea, making a mathematical connection or claim, or evaluating the idea of a peer" (Turner et al., 2013, p. 209). They sought to promote these discursive moves through positioning moves on the researcher's part that encouraged students. This study resulted in greater mathematical agency among the students, as evidenced by their increased confidence in their ability to contribute to the mathematical discussions held in the club. Students' mathematics identities were not directly studied; however, the researchers contend that this building of agency and perceived competence will lead to the development of positive mathematics identities.

Lampen and Brodie (2020) studied the development of a high school mathematics club curriculum with the goal of supporting students' mathematics proficiency, identity, and agency. They aimed to integrate the mathematics that students were learning in school with real-world mathematics and support students' enjoyment of mathematics. Pedagogically, the researchers ascribed the beliefs that all students are capable of learning and doing mathematics, collaboration is encouraged, mistakes are normal parts of learning mathematics, and mathematics should be modeled and valued. They focused on four types of tasks: "becoming mathematical with everyday tasks, becoming mathematical about mathematics, being mathematical and making mathematics, and mathematics" (Lampen & Brodie, 2020, p. 7). They conducted this curriculum design reflexively, considering how tasks might promote mathematics proficiency, identity, and agency and then reflecting upon whether they did or did not promote each. Their findings did not focus on the exact trajectories of students' mathematics identities, but they did observationally find that students were improving in all three areas. They found that this model for developing a mathematics club was useful and continued to use it for future mathematics clubs.

Gulemetova et al. (2022) studied the impact of a club called After-School Math Plus on low-income and minoritized students' mathematics achievement and mathematics identities. This club was open to fourth- and fifth-grade students across several schools. This program was built along four themes, with one theme per semester. Themes included ArtMath, The Built Environment, Jump Rope Math, and MusicMath (Gulemetova et al., 2022). Activities within these themes were designed to promote mathematical thinking and reasoning skills. Additional elements were incorporated into the curriculum to promote positive mathematics identity, such as equity activities to challenge stereotypes surrounding mathematics and promote the idea that mathematics is for everyone. The researchers developed a student survey tool for measuring students' mathematics identity and analyzed pre- and post-survey data and academic achievement. The study found that the program did not influence mathematics identity or achievement; however, a positive relationship was found between mathematics identity and mathematics achievement.

This study is unique because it focuses on the impact of a before-school mathematics club on the mathematics identities of third through fifth-grade students who are classified as low-income. All previous studies were of clubs that met after school, and none included students as young as third grade. It includes the development of a mathematics club curriculum and how students respond to that curriculum, which is also unique to my study. I will build on previous work by adapting Lampen and

Brodie's (2020) reflexive model for developing a curriculum for a mathematics club, Boaler's (2016) student reflection prompts, and Gulemetova et al.'s (2022) mathematics identity survey as I use action research to study the development of students' mathematics identities through a Community of Practice that influences their Figured World of mathematics.

Theoretical Frameworks

In this study, I develop a curriculum for and facilitate a mathematics club in which the goal is to promote students' positive mathematics identity through equitable, strengths-based, collaborative, and joyful mathematics tasks. The theories that underpin this work are Wenger's (1998) theory of Communities of Practice and Holland et al.'s (1998) theory of Figured Worlds.

Communities of Practice

Communities of Practice are groups of people who share a common interest or passion and enhance their knowledge and expertise by frequently engaging with one another to share information and perspectives (Wenger et al., 2002). Individuals need opportunities to engage with others to gain expertise, as knowledge is a dynamic collection of one's experiences and the experiences that have been shared with them, which is built upon collectively (Wenger et al., 2002). Communities of Practice offer value by assisting members in overcoming challenges, boosting problem-solving confidence, fostering enjoyable interactions with peers, nurturing a sense of belonging, and cultivating a sense of identity relative to the Community of Practice's domain of interest (Wenger et al., 2002). In my study, I facilitated a Community of Practice through a mathematics club. A Community of Practice is composed of three structural units: domain, community, and practice (Wenger et al., 2002).

Domain creates common ground and identity in Communities of Practice – without it, a community is just a group of friends (Wenger et al., 2002). A shared domain fosters accountability and guides learning – it defines the community's identity and values (Wenger et al., 2002). Mathematics is the domain of the Community of Practice that is MATH Club.

Communities shape learning through interactions and relationships (Wenger et al., 2002). Combining shared and individual insights, Communities of Practice form a dynamic social learning system (Wenger et al., 2002). Students in MATH Club are a diverse group in terms of gender, race, ethnicity, grade level, and past mathematics achievement.

Practice encompasses shared knowledge, frameworks, tools, language, and behaviors within a community (Wenger et al., 2002). It guides action, problem-solving, and communication, creating a cohesive micro-culture within the group (Wenger et al., 2002). In MATH Club, students' practice involves working collaboratively to problem solve, contributing strategies and ideas freely and openly while abiding by group-developed norms.

This study uses the theory of Communities of Practice to contribute to students' mathematics identity by facilitating a mathematics club through which a Community of Practice is formed. This Community of Practice is meant to influence students' Figured World of mathematics.

Figured Worlds

According to Holland and colleagues (1998), identities are formed as individuals define themselves and strive to act accordingly. These identities combine personal experiences with cultural and social contexts and shape a person's behavior. Figured Worlds shape identities.

Holland et al. (1998) describe Figured Worlds as dynamic processes in which we participate, influencing our identity formation. Figured Worlds are social encounters influenced by participants' positions. They exist within specific times and places. They are socially organized and reproduced through interaction. They divide and connect participants, relying on collective work for their existence and significance in our lives. The identities we form within Figured Worlds are shaped by ongoing participation in socially organized activities.

One Figured World that anyone who attends school as a child develops is that of the mathematics classroom. The Figured World that one envisions will depend upon one's experiences and participation in mathematics classes. For example, the Figured World of mathematics classes I participated in as a child included specific characters, acts, and outcomes that held significance. Characters included teachers, the holders of all knowledge, and students – some students who were "good at math" and others who were not. I defined those who were good at mathematics as the students who could solve equations quickly and without difficulty. The acts that held significance in the Figured World of mathematics classrooms for students were raising one's hand to answer a question, sitting in rows, working silently, and completing homework. Unacceptable acts included using fingers to keep up with numbers, drawing to make sense of a problem, coming to school without homework, or asking a peer for help. Significant acts for the teacher included standing at the front of the classroom and directly teaching algorithms and procedures, assigning homework, and reviewing correct answers to homework. Outcomes that held significance were speed, such as in timed tests, and correct answers. As my identity developed in this Figured World, my positionality influenced how I identified myself. I struggled to memorize multiplication facts, even in high school – I could solve all of them, but my strategy involved keeping track of numbers with my fingers, so I kept them hidden under my desk. I was disorganized and often lost or forgot to complete homework assignments, so I spent much of my class time watching the teacher review the correct answers to problems I had never solved. I would become distracted while the teacher talked to the whole class, miss the directions for a new procedure, and then be unsure of what to do when we had to work on class assignments silently. I would draw pictures and use skills I had already mastered to try to work out the problems in other ways – and then quickly erase or hide those so the teacher would not see. In my Figured World of mathematics classes, I identified as someone who was not good at mathematics because it was not fast for me, I did not have things memorized, and I needed to draw to figure things out. This identification began in the third grade and continued throughout high school. I did not even attempt any upper-level mathematics courses because those were spaces where I did not feel I belonged, as my continual participation in this Figured World over time reinforced the same ideas.

My example is a Figured World which many students have experienced in mathematics classrooms. However, there are other options. When I became a teacher, I reenacted my Figured World of mathematics classrooms with my students. In my sixth year of teaching, I was accepted into a master's program focused on mathematics and science education. I was fully immersed in an alternate Figured World for mathematics classrooms that transformed my identity as it relates to mathematics. The characters remained the same – students and teachers – but the students were no longer characterized as good or bad at mathematics, but instead all contributors to knowledge of the whole. The teacher was the facilitator or guide. Acts of significance for students included solving problems in various ways, using manipulatives, drawing pictures, collaborating with peers, explaining and justifying one's mathematical solutions, and thinking deeper rather than faster. On the teacher's end, they proposed interesting and complex mathematics tasks, asked questions to guide and probe students' thinking, and carefully selected student work to present to the class to engage students in discourse. Significant outcomes included mistakes, interesting problem-solving methods, and conversations that led to deeper understanding. In this Figured World, I belonged and saw that I could do mathematics.

I provide these examples from my own experience because Figured Worlds, while situated within social constructs, change based on experience. Particularly in the case of mathematics education, students are placed in new classrooms with new teachers each year; with that, their Figured World will either be reinforced or altered. My experiences represent two paradigms of Figured Worlds of mathematics classrooms. However, it is essential to note that mathematics classrooms have no true dichotomy, and my experiences do not represent the only Figured Worlds of mathematics classrooms. Through MATH Club, I hope to introduce to students' Figured Worlds of mathematics the ideals of collaboration, learning from mistakes, having fun, using their strengths to problem solve, and influence their mathematics identities in a positive direction through this Figured World. The theory of Figured Worlds works alongside the theory of Communities of Practice to accomplish this goal.

Conceptual Frameworks

In addition to and alongside the theoretical frameworks of Communities of Practice and Figured Worlds, I utilized two conceptual frameworks that guide the development and implementation of MATH Club. These conceptual frameworks come from NCTM's (2020) *Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations (Catalyzing Change)* and from Aguirre et al.'s (2013) *The Impact of Identity in K-8 Mathematics Learning and Teaching: Rethinking Equity-Based Practices.*

Catalyzing Change

Catalyzing Change (NCTM, 2020) introduces four key recommendations to provide all students access to quality mathematics experiences. These recommendations include (1) broadening the purposes of learning mathematics, (2) creating equitable structures in mathematics, (3) implementing equitable mathematics instruction, and (4) developing deep mathematical understanding (NCTM, 2020). Although all four of these recommendations are important and necessary, the two that I focus on for the conceptual framework of this study are broadening the purposes of learning mathematics, specifically through promoting experiences of wonder, joy, and beauty in mathematics, and implementing equitable mathematics instruction.

Broadening the Purposes of Learning Mathematics

One of *Catalyzing Change*'s (NCTM, 2020) key recommendations is broadening the purposes of mathematics, including promoting the joy, beauty, and wonder of mathematics. According to *Catalyzing Change* (NCTM, 2020), nurturing children's curiosity in mathematics fosters confidence, joy, and an appreciation for its beauty. Creating mathematically empowering environments, prioritizing inquiry-based learning, and embracing cultural connections are fundamental to meaningful and joyful mathematics education. Teachers should encourage questioning and problem-solving while integrating play and exploration to promote students' joy and wonder. Unveiling the wonder of mathematics requires firsthand experiences where students can recognize underlying structures and make cultural connections. *Catalyzing Change* (NCTM, 2020) states that providing equal opportunities for all children to discover mathematics' joy, beauty, and wonder is essential for developing students' positive mathematics identities.

Implementing Equitable Mathematics Instruction

Another key recommendation from *Catalyzing Change* (NCTM, 2020) is implementing equitable mathematics instruction. In *Catalyzing Change* (NCTM, 2020), the authors explain that teachers and their instructional practices strongly influence children's mathematics identities and achievement, underscoring the importance of equitable teaching approaches that foster positive identities and agency. Limited representation of diverse mathematicians perpetuates stereotypes and hinders students' confidence and interest, while power dynamics and privilege in mathematics education contribute to exclusionary practices that harm marginalized students. Narrow views of mathematics restrict children's understanding and connection, so promoting pedagogies that value cultural backgrounds and center children's experiences is essential. Connecting mathematics to children's interests and cultural backgrounds empowers them, deepens engagement, and promotes critical understanding of the world.

Equitable mathematics instruction acknowledges and values the mathematical competence of every child, nurturing their mathematics identity and agency and ensuring that all children have access to fair and inclusive learning opportunities that support their engagement and growth as mathematics learners. *Catalyzing Change* (NCTM, 2020) underscores the significance of enabling all children to develop a deep understanding of mathematics, fostering their mathematics identity and agency through NCTM's (2014) eight effective mathematics teaching practices that serve as a framework for enhancing the teaching and learning of mathematics. These eight practices include establishing mathematics goals to focus learning, implementing tasks that promote reasoning and problem solving, building procedural fluency from conceptual understanding, facilitating meaningful mathematical discourse, posing purposeful questions, using and connecting mathematical representations, supporting productive struggle in learning mathematics, and eliciting and using evidence of student thinking (NCTM, 2014, p. 9). Aguirre et al. (2013) also describe five key equity-based practices that cultivate students' mathematics learning and positive mathematics identity.

Equity-Based Practices

Aguirre and colleagues (2013) outline five mathematics teaching practices rooted in equity that enhance mathematics learning and foster students' positive mathematics identities. These practices, not in any particular rank order, include "going deep with mathematics, leveraging multiple mathematics competencies, affirming mathematics learners' identities, challenging spaces of marginality, and drawing on multiple resources of knowledge" (Aguirre et al., 2013, p. 43).

The first practice is going deep with mathematics. Equity-based mathematics teaching practices aim to foster a deep understanding of mathematics by incorporating lessons that involve challenging tasks that require high cognitive demand and promote students' development of conceptual understanding, procedural fluency, and problem-solving skills (Aguirre et al., 2013). Lessons focused on going deep with mathematics encourage students to explain and justify their solutions, participate in discourse, and use various solution strategies and representations (Aguirre et al., 2013).

The second practice is leveraging multiple mathematics competencies. Acknowledging and valuing students' diverse mathematical backgrounds and abilities is crucial for promoting equity (Aguirre et al., 2013). Lessons that focus on this practice are collaborative and provide multiple entry points so that students of all skill levels can contribute meaningfully (Aguirre et al., 2013).

The third practice is affirming mathematics learners' identities. Instruction that values diverse mathematical contributions, offers multiple ways to engage, and encourages student participation supports the development of students' mathematics identities (Aguirre et al., 2013). Lessons focused on affirming mathematics learners' identities promote productive struggle and sense-making, instill confidence, embrace mistakes as opportunities for learning, and recognize competence through various types of contributions (Aguirre et al., 2013).

The fourth practice is challenging spaces of marginality. To cultivate a more inclusive and empowering learning environment than traditional lectures and seatwork, it is crucial to adopt practices that recognize student strengths and value diverse mathematical contributions (Aguirre et al., 2013). Lessons focused on this practice embrace students' experiences and background knowledge, position students as experts, distribute authority evenly across the classroom, and foster collaboration and discourse (Aguirre et al., 2013).

The fifth and final practice is drawing on multiple resources of knowledge. Equitable teaching involves recognizing and leveraging students' diverse knowledge and experiences as valuable resources for learning (Aguirre et al., 2013). Lessons focused on this practice connect multiple knowledge sources, bridge prior and new mathematical understanding, incorporate cultural and linguistic elements, and support multilingualism (Aguirre et al., 2013).

Together, these five equitable practices lead to a greater student understanding of mathematics and a positive mathematics identity. Combining the frameworks found in *Catalyzing Change* (NCTM, 2020) and *Impact of Identity in K-8 Mathematics* (Aguirre, 2013), I make decisions regarding instructional choices for the mathematics club in this study.

In Figure 1, I demonstrate how I envision the theoretical and conceptual frameworks of this study coming together to aid in the development of students' positive mathematics identities. The entire circle represents MATH club, a Community of Practice (Wenger, 1998). The heads all represent students in the club. One head is larger to show that it is "zoomed in." To be clear, the large head is the same as and representative of all the smaller ones; it is just more detailed as it is zoomed in. The brains in the heads represent students' Figured Worlds (Holland et al., 1998) of mathematics. The words surrounding the students are facets of *Catalyzing Change's* (NCTM, 2020) key recommendations and Aguirre et al.'s (2013) five equity-based practices, which are all integrated into the tasks and community of MATH Club. The words with arrows pointing to the head represent how students are positioned in the club. The thought bubble represents students' mathematics identity.

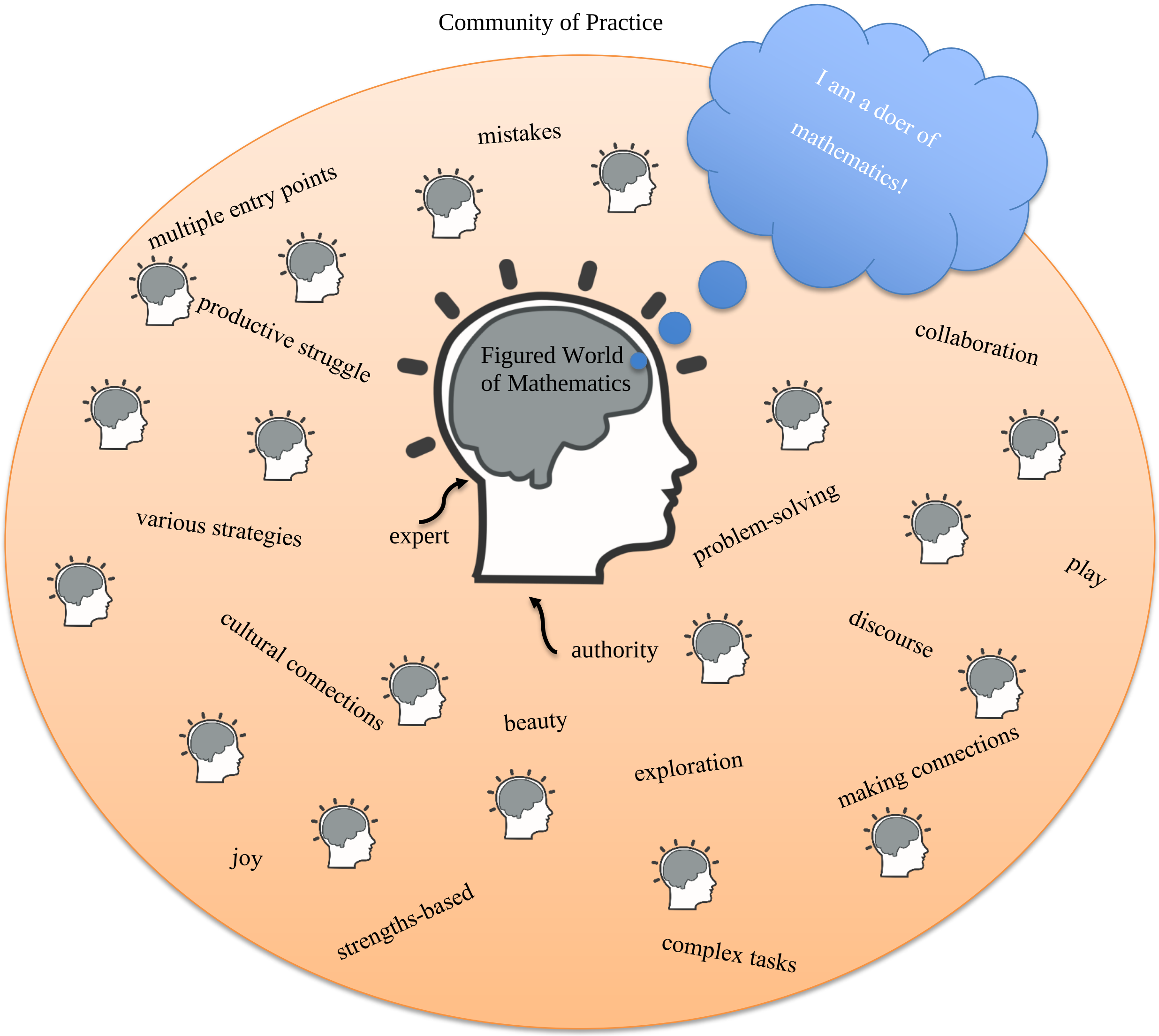

Figure 1: Overall Conceptual Diagram of MATH Club

This figure incorporates the ideas of Communities of Practice (Wenger, 1998), Figured Worlds (Holland et al., 1998), key recommendations of *Catalyzing Change* (NCTM, 2020), and Aguirre et al.'s (2013) five equity-based practices.

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Summary and Concluding Thoughts

In summary, mathematics identity is defined by students' engagement and active participation in mathematics (Black et al., 2010; Wenger, 1998), beliefs and views about themselves as learners (Aguirre et al., 2013; Bishop, 2012; Boaler & Greeno, 2000; Gee, 2001; Martin, 2000) and the nature of mathematics (Black et al., 2010; Solomon, 2009; Wenger, 1998), sociocultural contexts (Black et al., 2010; Darragh & Radovic, 2020; Martin, 2000), and mathematics community contexts (Aguirre et al., 2013; Bishop, 2012; Darragh & Radovic, 2020). Mathematics identity has been operationalized in the literature as participative, narrative, discursive, psychoanalytic, and performative (Darragh, 2016). Dimensions of mathematics identity include the "subjective/social, representational/enacted, and change/stability dimensions" (Radovic et al., 2018, p. 26). Those dimensions were used to categorize studies of mathematics identity, including "identities as individual attributes, narratives, relationships with a specific practice, ways of acting, and as afforded and constrained by local practices" (Radovic et al., 2018, p. 28).

Mathematics identity is important because it contributes to student engagement (Boaler & Greeno, 2000; Cribbs et al., 2015; Nasir & de Royston, 2013), achievement (Fernández et al., 2022), and aspirations toward STEM (Cass et al., 2011; Cribbs et al., 2021; Godwin et al., 2020). Mathematics identity is influenced by sociocultural factors, including race (McGee & Martin, 2011), gender (Epstein et al., 2010; Mendick, 2005), and socioeconomic status (Galindo & Sonnenschein, 2015); personal factors, including purposes and goals for doing mathematics (Black et al., 2010), perceptions of mathematics and mathematicians (Epstein et al., 2010), self-efficacy beliefs (Cribbs et al., 2015), positioning and sense of authority (Bishop, 2012; Langer-Osuna, 2017), and external affirmation (Cribbs et al., 2015; Sfard & Prusak, 2005); and educational factors, including equitable teaching (Boaler, 2002; Cobb et al., 2009; NCTM, 2014, 2020), ability grouping (Hodgen & Marks, 2009; Lleras & Rangel, 2009), and academic pressure (Boaler, 2016; Boylan & Povey, 2009). When considering students' mathematics identities, it is important to consider the intersectionality involved in their racial, gender, ethnic, and other identities that influence the unique ways they experience mathematics (Atrey, 2019; Crenshaw, 1989; McGee & Martin, 2011; Zavala, 2014).

Mathematics clubs have been shown to have several benefits, including removing restraints of school structures and policies (Horn, 2007), supporting students' sense-making and problem-solving skills (Diez-Palomar et al., 2006; Turner et al., 2013), increasing engagement and enjoyment of mathematics (Prescott & Pressick-Killborn, 2015), and promoting students' positive mathematics identities (Graven, 2011; Gulemetova et al., 2022; Lampen & Brodie, 2020; Turner et al., 2013).

Theories undergirding this study include Wenger's (1998) theory of Communities of Practice and Holland et al.'s (1998) theory of Figured Worlds. Communities of Practice are groups of people who share a common interest and improve their learning by engaging with one another (Wenger, 1998), while Figured Worlds are the socially constructed realities in which we participate, which are shaped by participation in social activities (Holland et al., 1998). Both contribute to identity development, and a Figured World can be formed through a Community of Practice. The conceptual framework of this study includes key recommendations from *Catalyzing Change* (NCTM, 2020) of broadening the purposes of mathematics and implementing equitable teaching practices, as well as Aguirre et al.'s (2013) five equity-based practices.

In the following chapter, I will detail how I conducted action research, using iterative cycles of planning, acting, observing, and reflecting, and collected data through the use of student surveys, teacher interviews, student reflections, and reflexive journaling to answer the question of how students' mathematics identities developed through MATH Club.

CHAPTER THREE: METHODS AND RESEARCH DESIGN

In this study, I created a curriculum for MATH Club and analyzed how participation in this club influenced students' mathematics identities. MATH Club was a morning mathematics club where students met twice weekly to collaborate on interesting and challenging mathematics tasks in an affirming, low-pressure, and equitable environment. I utilized Aguirre and colleagues' (2013) five practices for building student mathematics understanding and identity and key recommendations from *Catalyzing Change* (NCTM, 2020), as well as the theories of Figured Worlds (Holland et al., 1998) and Communities of Practice (Wenger, 1998) as frameworks guiding the structure and implementation of MATH Club.

Restatement of Purpose and Research Question

This study sought to investigate the influence of a mathematics club that incorporated equitable, strengths-based teaching practices on the development of students' mathematics identities. As such, my research question was: How does my facilitation of a strengths-based mathematics club focused on equitable teaching practices influence the development of students' mathematics identities?

Research Design

My study used a qualitative research approach so that I could understand how individuals' mathematics identities developed throughout the study as a result of participating in MATH Club. I conducted action research, specifically practitioner research, following the work of Anderson et al. (2007). Practitioner research aligns well with my study because I studied an intervention and its impact on human participants as the researcher and the practitioner providing the intervention.

Anderson et al. (2007) state that practitioner action research involves reflective, systematic research conducted by practitioners within their settings, aiming to address specific situations through cycles of planning, acting, observing, and reflecting. Action research seeks to improve practice and address social problems. Initially, I *planned* beginning tasks for MATH Club, *acted* by implementing the club plans, *observed* how students interacted with those plans, and then *reflected* on what I understood and found at that point. I used those initial observations to support my first reflection. From there, the cycle iterated as I *planned* more MATH Club sessions, *implemented* those plans, *observed* students, and *reflected* on my current understanding. This cycle continued throughout the research study, with me recording my reflections and using them to make decisions as I moved forward.

Setting and Population

LES is a Title I school in DCSD, an urban school district in Florida. During the 2023-24 school year, LES served approximately 560 students, with an even 50% female and 50% male. Approximately 50% of the student population were Black, 33% were Latinx, 10% were White, 5% were Multi-Racial, and 2% were Asian. Approximately 80% of students were classified as economically disadvantaged, 10% were students with identified disabilities, 15% had limited English proficiency, and 2% were identified as gifted.

Before the COVID-19 pandemic, LES was progressing in terms of overall academic performance on state assessments. However, after 2020, there was a sharp decline. Students in third through fifth grades were impacted by the pandemic during their formative schooling years and denied the opportunity to learn as much as they typically would in a school year (Dorn et al., 2021). Due to insufficient online learning experiences, increased absences, and protocols in place to prevent the spread of COVID-19, students spent less time collaborating with peers and working with hands-on materials to solve complex mathematics tasks during kindergarten through second grade.

Due to heavy turnover, there also was a lack of coherence across the school. Approximately 75% of the teachers and nearly all of the administrative team were new to LES. The change in staff provided an excellent opportunity to build a school community that values mathematics and promotes key recommendations from *Catalyzing Change* (NCTM, 2020) to provide quality experiences in mathematics to all students. MATH Club served as a microcosm of the upper grades in the school, introducing to teachers a model of equitable approaches that are transferable to the classroom.

Participants

I began the recruitment process after gaining approval from the university and school district IRBs (see Appendix A). To recruit student participants, I employed voluntary response sampling (Murairwa, 2015). Using a district-approved flyer, I advertised MATH Club to all parents of students in the third through fifth grades. Interested parents were given an application for their child to be considered for the study and the club. Parents first, then students, were required to consent to research, confirm availability, and commit to regularly attending MATH Club. The club was open to no more than 18 students, allowing a large enough group to generate knowledge from many students, but not so large that it was difficult to manage. Wenger et al. (2002) note that communities with fewer than 15 members foster a sense of intimacy, and with 15 to 50 participants, relationships become more dynamic and diverse.

I received 55 applications from interested parents. To study a microcosm of the larger school community, I used stratified sampling to select a representative population from the returned applications to mirror the population of our school community, considering factors including race and gender. Robinson (2014) states that stratified sampling requires clear grounds for the chosen categories. Race and gender influence students' mathematics identities (Epstein et al., 2010; Flores, 2007; McGee & Martin, 2011; Mendick, 2005). The problem guiding this research is a lack of mathematics engagement across the population of LES. By using stratified sampling, I can study a sample that is representative of the school population to determine whether the intervention of MATH Club might be beneficial for the school at large. The target student sample demographic is detailed in Table 2. I was able to match the target demographics through this sampling process, as detailed in Table 3.

Table 2: Target Student Demographics

Black 9		Latinx 6		White 2		Multi-Racial or Asian 1	
Male	Female	Male	Female	Male	Female	Male	Female
4-5	4-5	3	3	1	1	0-1	0-1

Table 3: Student Participant Demographics

Black 9		Latinx 6		White 2		Multi-Racial or Asian 1	
Male	Female	Male	Female	Male	Female	Male	Female
5	4	3	3	1	1	0	1

Once students were selected and I received parental consent and student assent, I used purposive sampling by contacting their classroom mathematics teachers to recruit teachers' participation in the study. This type of sampling was necessary for the teacher participants because only the teachers of students in MATH Club were useful to this study because I wanted to ask them about MATH Club student participants. Eight teachers were invited, with six agreeing to participate in the study. These six participants included three third-grade teachers, two fifth-grade teachers, and one mathematics intervention teacher who regularly interacted with the fourth-grade students. The teachers are detailed in Table 4.

Table 4: Teacher Participant Selection

Third Grade			Fourth Grade	Fifth Grade	
Teacher A	Teacher B	Teacher C	Teacher D	Teacher E	Teacher F
Students 1, 2, 3, 4, 5	Students 6, 7	Students 8, 9	Students 10, 11, 18	Student 12	Students 13, 14, 15, 16, 17

Data Collection Methods

Data were collected through pre- and post-surveys of student mathematics identity, interviews with students’ classroom mathematics teachers, students' written reflections, and my reflections as the practitioner.

Students were given the Afterschool Math Survey (Gulemetova et al., 2022) during the first and final MATH Club sessions. These data were used to aid in describing students’ mathematics identity development during the study.

Teacher interviews occurred in person during mutually beneficial times for the interviewer and interviewee(s), both at the start and end of MATH Club. Teacher participants were asked about their perceptions of individual students, their mathematical abilities, needs, and strengths, how they are grouped in class, and how they engage in classroom mathematics (see Appendix B for interview protocol). The analysis of these data provided another perspective on individual students’ mathematics identity development.

Students completed written reflections at the end of MATH Club sessions using an adaptation of Boaler’s (2016) prompts. These reflections provided further data about students’ mathematics identity development and MATH Club itself. Examples of student reflection prompts are included in Appendix C.

An essential component of action research is the researcher's reflexivity. As such, I continually reflected on task selection, what was occurring in MATH Club, and how students responded. These reflections adapted the protocol Lampen and Brodie (2020) provided for developing a mathematics club curriculum. They led to new plans and a continuation of the action research cycle.

Timeline for Data Collection

These data were collected during approximately four months, starting in November and concluding in February. Reflexive journaling was completed throughout the study. I began collecting data regarding students' mathematics identities at the start of MATH Club and again at the end of MATH Club. The timeline for data collection is detailed in Table 5.

Table 5: Data Collection Timeline

Date	Data Collected
November 2023	Student surveys Reflexive journaling Student reflections
December 2023	Teacher interviews Reflexive journaling Student reflections
January 2024	Reflexive journaling Student reflections
February 2024	Reflexive journaling Teacher interviews Student reflections Student surveys

Instruments and Data Sources

I collected data for this study using student pre- and post-surveys, ongoing written student reflections, teacher pre- and post-interviews, and ongoing practitioner reflexive journaling.

Student Survey

The Afterschool Math Survey (Gulemetova et al., 2022) was developed to study the Afterschool Math Plus (ASM+) program and its influence on fourth and fifth-grade students' mathematics identities. In my study, I examine the impact of MATH Club, which convenes in the morning despite the survey's title, which indicates an after-school setting. Gulemetova et al. (2022) built on previously existing measures to create a 46-item survey concentrating on evaluating students' self-perception of mathematics ability, enjoyment of mathematics, belongingness to the community of doers of mathematics, future aspirations in mathematics, and development of a growth mindset. This survey uses a Likert-style scale ranging from "disagree a lot" to "agree a lot". It uses language that is easily comprehended by children, such as "I can solve difficult math problems" and "Doing well in math is important for my future." The items are not all written in the positive, though, with some items going the opposite direction such as "Math is confusing to me" and "I plan to take as few math classes as possible in middle and high school." *[I do not have permission to include a copy of this survey in an appendix – only to provide examples.]*

Student Written Reflections

Reflection prompts were presented to students at the end of each MATH Club session. Reflection prompts were adapted from Boaler (2016) and used to describe students' perceptions of MATH Club and development of students' mathematics identities. These reflections took no more than five minutes per session, and students responded to prompts such as, "What good ideas did you have today?" or "How could the ideas in today's club be used in real life?" Examples of student reflection prompts are detailed in Appendix C.

Teacher Interviews

Teacher interviews were conducted twice with mathematics teachers whose students participated in MATH Club. The first interview was at the start of MATH Club, and the second was at the end. The purpose of the teacher interviews was to gain a better understanding of students' mathematics identities by gaining an outside perspective. Sfard and Prusak (2005) describe how identities are represented in first-person, second-person, and third-person. The first-person identity is composed of the stories of identity that a person tells about themselves, such as "I enjoy doing math puzzles." The second-person identity is made up of the stories of identity told about a person, to that person, such as "You can solve complex math problems." The third-person identity is formed by the stories of identity told about a person to another person, such as "He uses a variety of strategies to make sense of mathematics." The teacher interviews seek to address and gain data on students' third-person identities. Teachers were asked to describe how students are positioned in the mathematics classroom and how they tend to participate in relation to mathematics. The interview protocol can be found in Appendix B.

Reflexive Journal

A reflexive journal was used to keep track of everything in this study, from task selection to implementation to outcomes. I adapted Lampen and Brodie's (2020) protocol for reflexive journaling. I set aside specific times before and after each club session to add to my reflexive journal and create 40 entries describing what happened before and during each club session. I wrote to explain how and why I chose specific tasks, relating to how they met the goals of promoting students' positive mathematics identities through the key recommendations of *Catalyzing Change* (NCTM, 2020), Aguirre et al.'s (2013) five equity-based practices, and developing a Community of Practice (Wenger, 1998). I anticipated how students would respond to the tasks, including challenges they might face and how I planned to respond to those challenges. I wrote about my plans for task implementation. After implementing the tasks, I used rough notes taken during MATH Club to reflect on my implementation, how students responded to the task and interacted with one another, and any implications moving forward.

Mindful Approaches, Transforming Hearts (MATH) Club

During the first club session, students were welcomed into the classroom at 8:00 AM and provided with the Afterschool Math Survey (Gulemetova et al., 2022). After completing the survey, I worked with the students to develop norms for the club sessions, guiding students to consider important norms for a Community of Practice (Wenger, 1998) and collaborative mathematics work.

During a typical club session, students arrived at the school by 8:00 AM and were welcomed into the classroom. Students were seated in self-selected groups of two to five. After reminding students of the norms, they were given a new task or reminded of the task they would continue working on during that session. I facilitated by circulating through the room and asking guiding and linking questions to support student thinking and collaboration. At the end of the club session, students completed a reflection prompt.

During the final club session, students completed their final task and were again provided with the Afterschool Math Survey (Gulemetova et al., 2022).

Task Selection, Adaptation, and Implementation

Task selection, adaptation, and implementation were critical components of MATH Club. Tasks were selected, adapted, and implemented in such a way that they aligned with criteria consistent with Communities of Practice (Wenger, 1998), *Catalyzing Change* (NCTM, 2020), and Aguirre's (2013) equity-based practices. Tasks also needed to be appropriate for students in grades three through five, considering both accessibility and challenge for all students. In order to accomplish this, I needed a deep understanding of those criteria, the state mathematics standards for those grade levels, and the students' interests, strengths, and areas for growth.

To select, adapt, and implement tasks that aligned with the theoretical and conceptual frameworks of this study, I created a checklist that contained components of each. As I analyzed tasks, I checked off various components to aid in the determination of whether or not a task was a good fit and what adaptations may be needed. I also kept a running list of which components had been focused on in previous sessions, so that I could make a conscious effort to include all components.

Where state mathematics standards are concerned, I had previous experience teaching third through fifth grades. I worked as a mathematics intervention teacher at the time of this study, serving all three of these grade levels. I was familiar with the standards, benchmarks, and the scope and sequence followed by the school district, so I knew what content students had been exposed to in the curriculum. This knowledge helped me to select, adapt, and implement tasks in such a way that they were accessible to all, including the third grade students, while maintaining challenge for all, including the fifth grade students.

I also considered students' interests, strengths, and areas for growth in task selection, adaptation, and implementation. The tasks for MATH Club were not selected in advance, but rather through the action research process of planning, acting, observing, and reflecting (Anderson et al., 2007). MATH Club met on Tuesdays and Thursdays. After implementing a task on Tuesdays, I took time to reflect on the session in my reflexive journal. On Wednesdays, I worked to select and adapt a new task, using my observations and knowledge of the students to inform my choices. I recorded that process in my reflexive journal. On Thursdays, I implemented the new task and reflected on my observations afterward. On Fridays, I worked to select and adapt a new task for the following Tuesday. This process incorporated criteria from Communities of Practice (Wenger, 1998), *Catalyzing Change* (NCTM, 2020), and equity-based practices (Aguirre et al., 2013); accessibility and challenge for all with consideration of state standards and district scope and sequence; and students' interests, strengths, and areas for growth.

Study Procedures

After gaining district and university IRB approval, the recruitment process began. MATH Club was advertised to all parents of third- through fifth-grade students through a flyer. Parents who expressed interest were given MATH Club applications. To comply with state law, prior to official recruitment, the

Afterschool Math Survey (Gulemetova et al., 2022) was posted, with permission from the author, on the district website for ten days to allow parents the opportunity to opt their children out of the survey. Once the application deadline arrived and ten days had passed, 18 applications were selected to be representative of the school population, as described earlier. At that time, parent consent was obtained, followed by child assent. One student dropped out before the first session, and another student matching the same demographics was selected to replace them as Student 18. Student 18 completed the parent consent and student assent process, followed by the student survey, before they began attending during Week 2, Session 3.

Before the first club session, reflexive journaling started as I worked to select the beginning tasks for the club. All tasks were chosen from a task bank (see Appendix D). The task bank includes 14 sources I employed for finding tasks to use with students during MATH Club. Tasks chosen needed to be appropriate for students in third through fifth grades, involve more than just procedures, allow for multiple entry points based on student strengths, be interesting and challenging, and be useful for collaborative structures. Reflexive journaling continued throughout the study, with entries started before each club session, rough notes taken during club sessions without student identifiers, and entries completed after each club session.

Students completed the pre-survey during the first club session using the Afterschool Math Survey (Gulemetova et al., 2022). The survey was explained to students in child-friendly terms, and the statements were read aloud for the group as students independently selected their responses. Students completed their first reflection prompt at the end of the second session and continued completing reflection prompts at the end of each session.

I started scheduling and conducting teacher interviews after the first club session, working to secure data about teachers' perspectives on the students' mathematics identities before being in MATH Club.

Once the initial data were collected, I focused on promoting the students' positive mathematics identities through MATH Club. I consistently recorded the ongoing selection, implementation, and outcome of tasks used in MATH Club and my reflections on those in my reflexive journal.

During the final MATH Club session, students completed the post-survey. After the MATH Club concluded, I scheduled and conducted a second interview with the students' teachers.

Data Analysis

I analyzed data to describe 1) the mathematics club and 2) student participants' mathematics identity development throughout the study.

Utilizing my reflections, I describe the mathematics club. Reflexive journaling included notes on tasks prior to implementation in MATH Club, including the mathematics involved in the tasks, how those tasks brought in the key recommendations of *Catalyzing Change* (NCTM, 2020) and Aguirre and colleagues' (2013) five equity-based practices, how I thought students might approach the tasks and what challenges I thought they might encounter, how I planned to facilitate the implementation of the task, and how and why the task was chosen, including any connections to experiences with previous tasks and the goals of MATH Club. Reflexive journaling also included notes taken after each MATH Club session about how the students approached the tasks, what challenges they faced, how I responded to those challenges, and what students found joyful. I analyzed the reflexive journal to look for ways the club built a Community of Practice (Wenger, 1998) and supported the development of positive mathematics identity through Aguirre et al.'s (2013) five equity-based practices and *Catalyzing Change* (NCTM, 2020). In analyzing the reflexive journal, I used deductive coding, creating codes related to the theoretical and conceptual frameworks prior to the start of the study (Linneberg & Korsgaard, 2019). These codes are located in Appendix E. In the first coding cycle, I aligned segments of my journal entries to the descriptive codes. In the second cycle, I looked for patterns to aid in my description of the club.

I used the teacher interviews, student reflections, and student surveys to describe individual students and their mathematics identity development throughout the study.

I followed the open coding technique for the teacher interviews and student reflections, outlined by Creswell and Guetterman (2019, pp. 243-245). I scanned my data and did a preliminary exploratory analysis. I then created text segment codes. I combined these to create coding categories and code the data based on these categories. The codes developed for teacher interviews can be found in Appendix F, while those for the student reflections are located in Appendix G. Finally, I looked for patterns in the data. Using the teacher interviews and student reflections, I describe students individually and as a group, especially related to change throughout the study.

The student survey is a Likert-style scale with student-rated statements written in the positive and negative. Those that are written in the positive were scored as 1 = Disagree a lot, 2 = Disagree a little, 3 = Don't know, 4 = Agree a little, and 5 = Agree a lot; for those written in the inverse direction, the scale is also inverted with 1 = Agree a lot, 2 = Agree a little, 3 = Don't know, 4 = Disagree a little, and 5 = Disagree a lot. Higher scores on the Afterschool Math Survey indicate more positive indicators of mathematics identity. I compared the pre- and post-surveys using a paired samples t-test.

I triangulated data obtained from student reflections, teacher interviews, and student surveys to describe students' mathematics identities at the start and end of the intervention.

Trustworthiness and Validity

To increase the validity of my research, I utilized triangulation and reflexive journaling. Triangulation was used to analyze data across student surveys, student reflections, and teacher interviews. Reflexive journaling included my ongoing thoughts about the study, including insights, concerns, and decision-making processes.

Interview recordings and raw data from student surveys, reflexive journaling, and student reflections were only accessible to me. This research can be replicated. I have positionality and bias as a mathematics instructor in the school being studied and kept this in mind to ensure bias was set to the side and data were viewed impartially.

Limitations and Strengths

There are several strengths of this study. By explicitly targeting upper elementary students, the study can provide insights into the development of mathematics identity during an important stage of children's growth. This study uses multiple data sources, including student surveys, teacher interviews, student reflections, and reflexive journaling, allowing for triangulation and a broader understanding. The tasks chosen for the curriculum in this study have been used with students before, come from reputable sources, and are of good quality. This study offers a holistic perspective of students' overall mathematics identities by considering multiple dimensions and operationalizations of mathematics identity. Due to the careful documentation of MATH Club, the findings are transferable to other settings. My expertise and experience in elementary mathematics education also contribute to the credibility of this study.

There are also several potential limitations to consider in this study. Students who applied to join MATH Club may possess specific characteristics or interests that could impact their mathematics identity differently than those who did not apply. I tried to mitigate this limitation by placing MATH Club during a time when many students were already at school and sitting in the hallways awaiting the start of the school day, so engaging in MATH Club may be more appealing than the alternative. Programs such as safety patrol and news crew were also available during the mornings for students with good grades; however, nothing was available at that time for students who were currently struggling academically. There is also a possibility that students responded to the survey items in such a way that their responses aligned with perceived outside expectations, which could affect the accuracy of the data. Time is another limitation – MATH Club met twice weekly for 45-minute sessions. Students attended 20 sessions for a combined total of 15 hours. Due to the limited time, there may be limitations on the extent to which meaningful changes in student mathematics identity can occur. External factors are always at play, influencing students' mathematics identities, including their mathematics experiences at home and in their regular mathematics classroom. I did not study a control group, so attributing fluctuation in mathematics identity solely to MATH Club is challenging. My expectations about MATH Club and its ability to influence students' mathematics identities introduce researcher bias, and efforts will be made to acknowledge and minimize that bias.

Conclusion

In this qualitative action research study, I facilitated a MATH Club using equity-based and strengths-oriented practices following frameworks of Communities of Practice (Wenger, 1998), Figured Worlds (Holland et al., 1998), key recommendations from *Catalyzing Change* (NCTM, 2020), and Aguirre et al.'s (2013) five equity-based practices. I implemented iterative cycles of planning, acting, observing, and reflecting. I collected and analyzed data through student surveys, teacher interviews, student reflections, and reflexive journaling to answer the question of how students' mathematics identities developed through MATH Club.

CHAPTER FOUR: RESULTS

Introduction

The purpose of this study was to understand how participation in a mathematics club (i.e., MATH Club) based on equitable teaching practices, interesting and challenging mathematics tasks, collaboration, and the affirming experience of success may promote the development of students' positive mathematics identities. Through this study, I sought to answer the research question: *How does my facilitation of a strengths-based mathematics club focused on equitable teaching practices influence the development of upper elementary students' mathematics identities?* In this chapter, I analyze the various data sources of this study, including my reflexive journal, student reflections, teacher interviews, and student surveys, with the overarching goal of answering my research question. By analyzing these diverse sets of data, I provide insight into the pedagogical choices guiding my facilitation of MATH Club through the reflexive journal, students' mathematical beliefs and attitudes through their written reflections and survey scores, and teachers' perceptions of students in relation to mathematics through their interviews. Each data set is analyzed individually, with the chapter culminating in the triangulation of the four data sources.

Analysis of Reflexive Journal

Throughout MATH Club, I kept a reflexive journal. The reflexive journal played an instrumental role in planning for and reflecting on MATH Club sessions. I recorded notes in my reflexive journal during the planning and reflection phases for each of the 20 MATH Club sessions. Across the 40 journal entries, I recorded how and why I selected tasks, my plans for supporting students, my observations of what occurred during each session, and my reflections on my practice. Through analysis of the reflexive journal, I can describe MATH Club.

The contents of the reflexive journal were analyzed using deductive coding and predetermined codes based on this study's conceptual and theoretical frameworks. This analysis can help describe MATH Club. The reflexive journal consists of entries that are consistent with Communities of Practice (Wenger, 1998); joy, beauty, and wonder as described in *Catalyzing Change* (2020); and equitable or equity-based teaching practices (Aguirre et al., 2013; NCTM, 2020).

Communities of Practice

Creating a Community of Practice within MATH Club was a top priority. A Community of Practice is a group of people who frequently interact with one another to exchange ideas and build knowledge in an area of interest. In this case, MATH Club was meant to be a Community of Practice specifically for mathematics. This Community of Practice was cultivated by nurturing students' sense of belonging, promoting positive interactions with peers, and providing students with opportunities to overcome challenges and boost their problem-solving skills.

One way the Community of Practice was built throughout MATH Club was by nurturing students' sense of belonging. The work toward building this sense of belonging began in the first session when students created agreed-upon norms. In planning for the first session, I wanted to guide students toward norms that encouraged belonging, collaboration, and celebrating mistakes as opportunities to learn and grow. During the session, I prompted them to give me ideas of things that they did not like to happen when working with a group in their mathematics classes. Students reported that they did not like when people shouted out the answer to a problem, when people in a group were being mean to one another, when it became a competition of who could solve the fastest, when people laughed at them for making a mistake, and when they were put on the spot to answer questions that they had not finished solving. As students provided these ideas, the group worked together to turn them into statements about what they wanted to see happen instead. These became the MATH Club norms (see Figure 2). At the start of each subsequent MATH Club session, we revisited the norms, and students were asked if they still agreed or wanted to change anything. Students agreed to the norms during these sessions and never offered any revisions.

In MATH Club:

- We all work together.
- We give each other and ourselves time to think.
- We celebrate each other.
- Mistakes happen and help us.
- No spoilers!

Figure 2: MATH Club Norms

Another way that a Community of Practice was cultivated in MATH Club was through enjoyable interactions with peers. A choice that I made to help facilitate this was allowing students to choose where they sat and who they worked with during each session. The classroom was arranged in table groups, with five tables comfortably fitting up to 6 students. Before the first session, I considered whether I should assign students to table groups to mix the grade levels and make each group heterogeneous. However, I decided against this idea. The MATH Club students did not exist in a vacuum, and they interacted with one another outside of MATH Club, which I was not privy. Some students were siblings, some were in the same class during the school day, and some lived in the same neighborhood. I did not want to inadvertently situate students in such a way that they were uncomfortable with a peer with whom they were assigned to collaborate. I wanted students to feel comfortable with the people they were collaborating with so that they could have enjoyable interactions. In my reflexive journal, I recorded who students worked with each week, and on average, each student worked with nine different peers throughout their time in MATH Club.

In MATH Club, students had the opportunity to overcome challenges and boost their problem-solving confidence, critical components of a Community of Practice. During the sessions, students were faced with challenging tasks to work through. They typically began by working with their table group and then shared ideas with the entire club. For example, in Session 2, when students worked to complete a maze activity, they had quite a challenge to overcome. They needed to complete a maze full of numbers so that their path came to a sum of 100. Students were provided with several copies of this maze. Most students started working on this task immediately, either adding the numbers as they went or completing a maze route and then finding the sum. These students collaborated and discussed as they worked, sharing their findings. One group of four students was unsure how to start, so I joined them with my copy of the maze. I told them I saw another group adding the numbers as they moved through the maze. I worked alongside them for two "moves" on the maze, ensuring they understood how the task worked, and then I walked away. No students could solve this puzzle on the first try, with all students needing to use multiple copies of the maze before they found the correct solution. When the first student solved the maze correctly, she shared a strategy she had used with the group to help everyone. As students finished, they supported each other without giving away the solution. By the end of the session, all students had found the solution and experienced success with this challenging problem. Students had many opportunities to overcome challenges and boost their confidence in problem-solving throughout MATH Club.

MATH Club was a Community of Practice for the students who were members. They came together regularly to engage in activities and discussions related to mathematics. Through MATH Club, they had a space where they belonged and could experience joyful interactions with peers as they worked together to overcome challenges and solve problems. In this space, they could also experience the joy, beauty, and wonder of mathematics.

Joy, Beauty, and Wonder

Throughout MATH Club, students experienced the joy, beauty, and wonder of mathematics. It was important that MATH Club was a mathematically empowering environment where they could find enjoyment, appreciate beauty, and ignite their curiosity about mathematics. Providing students with these experiences is an essential component in developing students' positive mathematics identities (NCTM, 2020).

Students experienced joy in MATH Club. Play and exploration were vital components of students' tasks in several sessions. For example, in Session 13, students interacted with a mathematics game. The session started with me relating to students' backgrounds and interests by asking them about games they play at home. Students shared the games they played with their families and then discussed whether they thought any math or strategy was involved in their games. They started cheering and clapping when I told them we would play a game. In the game, students rolled dice to fill nine boxes and created an addition problem with three 3-digit addends. The winning sum was the one that was as close to 999 as possible without going over. As students played the game, I could see them developing better strategies as the rounds went on. In one conversation, a student remarked that they had to regroup in every round they had played thus far, so they would likely have to regroup. Because of this, they did not want to make the hundreds place have a sum of nine, but a sum of eight to account for the regrouping that was likely to happen. When students won, they could pick a special prize die to take home so they could continue playing the game, with one prize per student. Because I set it up this way, once a student won, they tended to help their partner use good strategies to win. Students were excited when their strategy worked out for them and led them to victory. Because this was a voluntary club, ensuring students found it enjoyable was imperative, although this should be the case generally. I worked to choose tasks that brought out the joy of doing mathematics regularly.

The beauty of mathematics was on display in MATH Club. It is best illustrated in Sessions 16 through 19, when students completed a four-session project based on the Fibonacci sequence. In Session 16, students used manipulatives to unpack and begin to solve the famous word problem that led to the Fibonacci sequence. In the process of solving, students noticed the underlying structure and pattern and were able to solve the problem and determine the first 12 numbers in the sequence using this pattern. In Session 17, students recognized mathematical beauty in the natural world as they found the Fibonacci sequence in nature, such as in the number of petals on many flowers and the spirals in pinecones and seedheads. In Sessions 17 through 19, students worked carefully to use rulers and compasses to measure and represent beautiful Fibonacci rectangles and Fibonacci spirals. They added their creative designs and displayed their beautiful works of mathematical art. The beauty of mathematics was emphasized and experienced early and often in MATH Club.

Students' wonder for mathematics was drawn out regularly in MATH Club. For example, in Session 6, students engaged in a glow-in-the-dark geometry activity. They were intrigued when they saw glow sticks in the dark classroom. After having time to use the glow sticks to create triangles and quadrilaterals, relating to their background knowledge of polygons, students sat in a circle on the floor. I asked, "If we wanted to make a large pattern on the floor with repeating shapes, what shapes do you think we could use?" Students devised their ideas and then worked together to test them on the floor. They started by testing squares and then worked to create a giant lattice of glowing squares on the floor. Next, they worked to see if they could create a repeating pattern with triangles and found that they could. A student told the group he could see many hexagons made from triangles on the floor. I asked, "So, do you think you can make repeating hexagons? How can we use what we already have to make hexagons?" He showed the group how to remove the glow sticks inside a hexagon and use them to create a new one. Students also worked to complete this pattern, and one student even remarked that she thinks bees use hexagons in their hives because they fit together perfectly, and each side could be used for more than one hexagon. In this session, students had ideas about what might work to create repeating shape patterns and were allowed to explore these ideas, and through that, they were able to experience the wonder of mathematics. They were given plenty of similar opportunities to unveil the wonder of mathematics throughout their time in MATH Club.

Helping students see the joy, beauty, and wonder in mathematics was a critical component of MATH Club. Nearly every entry in my reflexive journal mentions at least one of these three. When we teach a class of students, the students are required to be there. However, in MATH Club, students were there by choice and could decide that it was not something they were interested in. Not only did I need to choose these types of tasks and activities to aid in developing students' positive mathematics identities, but I also needed to keep them returning for more. Therefore, I consistently and purposefully sought out activities emphasizing the joy, beauty, and wonder of mathematics.

Equitable Teaching Practices

Another critical component of MATH Club was the use of equitable teaching practices. In MATH Club, the mathematical competence of every child needed to be acknowledged and valued. NCTM (2020) recommends mathematical experiences that connect to children's backgrounds and interests, provide representation of diverse mathematicians, and enable all children to develop a deep understanding of mathematics through NCTM's (2014) eight effective mathematics teaching practices.

Several tasks used in MATH Club were selected or adapted for their connection to students' interests and backgrounds. For example, in Session 9, I chose a task that asked students to find all possible ways a necklace could be designed symmetrically using eight beads, with four beads of one color and four of another. I adapted this task to connect to students' interests and backgrounds. First, I introduced the idea of symmetry by showing students various symmetrical pieces of jewelry from a variety of cultures and asking what made them symmetrical. Students commented on the beauty of the pieces and demonstrated an understanding of symmetry. The MATH Club students were very interested in friendship bracelets, with boys and girls regularly wearing and trading bracelets. Therefore, rather than presenting this task as necklaces, I presented it as friendship bracelets. Students then used two colors of connecting cubes to create symmetrical designs, recorded their ideas on paper strips, and found every possible configuration. At the end of the session, students chose their favorite design and used their choice of beads to create their own bracelets. This task purposefully incorporated cultural elements and students' interests, as did several other tasks in other sessions of MATH Club.

Another essential component of equitable mathematics instruction is ensuring students see diverse representations of mathematicians. For example, in Sessions 14 and 15, we explored a book in NCTM's *Powerful Mathematicians Who Changed the World* series. *Knotting Numbers* (Thanheiser & Jessup, 2023) emphasizes the meaning of mathematics, diversity among mathematicians, and the value found in exploring various mathematical strategies. Students were introduced to and made sense of the Incan quipus, as well as Professor Marcia Ascher and her work exploring how different cultures used mathematics. As we read the book, students solved the mathematics task alongside the children in the story. They answered the questions on the pages, such as, "Women make up about half of the people who work. How much do you think they make up of people working in STEM jobs?" and "What do you think it means to do math?" When I asked students, "Who does mathematics?" in Session 15, I anticipated they would list career choices that are obviously mathematical. However, the response I got immediately was that everyone does math. I challenged and asked the group, "Is that true? Does everyone do math?" Students unanimously agreed and provided examples of why they believed this. This session was in the final quarter of MATH Club. It demonstrated that students were internalizing the conversations we had been having throughout MATH Club about the diversity of mathematicians.

Equitable teaching includes providing all students with the opportunity to develop a deep understanding of mathematics, particularly through using NCTM's (2014) effective mathematics teaching practices (MTPs). These mathematics teaching practices were integrated into my facilitation of every MATH Club session. This is well-demonstrated in Session 7, where students engaged in a sequence of tasks involving estimation. The first MTP is establishing mathematics goals to focus learning, and in this task, I set a goal of helping students develop strategies for estimation. The primary purpose of this task was to promote reasoning and problem-solving, which is the second MTP. Students were first presented with an image of a $\frac{1}{4}$ cup scoop of candy corn and were asked to estimate how many pieces of candy corn were in the scoop. They engaged in discourse with their groups about the meaning of estimation and their ideas about how many pieces there might be. Facilitating meaningful mathematical discourse is the fourth MTP. I asked students, “What number would you say is too few pieces of candy corn?” and “What would be clearly too many?” I was posing purposeful questions, the fifth MTP, to get students thinking about reasonableness and developing better estimates. After developing estimates, we were shown that there were 19 pieces of candy corn in the scoop. The following image in the sequence showed the scoop containing 19 pieces of candy corn next to a 4-pound bag. Students needed to estimate how many pieces of candy corn were in one bag. I noticed several groups listing that one piece of candy corn was not enough, and 999,999 pieces of candy corn was too much. I brought the group back together and shared what I noticed, asking if they thought that would help us develop a reasonable estimate or if those numbers were too broad and unhelpful. I said, “We know there are 19 pieces of candy corn in one scoop. Are there more than two scoops in the bag? Are there more than five? What is a reasonable amount for us to choose that is close but still not enough?” Rather than allowing students to become complacent in their work to avoid deeper thinking or saving them from having to think and telling them more accurate numbers, I supported students to engage in productive struggle, the seventh MTP. Once students had determined their estimates, we were provided with an image of the nutrition facts detailing the serving size of 19 pieces and a total of 47 servings in the 4-pound bag. Students then needed to determine how many pieces were in the bag to check their estimates, with some students using area models, some attempting to use the distributive property, a few using a standard algorithm for multiplication, and a few attempting repeated addition. I elicited and used evidence of student thinking, MTP eight, as I selected work from a third-grade student who used the distributive property to solve but had not quite figured out what to do with two 2-digit numbers and a fifth-grade student who accurately used an area model to solve for 893 pieces of candy corn. I presented their work side-by-side so students could see the differences and similarities, working to build procedural fluency through conceptual understanding, which is MTP three. In the third and final image in the sequence, students were shown the scoop of candy corn, the bag of candy corn, and an empty jar. They were asked to estimate how many pieces of candy corn would fit in the jar. A student suggested that the jar could hold half as many pieces of candy as the bag and drew an image of a rectangle with a line through the middle. Another student drew a representation of the jar and split it into different parts that they felt represented how much space one scoop would take up. They approached the tasks from various angles, and we talked as a group about what expressions could be represented by their drawings, utilizing MTP six, using and connecting mathematical representations. This task touched on all eight MTPs, which was not always the case in MATH Club. However, the MTPs were integrated into every MATH Club session.

Equity-Based Practices

In addition to the equitable teaching practices described by NCTM (2020), MATH Club focused on Aguirre and colleagues' (2013) equity-based practices for enhancing mathematics learning and fostering students' positive mathematics identities. These include "going deep with mathematics, leveraging multiple mathematics competencies, affirming mathematics learners' identities, challenging spaces of marginality, and drawing on multiple resources of knowledge" (Aguirre et al., 2013, p. 43).

Going Deep with Mathematics

Many tasks in MATH Club involved going deep with mathematics. For example, in Session 8, students engaged in a task describing a person who wants to build an animal pen using 40 cubes with no gaps or overlaps. They had to find how she could make a pen with the largest area inside for the animals to move around. This was a challenging task that required high cognitive demand. As students worked with grid paper and unifix cubes, allowing them to use various strategies and representations, it promoted students' development of conceptual understanding, procedural fluency, and problem-solving skills. When the first group created a pen with dimensions of 9 by 13, they solved for the area of 117 square units using the distributive property and recorded it on the board. Another group added their solution, a 10 by 12 pen with an area of 120 square units. Students then started to struggle to build rectangles with different dimensions, and a student noticed when looking at the solutions that had already been found that she could add them together, and they had a sum of 22. She decided to consider other pairs of numbers with a sum of 22 to see if she could find other dimensions that would work. After three more groups found solutions and recorded them on the board, I arranged the solutions into a table with columns for length, width, and area in square units. I placed them so the lengths gradually increased, as shown in Table 6. Students participated in discourse, examining the table and pointing out several things. They solved for two missing sets of dimensions between 5 by 17 and 8 by 14 by following the pattern they saw in the table. Students believed that whenever the length increased, the area also increased. To test their theory, I asked, “What would the width be if the length was 12?” Students realized it would be 10, and the area would be smaller than the rectangle with dimensions of 11 by 11. I asked, “What if we kept going?” Students then engaged in discourse with one another to make sense of the next several dimensions and areas. As I walked around the room, I asked students about the largest possible area, and they explained and justified their reasoning for why the 11 by 11 pen was the solution. This task allowed students to go deep with mathematics.

Table 6: Student Responses to Session 8 Task

Length (in units)	Width (in units)	Area (in square units)
5	17	85
8	14	112
9	13	117
10	12	120
11	11	121

Leveraging Multiple Mathematics Competencies

Throughout MATH Club, I leveraged multiple mathematics competencies so that students of all skill levels could contribute meaningfully. Students in MATH Club were very diverse in their mathematics performance, and tasks were carefully selected so that all students could engage. For example, in Session 3, students were presented with a game involving an enormous dart board. They divided into four teams to play the game and tossed bean bags to land on different numbers. There were also special spots within each wedge of a number that could double or triple the score. I worked to facilitate conversations about how students were solving for each round, mainly when they needed to double or triple their scores. While third-grade students had just recently learned single-digit multiplication and tended toward using the distributive property and drawings to solve, fourth-grade students preferred area models, and many fifth-grade students worked to solve mentally. Some students preferred to use repeated addition rather than multiply at all. These problem-solving strategies were acknowledged and valued, and students could work in whatever way made sense to them while collaborating with and learning from their team.

Affirming Mathematics Learners' Identities

Session 4 and 5's task on palindromes illustrates how I affirmed mathematics learners' identities through MATH Club. In this task, students were presented with a conjecture that stated that every number, when added to its opposite, would result in a palindrome. (For example, 16 + 61 = 77.) Students worked to determine whether or not that conjecture was true. Upon discovering that it was not, the conjecture was altered to say that any number added to its opposite would eventually result in a palindrome after however many steps necessary. (For example, 19 + 91 = 110; 110 + 011 = 121.) Students were provided with manipulatives and paper, so they had multiple ways to engage. There was a 100s chart where students would color code the numbers they used to find a palindrome based on how many steps it took, so all students could see how each problem they solved contributed to the group's goal of finding all the palindromes. By having them add to the chart that we were all working on collaboratively, every student could contribute, and the emphasis was not on how many each individual could solve. When students made mistakes, I responded in ways that helped them to see the mistakes as opportunities for learning by asking them guiding questions to help them feel successful and competent. As students solved and added to the chart, it instilled confidence in their abilities. Although my examples here are fairly small, the numbers get large for some of these as they take many steps to return a palindrome. It took students two sessions to complete the chart, aside from one set of numbers. At the end of Session 5, three students were very interested in solving how many palindromes it took for 98 and 89, which I told them they would not have time to complete in a club session. They returned at the following session with their solutions, showing how encouraged they were to engage in mathematics.

Challenging Spaces of Marginality

MATH Club belonged to the students of MATH Club, and I was simply the facilitator, challenging a traditionally very teacher-led space. For example, in Session 12, students worked to determine how many gifts were received in the 12 Days of Christmas song. Students were positioned as the experts and authority. As I played the song verse-by-verse, students worked to solve. Some students drew tally marks to keep track of the gifts, while others added the amounts. After every third verse, time was taken for students to explain their thinking. During the first pause, I purposefully selected students to share who I knew were more comfortable working with the smaller numbers at the song's beginning. At the second pause, a student demonstrated how she was no longer adding each day individually but adding the total from the previous day to the new amount. As the song got longer and the numbers became more complex, tally marks became time-consuming, and students talked about switching strategies. By allowing students to experience the journey of this task themselves and learn from one another, all students could make sense of efficient problem-solving strategies. Students felt agency and ownership over the tasks they were working with during MATH Club.

Drawing on Multiple Resources of Knowledge

With a diverse group of students comes a diversity of resources of knowledge. In MATH Club, I worked to pull ideas from students all over the room. For example, in Session 10, students engaged in physical movement tasks involving toilet paper. I chose these tasks because it was Field Day, and I wanted to connect to the students' excitement surrounding this day. Prior to the physical tasks, students measured a single square of toilet paper to find that it was four inches long. I said, "I wonder how many pieces of toilet paper it would take to make one foot." Students discussed this with one another. A third-grade student offered that one foot is 12 inches long, and a fifth-grader said that because $3 \times 4 = 12$, it would take three pieces. I asked, "Why did he multiply? How do we know if that is correct?" A third-grade student said that he agreed because he had added pieces from the students around him, and each piece is 4 inches long, so 4 + 4 + 4 = 12. I displayed both equations on the board, and students discussed what the numbers in each represented. We were able to connect multiple knowledge sources. We then moved into the first task, the long jump, where students all jumped as far as they could alongside a stretch of toilet paper. The farthest jumper had jumped the length of 15 squares of toilet paper. Students then worked to determine how far she jumped. When we discussed the solutions together, seven different students contributed to the conversation about how we could determine how many inches she jumped and how many feet she jumped. I called on different students to contribute based on their unique strengths, knowing they would contribute to the conversation in diverse ways.

In MATH Club, I incorporated tenants of Communities of Practice (Wenger, 1998), *Catalyzing Change*'s joy, beauty, and wonder of mathematics as well as equitable teaching practice (NCTM, 2020), and Aguirre and colleagues' (2013) equity-based teaching practices, as evidenced through the entries in my reflexive journal. Students were given reflection prompts at the end of each session, during which they could add their voices to this narrative. In the next section, I provide an analysis of those reflections.

Analysis of Student Reflections

Students' reflections provided insights into their thoughts and experiences during MATH Club. Students completed 17 reflections, all of which were completed at the end of MATH Club sessions. Through the open coding process, several themes emerged. These themes include the joy, beauty, and wonder of mathematics, engagement and participation, students' beliefs about themselves as mathematicians, students' beliefs about mathematics, and transformation.

Joy, Beauty, and Wonder

Students often reflected on the joy, beauty, and wonder of mathematics. Through the MATH Club sessions, students discovered fun in mathematical challenges and learned to recognize the mathematical beauty and wonder in art and everyday life.

Students wrote about how much they were enjoying mathematics. After Session 3, where students engaged in the enormous dartboard activity, they overwhelmingly expressed that they were discovering that mathematics could be fun, mentioning how they enjoyed playing darts and working with a team. Student 13 remarked, "The main idea I learned today was there is still fun in math." This sentiment indicates that perhaps he used to find mathematics fun, but as he got older, he began to lose that joy. This MATH Club session sparked something in him that helped him return to that enjoyment. After Session 6, in which students engaged in the glow-in-the-dark geometry task, students emphasized the fun and engaging aspects of this task compared to the perceived boredom associated with mathematics class activities. Student 5 expressed, "Glow-in-the-dark geometry is different from the geometry I do in math class at school because we just do math books and go on the computer in school." Similarly, Student 10 said, "In school, you have to sit and do work, and we don't do a lot of glow parties, but today was fun." By changing the medium through which they could engage with geometry and break away from the monotony of their daily tasks, students enjoyed learning mathematics. After Session 13, where students played a mathematics game where they rolled a die and tried not to have a sum over 999, they expressed that they enjoyed the challenge, had fun, and liked working together. Student 3 wrote, “Math is fun with you.” and drew a heart directed to me. Sentiments such as this show that not only were the tasks themselves helping students experience the joy of mathematics, but how I facilitated MATH Club was also helping students to find that enjoyment.

Students also reflected on the beauty of mathematics. In Sessions 17 and 18, sessions in which students worked on the Fibonacci projects, students compared mathematics to art and wrote about where they can find beauty in mathematics. After Session 17, students highlighted similarities between mathematics and art, such as using shapes, coloring, unique expression, the need for strategy, counting, and creating something “pretty.” After Session 18, students recognized mathematical beauty in nature, such as the hexagons in bee hives and symmetry in butterfly wings. They also mention shapes as containing beauty. Student 6 remarked, “Math is beauty. I love math.” She resonated with the idea of the beauty of mathematics, proclaiming that they are one and the same.

The wonder of mathematics was highlighted through students' reflections involving connections to their cultures and lives. After Session 9, where students made friendship bracelets using concepts of symmetry, students reflected on how they could use symmetry in their own lives. They emphasized how they could use symmetry for tasks like decorating their Christmas trees, making patterns, building with blocks, creating jewelry, and bringing joy to others. After Session 12, students wrote about how they would use mathematics during the winter break. They wrote about counting ornaments, presents, and cookies. They also mentioned engaging with fractions, both in baking and sharing cookies. Students understood that mathematics is not just something we do at school but a part of our everyday lives.

Engagement and Participation

Students' reflections provided insights into their thoughts on engagement and participation in mathematics. In particular, students remarked on collaboration and productive struggle.

Collaboration

Students reflect on an appreciation for teamwork several times throughout MATH Club. After Session 3, where students played the large darts game, they mentioned the enjoyment of working with a team. After Sessions 4 and 5, where students engaged in the palindromes task, students emphasized collaboration and teamwork. Student 3 remarked, "My group approached the problem set by working together, sharing answers, helping each other, being kind, and we can divide and conquer. I learned to work together." His response illustrates how vital collaboration was in this task. After Session 19, several students identified collaboration as their top mathematical strength, highlighting their ability to work with others.

Productive Struggle

Although students did not use the term "productive struggle," it was a concept that came up in many of their reflections. After Session 2, in which students completed the maze task, they expressed frustration, sadness, determination, and indifference to being unable to solve the puzzle on the first try. Upon finding a solution, they report a mix of positive emotions, including happiness, relief, and a sense of accomplishment. This was their first mathematics task in MATH Club, and for some students, it may have been one of their first experiences with a task that was not a more straightforward equation or word problem. All students had to make multiple attempts before correctly solving this task, providing them opportunities for struggle and grappling with the emotions involved in productive struggle. After Sessions 4 and 5, when students did the palindromes task, several emphasized that it was hard work. Student 12 reflected, "I learned that hard work can lead you to success." Her response shows how students were learning the value of productive struggle. After Session 19, several students highlighted perseverance through challenge as their top mathematical strength. Student 18 remarked, "I am good at trying even when it is hard." Students' reflections show that they value productive struggle.

Students' Beliefs About Themselves as Mathematicians

In their reflections, students often wrote about themselves in relation to mathematics. They wrote about their strengths on two occasions and frequently commented on things related to their sense of agency in mathematics.

Strengths

Students were asked about their strengths in mathematics after two different sessions. The first time was after Session 11. Students mentioned feeling confident in finding perimeter, solving challenging questions with assistance, addition, understanding area models for multiplication, multiplying and dividing fractions, and one expressed love for division. Their responses this first time were all skill-based strengths, leading me to spend more time in MATH Club exploring the meaning of mathematics with them. After Session 19, students' responses about their strengths had shifted. They expressed their strengths in problem-solving and collaboration. They highlighted their abilities to solve problems in unique ways, work with others, and use mathematics as an organizational tool. They also acknowledged perseverance and effort when faced with challenging mathematics tasks. Students demonstrated an understanding of what it means to do mathematics and where they felt successful in mathematics.

Agency

Students demonstrated their agency in mathematics when they reflected on how they could use mathematics in ways that made sense to them during MATH Club. After Session 7, when students did the estimation task, they reflected on their good ideas that day. Students mentioned various strategies that helped them estimate, including counting parts, using addition and multiplication, and reflecting on what is too much or not enough. In their reflections, it is clear that they perceive that their ideas, not those of the facilitator, helped them to estimate. After Session 14, Student 5 remarked, “Her did it a different way than I did and got the same answer,” and Student 10 wrote, “Everybody doesn’t do the same thing.” Students recognized that there are many strategies available to solve mathematics problems, and people, including themselves, can choose whatever way makes sense to them. After Session 19, several students said that their ability to solve problems in unique ways was their top mathematical strength. Student 6 remarked, “I am good at solving problems in my own way.” Students showed mathematical agency through their reflections on how various strategies are acceptable and how choosing a strategy that makes sense to oneself is useful in mathematics.

Students’ Beliefs About Mathematics

Students’ reflections occasionally brought out their understanding of the nature of mathematics. When asked about their struggles in mathematics after Session 10, students mentioned that they were struggling with challenges related to multiplication, division, and fractions. Some students mentioned concerns about balancing schoolwork with personal interests such as coloring or talking with friends. There was also mention of struggling with complex problems. After Session 11, they wrote about their strengths and mentioned only skills-based strengths, as described earlier. These reflections led me to spend more time ensuring students better understood the meaning and purpose of mathematics. After Session 15, students consistently suggested that mathematics is a way to make sense of the world. They also highlighted its role in understanding relationships and structure. They mention using various strategies with numbers and operations such as addition, subtraction, multiplication, and division. Mathematics is seen as a subject that involves asking questions, explaining, and solving problems. Students unanimously indicated that everyone engages in mathematics, with Student 18 saying, “All the people all world” do mathematics. After Session 19, they listed their strengths in mathematics and no longer listed concepts and skills but instead listed things such as collaboration, using various strategies, perseverance, and problem-solving. This suggests that their beliefs about mathematics shifted during MATH Club.

Transformation

Students reflected on how they were or were not changing through MATH Club on two occasions. After Session 8, Student 4 remarked, “MATH Club has changed the way I feel about math. I used to play around all day long. Now, I’m paying attention.” He noted an improvement in his focus in mathematics class. Student 9 wrote, “I used to not feel that comfortable. Now I feel nice.” Her reflection shows an improvement in her confidence. Student 11 emphasized, “I used to hate math. Now, I’m starting to like it.” Her enjoyment of mathematics was beginning to grow. Students mostly expressed a positive shift, transitioning from finding mathematics difficult or unenjoyable to feeling confident, happy, and even loving mathematics. Several students noted improvements in their mathematics skills, and they attribute this to the engaging and enjoyable activities in MATH Club. A few students mentioned no significant change. However, they commented that they already felt good about mathematics before joining MATH Club, which had not changed.

After Session 16, students again reflected on this topic. Student 15 remarked, “I used to think math was boring, and I didn’t like it. Now, it’s so good. I like math more with you.” She points to my facilitation of MATH Club as the reason she finds joy in mathematics. Most students expressed positive changes in their perceptions of mathematics. Many expressed that mathematics had become easier, enjoyable, and even fun through the engaging activities in MATH Club. Some mentioned a shift from finding mathematics boring to now considering it interesting, while others mentioned increased confidence and recognition of its importance to their lives. One student mentioned no change; however, they still mentioned a positive attitude toward mathematics. Every student had something positive to say when reflecting on their transformation through MATH Club.

The student reflections provided insights into students' thoughts and beliefs while present in MATH Club. An outside perspective is gained when analyzing interviews with their classroom mathematics teachers.

Analysis of Teacher Interviews

The teachers were interviewed a few weeks after MATH Club started and again shortly after it ended. The teacher interviews were useful in describing MATH Club students as perceived by their mathematics teachers and any noticeable changes during their time in the club. The transcripts of the interviews were analyzed using open coding techniques, and several recurring themes emerged. These fell under the categories of student engagement and participation, teachers' beliefs about the students as mathematicians, and student transformation.

Engagement and Participation

Teachers consistently spoke about how students engaged with mathematics and participated in the classroom. Their comments fell under two subcategories: collaboration in mathematics tasks and discussions, and productive struggle with challenging tasks.

Collaboration

During the initial interview, teachers described varying levels of comfort with collaboration in mathematics. Some students actively engaged in collaborative discussions, even taking on leadership roles. They were described as students who explain their thinking and provide cohesion in their groups. On the other hand, some students struggled to actively participate in collaborative mathematics discussions. Factors such as mood, perceived skill levels of their partners, confidence, and individual personalities were said to influence the extent to which these students would collaborate. Teacher A described Student 1, saying,

> If he is with someone who is pretty much at his level, they will collaborate and discuss. But if he's with someone who is too much lower than him, then he gets frustrated, and he will just find the answer and basically be like, "Here, this is the answer."

Most students described as being in the perceived highest performance group handled collaborative tasks this way. On the other hand, Teacher D describes Student 10's participation in collaborative groups by saying, "She shrinks back and lets other people do it." Teachers tended to describe students perceived as struggling the most in mathematics as fairly non-participative in collaborative mathematics and attributed this to a lack of confidence.

During the final interview, most students were described as actively engaging in collaborative mathematics discussions, sharing their reasoning and suggesting solutions. Teacher A described Student 2, saying, "It doesn't matter which partner he has, he will, they'll talk about what they're doing, why they came up with that answer, he will make suggestions. He's good at that." Teachers mentioned students' willingness to listen to input from peers and consider alternative strategies. Teacher B described Student 7's participation in collaborative discussions, saying,

> She also is really good about discussing her answers. Whether they are right or wrong, she is going to try to discuss them and work through them. And she doesn't get offended if someone combats her or disagrees with her; she tries to understand both sides, which I think is a good quality to have in a math discussion.

Several students were described as calm, cooperative, and encouraging in their mathematics discussions. A few students were described as not engaging well in collaborative discussions due to varying obstacles. However, most students were doing well with collaborative mathematics discussions, and many showed improvements in this area after participating in MATH Club.

Productive Struggle

In the initial interviews, students were described as having varying mathematics effort levels. Some students were described as tending to rush through assignments, while others were praised for their perseverance and hard work. Teacher F described Student 13, remarking,

> He tends to rush because he does know how to do it; he tries to do it in his head or he tries to skip steps. He just, because he is bright in math, he tends to rush it and make simple mistakes.

Several students were described in this way, where they were not engaging in productive struggle because they did not take time to consider the tasks, or perhaps the tasks they were being presented with were not complex enough to induce productive struggle. When faced with challenging tasks, some students were described as continuing to put forth effort and be diligent in carefully solving the task at hand. In contrast, other students would shut down or defer to other collaborative group members. Teacher E described Student 12, stating:

> If she doesn't see it straight away, she gets stuck, and she is right at my side, immediately wanting help, where she doesn't have that perseverance. Sometimes, she gets really frustrated, and she will shut down a little bit, and you have to walk her through it and build up her confidence.

Like several others, this student would put up a wall when a task became too challenging.

In the final interviews, teachers still described varying levels of effort, but many more students were willing to try, even when faced with challenges. Teacher A said about Student 5, "She doesn't always get it right, but she does try. Her strength is that she tries." Most students were described as persistent and hardworking. Teacher F described Student 15: "She puts a lot of effort in. She doesn't always understand what is going on, but she does put effort in." There were instances where some students struggle to put forth effort, particularly with a few of the highest achieving students who were less willing to return to a problem they have solved incorrectly and try again. One student was described as having become disinterested in all subjects and not putting forth effort in mathematics. However, overall, members of MATH Club tended to put forth a lot of effort and willingness to try.

Teachers' Beliefs About Students as Mathematicians

Teachers also described their beliefs about the students as mathematicians. These included beliefs about the students' mathematical ability based on their performance and how confident they perceived students to be in relation to mathematics.

Mathematics Performance

In the interviews, teachers identified students' mathematics abilities by describing levels of achievement, such as low, low-middle, middle, high-middle, and high. There were 22% of MATH Club students described by teachers as a part of the highest category, consistently demonstrating strength in mathematics and needing little assistance to perform well. The high-middle group, composing 28% of MATH Club, consisted of students who were described as tending to perform well in mathematics but occasionally needing support. An additional 28% of the MATH Club students were identified as being in the true middle category and described as capable of performing in mathematics with support. The low-middle group, comprised of 11% of MATH Club students, demonstrated moderate mathematics proficiency but faced challenges. Finally, the students perceived to be in the lowest category were those who faced the most significant challenges in mathematics performance and were working significantly below grade level. They were described as needing rigorous support and intervention in mathematics and made up 11% of the MATH Club population. Performance in mathematics was not a factor considered when recruiting and selecting students for MATH Club. However, it so happened that a diverse mixture of students was selected.

Teachers described a variety of student strengths and areas for growth. In the initial interview, several students were described as exhibiting strong foundational skills and a deep understanding of mathematical concepts. A few were described as strong at identifying patterns within numbers, while others were good at explaining and justifying their thinking. Some students were commended for their proficiency with specific mathematics skills. Teachers described challenges for students to include foundational skills, focus, confidence, and application of strategies. Some students were described as struggling with reading and vocabulary, contributing to difficulty in solving word problems. Teacher E described Student 12, saying, “She does struggle. Her basic skills she struggles with, but she also lacks a lot of confidence. So I think if her confidence was built up a little bit, that would help her performance as well.” Lack of confidence was identified as an issue for several students, and anxiety for one student. Their collaboration skills varied, with some needing support in that area.

In the final interview, teachers described diverse strengths and areas for growth. Some students were praised for their quick understanding, others for their collaboration skills, effort, foundational skills, or confidence. Teachers also described specific mathematics skills that students were performing well with. Teacher C described Student 9’s strengths, saying:

> She is amazing at multiplication and division, and she has been doing really, really well with establishing the patterns that we have been working on and figuring out the two-step word problems. She has been really awesome at figuring out what the first thing she needs to do is and what the second thing she needs to do is, and her solution statements, making sure it matches what the question is asking.

Regarding areas for growth, some students were described as struggling with focus, overconfidence, mathematical vocabulary, or word problems. Teacher A spoke about Student 5, relaying:

> Because she is such a poor reader, she needs everything read to her. Everything. And that's a huge obstacle because I can't sit next to her all the time. One of the biggest obstacles for her is her inability to read.

Several students were described as struggling with reading comprehension, impacting their ability to solve mathematics word problems.

Confidence

Confidence is a topic that came up frequently in the initial interviews. Students were described as expressing varying levels of confidence in mathematics, with some described as over-confident and others as insecure. Teacher A described Student 1, saying, "He is sometimes overly confident. I think he needs to just slow down a little bit and to now always assume that he knows the answer." Students described as overly confident were the same ones who were said to understand concepts fairly quickly and tend to rush through problems and make small mistakes. Alternatively, students described as lacking confidence were mostly the same students described as lacking foundational skills. Teacher D described Student 10, elaborating:

> I think she is worried if she is going to get it wrong and so forth like that. I think when she feels confident that she understands it, she is more willing to take a risk and possibly maybe getting it wrong. I think she is afraid to take that risk. What I usually do with her is when I approach her or ask her a question, it is something I know she will be successful on to try to boost her confidence. She needs a boost of foundational skills and confidence that she can do it.

Students like her, who were described as lacking confidence, were said to be hesitant, nervous, or experience frustration when faced with complex tasks.

In the final interview, confidence continued to be a topic teachers were eager to discuss. Some students continued to be described as overconfident, which caused problems in which they would rush through their work. Other students were described as growing in their confidence in themselves and their mathematics ability. Teacher E described Student 12, remarking:

> She seems a little more confident than she was at the beginning of the year. But like I said, at the beginning, confidence was a huge issue. She is becoming a better math student just because she has built some of her confidence.

Several teachers attributed students' growing confidence to their participation in MATH Club. Teacher C said of Student 8:

> Honestly since he has been in the club, he is way more confident in math now. He used to second guess himself a lot, and I have noticed even just in this last unit, he is not needing me to look at what he is doing as much. He is more like, he feels so confident in himself he doesn't feel the need to be like, "Teacher C, can you, did I get this right?"

Teachers remarked that students were more empowered and felt pride in their accomplishments. About Student 9, Teacher C said:

> She has become way more confident in math. Like, oh my gosh, she, like, was so excited for me to come and look at her paper every time I walked around. She's just so confident, whereas before it would be like, she would kind of cover it and be like, "I'm not ready, don't look yet." And now she is like, "Can you come here? You didn't see number five." Like, look at it and tell me it's good.

In the final interviews, there was no mention of students who lacked confidence.

Transformation

During the final interview, the topic of students' transformations came up frequently. Of the students, 50% were directly described as having undergone a positive transformation due to being in MATH Club. They were described as having grown in their mathematics performance. For example, Student 2 was said to have grown in his mathematics ability since being in MATH Club, with Teacher A stating that he was "really getting it." They were said to have become more confident, engaged, and willing to participate. Teacher F described Student 17's transformation, noting that his focus, proficiency, self-confidence, and mathematics ability had improved. Student 5 was described by Teacher A as putting forth more effort than she was prior to MATH Club, gaining more confidence in mathematics, and expressing joy and pride when she could solve mathematics problems successfully. Students were described as better collaborators than before and seemed to have a more positive attitude towards mathematics. For example, Student 3 was described as having improved in his collaboration skills after being in MATH Club. In the initial interview, Teacher A described him as a student who would take the lead and not accept suggestions from partners. However, this was no longer the case as he engaged in true collaboration by the final interview. Teacher B reported that Student 7 seemed to enjoy mathematics more after being in MATH Club. One student is described as declining in these areas. However, the teacher noted that this was happening in all subject areas and was believed to be related to factors the student faced outside school. Most students were described as having positive attitudes toward mathematics and remaining that way or having made a positive change in that direction through MATH Club.

Analysis of Student Surveys

Students answered a 45-item survey during the first and final sessions of MATH Club regarding their beliefs and attitudes towards mathematics. The survey questions were designed to describe their development of mathematics identity.

Pre-Survey

Students initially completed the survey during Session 1 of MATH Club. The overall mean score, *M* = 3.48, *SD* = 0.59, showed that students were in the mid-range regarding their mathematics identity scores. When examining the different aspects of mathematics identity, students' highest scores were in their enjoyment of mathematics, *M* = 3.81, *SD* = 0.99, then beliefs about the usefulness of mathematics, *M* = 3.53, *SD* = 0.50, followed by their perceptions of their mathematics ability, *M* = 3.47, *SD* = 1.02, then their feelings of belongingness in the community of doers of mathematics, *M* = 3.37, *SD* = 0.61, followed by their development of growth mindset, *M* = 3.33, *SD* = 0.78, and the lowest scores were in their future aspirations in mathematics, *M* = 3.20, *SD* = 0.62.

Students in MATH Club were identified demographically using information provided to the school by their families. During my analysis of their scores, I noticed that students' scores across the board were in the mid-range; however, the scores of the students identified as boys were higher than those identified as girls. When comparing the pre-survey mean scores of the girls versus the pre-survey mean scores of the boys, results of the independent samples *t*-test suggested there was a statistically significant difference in the pre-survey mean scores of the girls, *M* = 3.12, *SD* = 0.51, and those of the boys, *M* = 3.83, *SD* = 0.45, $t(16) = 3.14$, $p_2 = .006$, with a large effect size, *d* = 1.48. Based on this survey, the boys in the club demonstrated more positive beliefs about their mathematics identities than the girls.

Post-Survey

Students completed the survey for the second time during Session 20 of MATH Club. The overall mean score, *M* = 4.26, *SD* = 0.49, showed that students scored in the higher range regarding their mathematics identity scores. When considering different aspects of mathematics identity, students scored highest in their beliefs about the usefulness of mathematics, *M* = 4.63, *SD* = 0.64, then their enjoyment of mathematics, *M* = 4.48, *SD* = 0.52, followed by their future aspirations in mathematics, *M* = 4.15, *SD* = 0.68, then their development of growth mindset, *M* = 4.14, *SD* = 0.52, followed by feelings of belongingness in the community of doers of mathematics, *M* = 4.11, *SD* = 0.61, and the lowest scores were in their perceptions of their mathematics ability, *M* = 3.83, *SD* = 0.90.

When I examined the boys' and girls' scores this time, I noticed that both were in the higher range (as compared to the pre-survey); however, the boys' scores were still slightly higher than the girls'. When comparing the post-survey mean scores of the girls versus the post-survey mean scores of the boys, results of the independent samples *t*-test suggested there was no longer a statistically significant difference between the scores of the girls, *M* = 4.07, *SD* = 0.53, and those of the boys, *M* = 4.44, *SD* = 0.39, $t(16) = 1.71$, $p_2 = .107$, with a moderate effect size, $d = 0.80$. This means that based on this survey, there was no significant difference in boys' and girls' positive mathematics identity beliefs at the end of MATH Club.

Comparing Pre- and Post-Surveys

When comparing the pre-survey mean scores versus the post-survey mean scores, results of the correlated samples *t*-test suggested that there was a statistically significant increase from the pre-survey mean scores, *M* = 3.48, *SD* = 0.59, and the post-survey mean scores, *M* = 4.26, *SD* = 0.49, $t(17) = 6.12$, $p_1 < .001$, with a large effect size, $d = 1.44$. Based on the survey results, students' positive mathematics identity beliefs significantly improved after being members of MATH Club, and MATH Club significantly impacted this improvement.

In Figure 3, a box-and-whisker plot represents the students' pre- and post- mean scores on the survey. It shows the range of student scores as well as the mean. Each section of a box-and-whisker plot represents one quartile of students' scores, with the upper "whisker" representing the quartile of students with the highest mean scores, the box representing the middle 50% of scores, split to show both quartiles, and the bottom whisker representing the quartile with lower scores. Dots above or below the whiskers represent outlier scores. The *x* represents the mean of the mean scores.

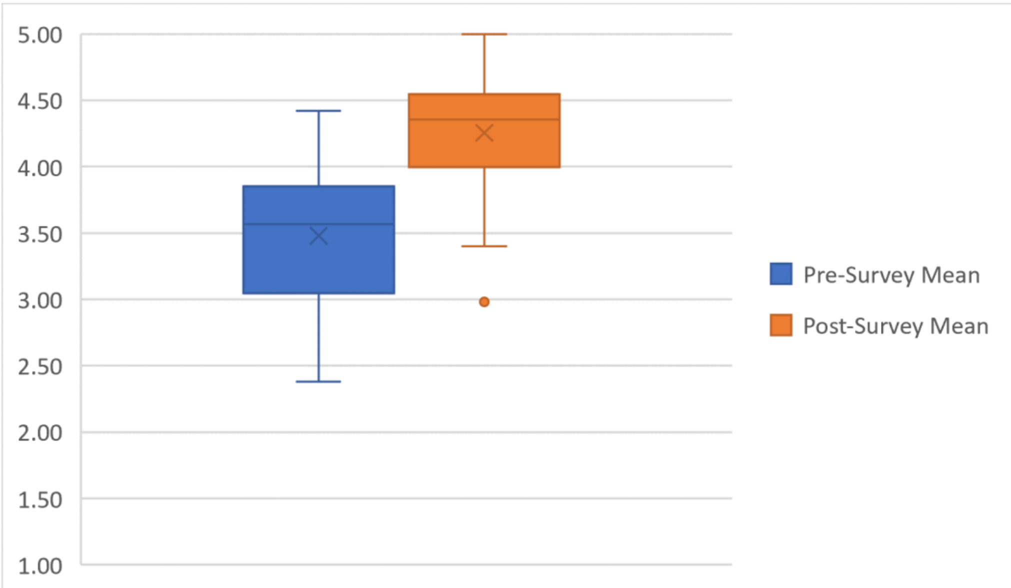

Figure 3: Pre- and Post-Survey Mean Scores

Analysis of Individual Aspects of Mathematics Identity

The survey covered six aspects of mathematics identity. Students' scores in each category were also averaged and compared using correlated sample *t*-tests. Figure 4 shows mean scores for these aspects in a box-and-whisker plot with pre- and post- scores side-by-side.

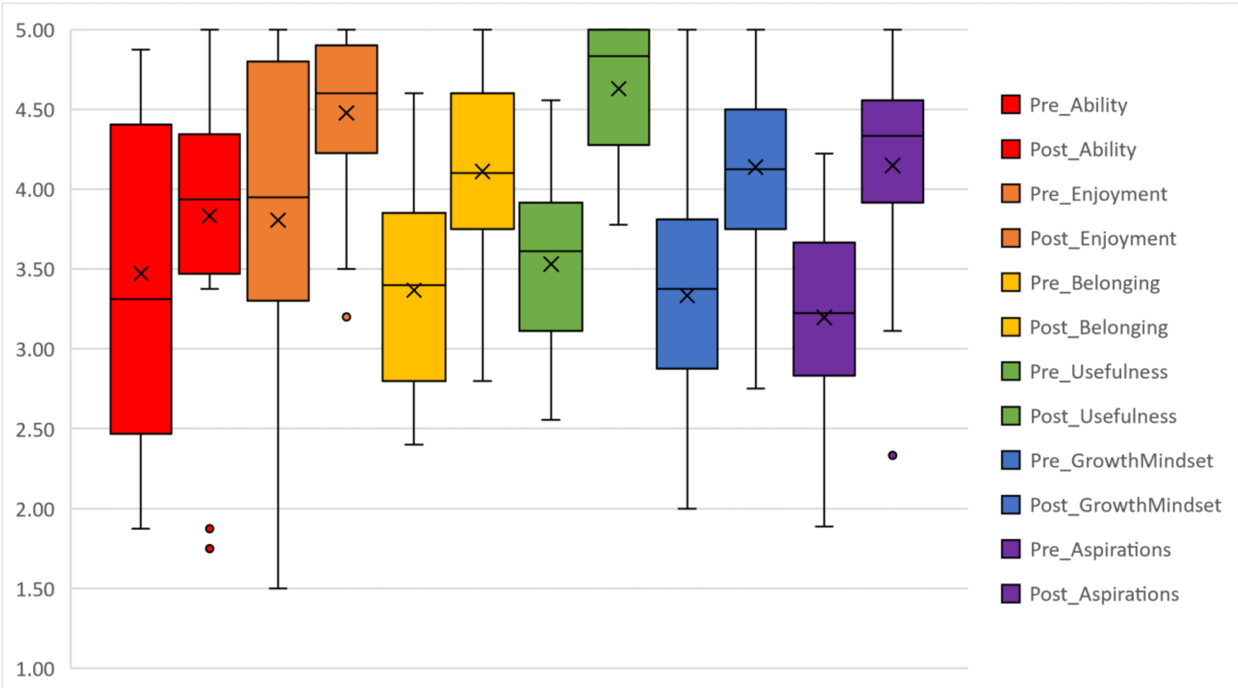

Figure 4: Mean Scores of Individual Aspects of Mathematics Identity

Self-Perception of Mathematics Ability

Students selected to what degree they agreed with eight statements about their mathematics ability, for example, "Math is very hard for me" or "I am really good at math." When comparing the pre-survey mean scores on student perceptions of mathematics ability versus the post-survey mean scores, results of the correlated samples *t*-test suggested that there was a statistically significant increase from the pre-survey mean scores, $M = 3.47$, $SD = 1.02$, and the post-survey mean scores, $M = 3.83$, $SD = 0.90$, $t(17) = 2.21$, $p_1 = .02$, with a small effect size, $d = 0.37$. This means that students' perception of their mathematics ability significantly improved after being in MATH Club; however, based on the small effect size, the overall impact of MATH Club on their perception of their mathematics ability was relatively minor.

Enjoyment of Mathematics

Students also selected how much they agreed with 10 sentiments about the enjoyment of mathematics, such as "Solving math problems is fun" or "Math is boring." When comparing the pre-survey mean scores on students' enjoyment of mathematics versus the post-survey mean scores, results of the correlated samples *t*-test suggested that there was a statistically significant increase from the pre-survey mean scores, M = 3.81, SD = 0.99, and the post-survey mean scores, M = 4.48, SD = 0.52, $t(17)$ = 3.41, p_1 = .002, with a moderate effect size, d = 0.85. This shows that students' enjoyment of mathematics significantly improved after being in MATH Club, with a moderate effect size suggesting that MATH Club likely contributed to this improvement in students' attitudes towards mathematics as enjoyable.

Belongingness to the Community of Doers of Mathematics

On the survey, students ranked their agreement with five statements, such as, "I think of myself as a math person," concerning their sense of belongingness to the community of doers of mathematics. When comparing the pre-survey mean scores on student feelings of belongingness to the community of doers of mathematics versus the post-survey mean scores, results of the correlated samples *t*-test suggested that there was a statistically significant increase from the pre-survey mean scores, M = 3.37, SD = 0.61, and the post-survey mean scores, M = 4.11, SD = 0.61, $t(17)$ = 3.67, $p_1 < .001$, with a large effect size, d = 1.21. These results indicate that students' feelings of belongingness significantly improved after being in MATH Club, and the large effect size underscores the impact of MATH Club on this improvement.

Beliefs About the Usefulness of Mathematics

Students responded to nine statements about the usefulness of mathematics, for example, "Math is important in the real world" and "I don't expect to use math much once I get out of school." When comparing the pre-survey mean scores on student beliefs about the usefulness of mathematics versus the post-survey mean scores, results of the correlated samples *t*-test suggested that there was a statistically significant increase from the pre-survey mean scores, M = 3.53, SD = 0.5, and the post-survey mean scores, $M = 4.63$, $SD = 0.64$, $t(17) = 10.24$, $p_1 < .001$, with a large effect size, $d = 1.92$. These findings show that students significantly improved their beliefs about the usefulness of mathematics, primarily attributed to their experiences in MATH Club.

Development of a Growth Mindset

Four statements regarding growth mindset were presented to students in the survey, such as "My intelligence is something I can't change very much." When comparing the pre-survey mean scores on the development of growth mindset versus the post-survey mean scores, results of the correlated samples *t*-test suggested that there was a statistically significant increase from the pre-survey mean scores, $M = 3.33$, $SD = 0.78$, and the post-survey mean scores, $M = 4.14$, $SD = 0.56$, $t(17) = 4.39$, $p_1 < .001$, with a large effect size, $d = 1.19$. These results indicate that students significantly improved in their development of a growth mindset, and due to the large effect size, this improvement can be attributed to the time they spent in MATH Club.

Future Aspirations in Mathematics

Finally, students selected to what extent they agreed with nine statements regarding their future aspirations in mathematics, such as "I plan to use math in my future career" and "I plan to take as few math classes as possible in middle and high school." When comparing the pre-survey mean scores on students' future aspirations in mathematics versus the post-survey mean scores, results of the correlated samples *t*-test suggested that there was a statistically significant increase from the pre-survey mean scores, $M = 3.20$, $SD = 0.62$, and the post-survey mean scores, $M = 4.15$, $SD = 0.68$, $t(17) = 4.34$, $p_1 < .001$, with a large effect size, $d = 1.46$. This means that MATH Club significantly impacted students' future aspirations in mathematics.

In summary, the student surveys provide insight into the impact of MATH Club on students' mathematics identities. Initially, students exhibited moderate scores across various aspects of mathematics identity, with statistically significant differences between boys and girls. After 20 MATH Club sessions, their scores significantly improved, indicating a shift towards more positive beliefs and attitudes towards mathematics. Students' perceptions of their mathematics ability, enjoyment of mathematics, sense of belongingness in the mathematics community, beliefs about the usefulness of mathematics, future aspirations in mathematics, and development of growth mindset all significantly increased. These findings underscore the transformative influence of MATH Club on students' development of positive mathematics identities. The narrowing gap between boys' and girls' scores by the final survey also highlights its potential contribution to equity and inclusion.

Triangulation of Data

When examining across all data sets, several common themes emerge. Joy, beauty, and wonder can be seen in the reflexive journal, student reflections, and the student survey. Beliefs about students as mathematicians are analyzed through teacher interviews, student reflections, and student surveys. The reflexive journal, teacher interviews, and student reflections offer insight into collaboration. Productive struggle is highlighted in the reflexive journal, teacher interviews, student reflections, and student surveys. Transformation is showcased through teacher interviews, student reflections, and student surveys. By analyzing these themes across multiple data sources, we gain greater insight into how these played a part in students' experiences in MATH Club.

Joy, Beauty, and Wonder

When considering multiple data sources, including my reflexive journal, student reflections, and student surveys, there is evidence of how the joy, beauty, and wonder of mathematics were effectively showcased in MATH Club, contributing to the development of students' positive mathematics identities. The reflexive journal entries documented sessions where students experienced the joy, beauty, and wonder of mathematics through engaging activities in which they could explore, be curious, make connections, and appreciate mathematical beauty. Students' reflections echoed these sentiments, highlighting their enjoyment of MATH Club activities, recognition of mathematical beauty in nature and art, and the wonder of how mathematics is connected to their everyday lives. Moreover, student surveys revealed a statistically significant increase in students' enjoyment of mathematics and students' beliefs about the usefulness of mathematics, underscoring the effectiveness of MATH Club in fostering positive attitudes towards mathematics. Together, these findings demonstrate a consistent pattern of students experiencing joy, appreciating beauty, and expressing wonder in mathematics, affirming the role of my facilitation of MATH Club in cultivating positive mathematics identities among the students.

Beliefs About Students as Mathematicians

Considering the data across multiple sources provides insight into beliefs about students as mathematicians during and after MATH Club. Student reflections revealed evolving perceptions of their strengths in mathematics, with students initially emphasizing skill-based strengths and later transitioning to recognition of things like problem-solving and collaboration as their strengths. Moreover, students expressed their agency by reflecting on their ability to use various strategies that made sense to them. Teacher interviews provide third-person insight into beliefs about students as mathematicians, including beliefs about mathematical performance and confidence. Teachers described a spectrum of performance levels among students, ranging from high proficiency to students facing significant challenges. Several students were described as improving in their mathematics performance. Teachers could describe the mathematical strengths of all students, regardless of the mathematical performance level they attributed to the students. Additionally, teachers highlighted varying levels of confidence among students, with some being overly confident and others lacking confidence, impacting their mathematics performance. Several students who lacked confidence before MATH Club were described as becoming more confident after being in MATH Club, with no students described as lacking confidence during the final interviews. The survey data supports these findings, indicating statistically significant improvements in students' perceptions of their mathematics ability, feelings of belongingness to the mathematics community, future aspirations in mathematics, and development of a growth mindset after participating in MATH Club. These findings collectively show that while students were all working at varying performance levels in mathematics, the affirming environment of MATH Club contributed to improved beliefs about themselves as mathematicians and aided in the development of positive mathematics identities.

Collaboration

We can understand how my facilitation of MATH Club influenced student collaboration in mathematics by looking across multiple data sources. My reflexive journal highlights the intentional integration of collaborative mathematics teaching practices throughout every session. Students were positioned as experts, encouraged to engage in discourse, and empowered to explore various strategies collaboratively. This approach fostered students' sense of mathematical agency and ownership, allowing them to learn from one another. Student reflections echo the importance of collaboration, with several students emphasizing teamwork and the enjoyment of working together. Their reflections illustrated how collaboration aided in problem-solving and contributed to their experiences. Moreover, teacher interviews provide insights into students' varying comfort levels and participation in collaborative mathematics discussions in the regular classroom. While some students actively engaged in discussions before MATH Club, others struggled to participate due to factors like confidence levels and perceived skill differences among group members. The final interviews revealed notable improvements in students' collaborative skills after participating in MATH Club. Most students were described as actively engaging in discussions and listening to peers' input. Despite some students continuing to be described as facing obstacles to collaboration, the overall trend showed growth in this area. Collectively, the data underscores the significance of collaboration in MATH Club and its positive impact on students' skills in this area, impacting their development of positive mathematics identities.

Productive Struggle

When considering multiple data sources, productive struggle is a common theme. My reflections highlight the intentional selection of tasks that promote deep mathematical thinking and challenge students to engage in productive struggle. My approach to facilitating productive struggle involved guiding students through purposeful questioning when they needed support rather than directly showing them how to solve. Student reflections further emphasized the value of productive struggle. Students highlighted the importance of hard work and perseverance in overcoming obstacles and achieving success in mathematics. Teacher interviews revealed varying levels of effort and perseverance among students in their regular classroom environments. In the initial interviews, some students were described as tending to rush through assignments or shut down when faced with challenging problems, while others demonstrated persistence in problem-solving. However, by the final interviews, there was a notable improvement in students' willingness to try, even when faced with challenges. Most students were described as hard-working and persistent, indicating a positive shift in their ability to engage in productive struggle after being in MATH Club. Finally, the data from student surveys showed a statistically significant improvement in students' growth mindset development, aligning well with the productive struggle described in the other data sources. The data supports the significance of fostering productive struggle as a vital part of MATH Club. By providing students with opportunities to engage in challenging tasks, persevere through struggle, and reflect on their experiences, MATH Club promoted a growth mindset and contributed to developing students' positive mathematics identities.

Transformation

The triangulation of data from student reflections, teacher interviews, and student surveys provides a comprehensive understanding of the transformational impact of MATH Club on students' mathematics identities. Student reflections consistently highlighted positive changes in their perceptions of mathematics due to their participation in MATH Club. Students expressed increased confidence, enjoyment, and appreciation for mathematics, with many noting improvements in their skills and attitudes towards mathematics. Teacher interviews corroborate these reflections, with teachers describing observable transformations in students' mathematical performance, confidence, engagement, and collaboration skills. Teachers reported that students who previously struggled or lacked confidence in mathematics had shown notable improvement and growth, attributing these positive changes directly to their participation in MATH Club. The findings from student surveys provide quantitative support for the observed transformations. Not only did students' mean scores increase in a statistically significant manner overall, but every aspect of mathematics identity measured on the survey had a statistically significant increase. This validates the accounts from student reflections and teacher interviews, confirming the positive impact of MATH Club on students' mathematics identities. Overall, MATH Club effectively cultivated the development of students' positive mathematics identities.

Summary

In this chapter, I analyzed data from my reflexive journal, student reflections, teacher interviews, and student surveys. I then triangulated this data. The reflexive journal offered insights into MATH Club, including task selection and facilitation of the club as a community of practice integrating the joy, beauty, and wonder of mathematics and equitable teaching practices. Student reflections and student surveys provided data about students' experiences, attitudes, and mathematics identity development. Teacher interviews offered an outside perspective of the students and how they engaged with mathematics outside of MATH Club. By examining within and across all data sources, I was able to answer the research question regarding how students' participation in a strengths-based MATH Club that I facilitated using equitable teaching practices impacted their development of positive mathematics identities.

CHAPTER FIVE: DISCUSSION

Introduction

This chapter discusses the findings presented in chapter four, the strengths and limitations of this study, implications for policy and practice, recommendations for my school and district, and recommendations for future research. The purpose of this study was to understand how participation in Mindful Approaches, Transforming Hearts (MATH) Club, a Community of Practice that incorporated equitable teaching practices and promoted the joy, beauty, and wonder of mathematics, influenced the development of students' mathematics identities. This work was guided by theoretical frameworks of Communities of Practice (Wenger, 1998) and Figured Worlds (Holland et al., 1998), as well as conceptual frameworks focusing on recommendations from *Catalyzing Change in Early Childhood and Elementary Mathematics: Initiating Critical Conversations* (NCTM, 2020) and *The Impact of Identity in K-8 Mathematics Learning and Teaching: Rethinking Equity-Based Practices* (Aguirre et al., 2013). Data collected included my reflexive journal, student reflections, teacher pre- and post-interviews, and student pre- and post-surveys. Data were collected over approximately four months and across 20 MATH Club sessions.

Discussion of Findings

This study illuminated findings related to cultivating students' development of positive mathematics identities. This was achieved by facilitating a Community of Practice, exploring the joy, beauty, and wonder of mathematics, and integrating equitable teaching practices.

Cultivating Students' Development of Positive Mathematics Identities

Through my facilitation of MATH Club and their participation, students improved in their development of positive mathematics identities. Mathematics identity consists of engagement and participation in mathematics, students' beliefs about themselves as mathematicians and the nature of mathematics, sociocultural contexts, and students' experiences within the mathematics community.

Engagement and participation in mathematics-related activities, particularly collaborative mathematics activities, play pivotal roles in identity development (Black et al., 2010; Wenger, 1998). Students regularly engaged and participated in these activities in MATH Club, which led to improved engagement and participation in the mathematics classroom, including increased skills and willingness to collaborate and engage in productive struggle.

Students' self-perceptions determine whether or not they perceive themselves as belonging within the mathematics community (Boaler & Greeno, 2000; Gee, 2001) and are often influenced by their confidence in their mathematics ability (Aguirre et al., 2013; Bishop, 2012; Martin, 2000). Students chose to be members of MATH Club and continued to attend, with none choosing to exit the study, indicating that they felt a sense of belonging within the club itself. Through their involvement in MATH Club, students expanded their understanding of the meaning of mathematics and who does mathematics. Students improved their self-perceptions of mathematics and themselves as mathematicians, including their confidence, beliefs about the usefulness of mathematics, sense of belonging to the mathematics community, and perceptions of their mathematics ability.

Mathematics identity is socioculturally constructed through interactions with others, the surrounding environment, and how individuals are perceived and treated in the context of mathematics (Darragh & Radovic, 2020). MATH Club consisted of a diverse group of students. A major focus of my facilitation of MATH Club was the consistent integration of equitable teaching practices that celebrated the mathematical competence of every student. Through this experience, students improved in their willingness to engage and participate in mathematics, their sense of belonging to the community of doers of mathematics, their confidence, and their future aspirations in mathematics.

The expectations, norms, and treatment within the mathematics community, including interactions with teachers, peers, parents and families, and other individuals involved with students in mathematical contexts, significantly influence individuals' sense of belonging, positioning, and how they perceive themselves in relation to mathematics (Bishop, 2012; Radovic, 2020). Student-developed norms, the development of a Community of Practice (Wenger, 1998), and the implementation of equity-based practices (Aguirre et al., 2013) provided students with a safe and affirming environment to engage in mathematics meaningfully. This led to improved self-perceptions of ability, future aspirations in mathematics, mathematical confidence, and an improved sense of belonging in the mathematics community.

My facilitation of MATH Club fostered positive mathematics identities among students. Their mathematics identities consist of their engagement and participation in mathematics activities, their beliefs about themselves as mathematicians and the nature of mathematics, sociocultural influences, and experiences within the mathematics community. These facets of mathematics identity were addressed through MATH Club, primarily through facilitating a Community of Practice, exploring the joy, beauty, and wonder of mathematics, and integrating equitable teaching practices.

Facilitating a Community of Practice

Communities of Practice are made up of individuals who are brought together by a shared interest and continually improve their knowledge and skills through frequent engagement with one another, sharing ideas and information (Wenger et al., 2002). MATH Club was a Community of Practice in which all members shared an interest in learning and doing mathematics together, meeting twice weekly to collaborate and grow their mathematics understanding. Communities of Practice are structured around three core components – domain, community, and practice (Wenger et al., 2002). The domain establishes the shared foundation and identity with Communities of Practice (Wenger et al., 2002); in this case, the domain was mathematics. Interactions and relationships within the community shape the learning that occurs (Wenger et al., 2002), and in MATH Club, students collaborated and built relationships during every session. Practice includes the shared knowledge, framework, tools, language, and behaviors of the community (Wenger et al., 2002), and in MATH Club, this was evident in the norms students developed, agreed to, and abided by during every session as they worked together to overcome challenging mathematics tasks. The value of Communities of Practice lies in their ability to support members in overcoming challenges, boosting confidence in problem-solving, fostering enjoyable peer interactions, instilling a sense of belonging, and nurturing an identity within the community's domain of interest (Wenger et al., 2002). MATH Club was structured in such a way to support these values, such as with the setting of group norms, the opportunities for students to select which peers they would work closely with, the types of tasks that I selected, how I interacted with students, and how students interacted with one another. Students who were struggling with confidence in mathematical problem-solving became more confident through their experiences in MATH Club. Students overcame challenging tasks regularly and enjoyed opportunities to collaborate with peers. Their sense of belonging in the community of doers of mathematics improved, as did their overall mathematics identities.

Exploring the Joy, Beauty, and Wonder of Mathematics

One of the key recommendations outlined in *Catalyzing Change* (NCTM, 2020) is broadening the purposes of mathematics, including promoting the joy, beauty, and wonder of mathematics. According to *Catalyzing Change* (NCTM, 2020), establishing environments that empower students mathematically, prioritize inquiry-based learning, and embrace cultural connections is essential to meaningful and joyful mathematics. Teachers play a crucial role in this process by encouraging questioning and problem-solving while incorporating elements of play and exploration to ignite students' joy and wonder (NCTM, 2020). In MATH Club, tasks were selected so that inquiry-based learning, cultural connections, play, and exploration were emphasized and experienced regularly. Students were empowered as the authority and experts in the room, collaborating to problem-solve, while I facilitated by using purposeful questioning to guide as needed. Through this, students connected mathematics to their everyday lives, recognized and admired the beauty found in mathematics, and expressed how much fun they were having with mathematics. Because of these experiences, students' overall enjoyment of mathematics increased through their experiences in MATH Club.

Integrating Equitable Teaching Practices

Equitable teaching practices are described in *Catalyzing Change* (NCTM, 2020) as recognizing and valuing the mathematical competence of each and every student by connecting to their backgrounds and interests, showcasing diverse mathematicians, and promoting a deep understanding of mathematics through NCTM's (2014) eight effective mathematics teaching practices (MTPs). In MATH Club, tasks were selected and facilitated so that all three components were integrated consistently. Students connected mathematics to their lives, understood that all people engage in mathematics, and experienced and learned from tasks in which MTPs were always at play. Due in part to these experiences, students grew in their sense of belonging to the community of doers of mathematics.

In *The Impact of Identity in K-8 Mathematics Learning and Teaching: Rethinking Equity-Based Practices,* Aguirre and colleagues (2013) describe five equity-based practices for enhancing mathematics learning and fostering students' positive mathematics identity. An expanded version of this book was published in 2024, after the conclusion of MATH Club; however, the five equity-based practices remain the same. These include "going deep with mathematics, leveraging multiple mathematics competencies, affirming mathematics learners' identities, challenging spaces of marginality, and drawing on multiple resources of knowledge" (Aguirre et al., 2013, p. 43).

Going deep with mathematics involves providing students with challenging tasks with high cognitive demand that promote the development of conceptual understanding, procedural fluency, and problem-solving skills (Aguirre et al., 2013). The tasks selected for use in MATH Club consistently met these qualifiers. Going deep with mathematics also means allowing students to explain and justify their solutions, participate in discourse, and use various solution strategies and representations (Aguirre et al., 2013). In my facilitation of MATH Club, I provided ongoing opportunities for students to engage with mathematics collaboratively, solving tasks in ways that made sense to them and that they could explain to others. Students reflected on how they achieved success through hard work, the joy and appreciation they found in working with a team, how they found strengths in their ability to solve problems in their own way, and their acceptance of the various strategies their peers may use. Students grew in their collaboration skills and ability to engage in productive struggle in their mathematics classrooms. Furthermore, students showed improvements in their growth mindset development, which can be partially attributed to their experiences finding success with challenging tasks that they may have felt were beyond their capacity at first glance.

Leveraging multiple mathematics competencies means acknowledging and valuing students' diverse mathematical backgrounds and abilities by providing opportunities for collaboration and multiple entry points so that all students can contribute, regardless of skill level (Aguirre et al., 2013). Tasks were specifically selected and, at times, modified to ensure that all students could participate, considering the varying ages and skills of students in MATH Club. There were never any indications from students that they felt left out or were not a part of the process. On the contrary, due to leveraging multiple mathematics competencies, students improved their confidence, feelings of belongingness, collaboration skills, self-perception of mathematics ability, and overall mathematics identities.

Affirming mathematics learners' identities involves valuing diverse mathematical contributions, providing students with multiple ways to engage, encouraging student participation, promoting productive struggle and sense-making, instilling confidence, embracing mistakes as opportunities for learning, and recognizing competence through various types of contributions (Aguirre et al., 2013). In

MATH Club, students were regularly presented with tasks that I facilitated in such a way that they could engage in ways that were meaningful and comfortable for them. As I elicited and used evidence of students' thinking, I worked to ensure that those who were more likely to be underrepresented had their contributions showcased. Students engaged in productive struggle and sense-making consistently. The student-created norms emphasized that mistakes were a normal and helpful part of the learning process, and they were treated as such. As a result, students grew in their mathematical confidence, even outside MATH Club. They became more willing to collaborate with peers. Students developed more positive mathematics identities due to my affirming of mathematics learners' identities.

Challenging spaces of marginality involves creating a learning environment that is more inclusive and empowering than traditional teaching methods such as lectures and seatwork (Aguirre et al., 2013). It involves acknowledging students' strengths and appreciating diverse mathematical contributions by embracing students' background knowledge and experiences, empowering them as experts, sharing authority equitably throughout the classroom, and encouraging collaboration and discussion (Aguirre et al., 2013). Students were centered during every session, while I acted as the facilitator of MATH Club rather than the lecturer. I selected and adapted tasks, presented those tasks to students, and guided discussions as necessary through questioning strategies. This also included selecting which students would be placed in the role of explaining solutions and strategies to the whole group, which I worked to ensure was done equitably so that those who were more likely to have less opportunity to share in mathematics were supported in doing so. Students were the authority and experts in MATH Club, while I was simply the guide. Due to this practice, students became more confident and grew in their collaboration skills. Students also had an increased sense of belonging to the community of doers of mathematics, self-perception of mathematics ability, and overall more positive mathematics identity due partly to their positionality in MATH Club.

Drawing on multiple resources of knowledge entails acknowledging and using students' diverse knowledge and experiences as resources for learning by connecting multiple knowledge sources, linking previous and emerging mathematical understanding, integrating cultural and linguistic elements, and supporting multilingualism (Aguirre et al., 2013). The students in MATH Club were diverse in race, gender, ethnicity, grade level, and mathematical strengths. Several tasks were selected and adapted to incorporate cultural elements representing MATH Club students' backgrounds. However, linguistic elements and multilingualism were not given enough emphasis. Connections were consistently pointed out and explored between students' variety of solution strategies and how their work in MATH Club connected to the mathematics they experienced in the classroom or at home. These practices contributed to students' improved perceptions of their belongingness in mathematics and overall positive mathematics identity development.

This study explored the cultivation of students' positive mathematics identity development through my facilitation of MATH Club. Students' mathematics identities were consistently nurtured, consisting of engagement and participation, beliefs about themselves as mathematicians and the nature of mathematics, sociocultural influences, and experiences within the mathematics community. Facilitating MATH Club as a Community of Practice fostered collaborative learning experiences, empowering students and promoting a sense of belonging. Emphasizing the joy, beauty, and wonder of mathematics and integrating equitable teaching practices further enhanced students' positive mathematics identities. Through MATH Club, I facilitated a holistic approach to positive mathematics identity development, contributing to a more inclusive and empowering mathematics community.

Strengths and Limitations

This study had several strengths. It reinforces prior research on mathematics identity and builds upon that research by exploring specific ways to influence the mathematics identity development of upper elementary students. Furthermore, by using several data sources, including teacher interviews, student reflections, student surveys, and the reflexive journal, triangulation was possible and strengthened the reliability of the findings. In addition, these data allowed for analysis of students' mathematics identity development from three different perspectives, including that of the students, their classroom mathematics teachers, and the MATH Club facilitator.

This study also had several limitations. First, the study occurred at a single elementary school in Florida with a sample of 18 students, reducing the strength of the findings. Implementing MATH Club in several schools with diverse populations would provide greater insight into its applicability to the general population and provide a larger sample size to study. MATH Club was voluntary, with 22% of the eligible population applying for membership. While some did not apply due to scheduling conflicts, others chose not to apply and may possess characteristics that impact their development of positive mathematics differently than those who were members of MATH Club. Analyzing the use of the framework of MATH Club during regular instructional time would provide insights into the mathematics identity development of students who would never apply for such a club. Another limitation was within the data collection method of student reflections. Several students struggled with their writing skills and found it difficult to express themselves fully through that medium, especially with limited time. Interviewing students would have likely provided greater insight into their experiences and perceptions. Finally, this study took place over a short time, with students only participating in the program for 20 sessions from November to February. A more extended intervention period might provide more substantial results.

Implications for Policy and Practice

This study provides a framework for promoting students' positive mathematics identities through a holistic approach, including building a Community of Practice (Wenger, 1998), experiencing the joy, beauty, and wonder of mathematics (NCTM, 2020), and integrating equitable teaching practices

(NCTM, 2020; Aguirre et al., 2013). By weaving together these evidence-based approaches, students developed more positive mathematics identities. These findings have several implications for policy and practice in mathematics education.

First, policymakers and educators should prioritize integrating equitable teaching practices in mathematics instruction. This includes following NCTM's (2020) recommendations of connecting to children's backgrounds and interests, providing representations of diverse mathematicians, and using NCTM's (2014) effective mathematics teaching practices to enhance the mathematics experiences of all students. It also includes integrating Aguirre and colleagues' (2013) five equity-based practices for enhancing mathematics learning and fostering students' positive mathematics identities.

In addition, policymakers and educators should also emphasize the joy, beauty, and wonder of mathematics. This includes creating mathematically empowering environments for students, prioritizing inquiry-based learning, and embracing cultural connections. Policies should advocate for curriculum frameworks that incorporate these aspects into mathematics instruction.

In addition, policymakers and educators should recognize the sociocultural influences on students' mathematics identities and promote acknowledging and celebrating students' diverse backgrounds and experiences. Professional development for educators can focus on cultural understanding and strategies for fostering positive mathematics identities for all students.

Finally, policymakers should support initiatives promoting student engagement and participation in mathematics-related activities inside and outside the classroom. This could include funding for extracurricular programs such as mathematics clubs, professional development for educators on effective strategies for promoting student engagement, and creating a mathematics curriculum that emphasizes collaborative learning experiences.

Recommendations for My School and District

As mentioned previously, Larkspur Elementary School (LES) (pseudonym) is a Title I school within Delphinium County School District (DCSD) (pseudonym) in Florida. Florida recently adopted new mathematics standards, initially providing DCSD with little time to curate their mathematics curriculum. As observed by the principal, less than 50% of LES students were engaging in mathematics discussions at the start of the 2022-23 school year. This may be partly due to the types of tasks included in the curriculum; however, that is unknown as it was beyond the scope of this study. I want to encourage DCSD to select and adapt complex and interesting mathematics tasks with multiple entry points, allowing various strategies and representations. Tasks selected should connect to students' interests and cultural backgrounds and provide opportunities for students to experience the joy, beauty, and wonder of mathematics.

I would also like to recommend professional development for educators at LES on equitable teaching practices. As evidenced by interviews, teachers often used deficit labels when describing students' mathematics performance. This is no fault of the teacher, as deficit labels are commonly used to describe students in DCSD and other school districts nationwide and is a deeply ingrained norm. However, when we acknowledge and value the mathematical competence of each and every child, we do not compare them to their peers in such a way that we consider some students "high" and others "low." Teachers all expressed that their students are given some level of opportunity to engage in mathematics in their classrooms collaboratively and were able to describe strengths and areas for growth for each child, so I do not doubt that they are incorporating some level of equitable teaching, whether they realize it or not. However, professional development that delves deeper into this matter would be beneficial to create a common language and understanding among the teachers and administrative staff. Encouraging teachers to integrate equity-based practices into their classroom instruction would positively impact the students of LES.

For DCSD, I recommend an opportunity for all students to engage in experiences like MATH Club. This might include a network of MATH Clubs at several elementary schools across DCSD which use the same framework for task selection, adaptation, and implementation as discussed previously. The district promotes a different type of extracurricular mathematics activity for elementary school students, emphasizing competition and speed. This program is exceptional for some students; however, it does not promote a positive mathematics identity for all students, regardless of skill or confidence level, like MATH Club. Promoting a club like this throughout the district would be transformative for many students.

However, as mentioned in the limitations section, not all students have access to clubs before or after school, often due to transportation concerns. MATH Club can be structured to influence every student in the participating schools. To provide some background, I was previously hired elsewhere within DCSD as a resource teacher and worked with all kindergarten through fifth-grade students using activities similar to those I selected for MATH Club. I worked with every class in the school weekly or biweekly, depending on grade level. Teachers remained in the classrooms during these sessions, with my facilitation acting as professional development for the teachers and a source of common language used throughout the school. This approach aligns with the concept of a Mathematics Whole School Agreement (MWSA), as advocated for in *The Math Pact* (Karp et al., 2020), which promotes coherence in high-quality mathematical language and experiences across all classrooms. Having a dedicated teacher foster equitable teaching practices and promote students' positive mathematics identity development in every classroom would ensure ongoing professional development for teachers and consistent learning experiences for students, regardless of their class placement or ability to attend an extra-curricular activity.

Recommendations for Future Research

Through my experiences with this study, I have several recommendations for future research. The most logical next step is to employ the framework of MATH Club in more schools with more students to see its applicability in a broader sense. When studying a program such as MATH Club, it would be valuable to conduct a longitudinal study to examine the long-term effects of participation. Mathematics identity is malleable (Radovic et al., 2018) and formed throughout a student's life. It would be interesting to track students over time to examine how their identities evolve and any impact on mathematics achievement, future aspirations in STEM, and mathematics engagement. Another exciting place for research is within classrooms using this framework, where students are not members of an outside club but receive this intervention within the regular school day. This would provide insight into the mathematics identity development of students who would not choose to be in a mathematics club. It would also be enlightening to follow a few students in MATH Club and understand their mathematics experiences inside and outside the club, how those experiences are similar and different, and their contribution to the students' mathematics identity development. In addition, I noticed some anecdotal struggles with engagement in complex tasks from the students who were described by teachers as the highest achieving. Studying differences in student responses to MATH Club when considering their starting mathematics achievement levels could provide further insight.

Conclusion

In summary, this study demonstrates the effectiveness of cultivating positive mathematics identity development through my facilitation of MATH Club. By creating a Community of Practice, exploring the joy, beauty, and wonder of mathematics, and integrating equitable teaching practices, students showed improvements in their mathematics identities, including their engagement and participation in mathematics, their beliefs about themselves as mathematicians and the nature of mathematics, their enjoyment of mathematics, and their future aspirations in mathematics. This study contributes new and unique knowledge to the mathematics community due to the combination of all of these elements in an upper elementary mathematics club, which has not been studied previously. The implications for policy and practice include prioritizing equitable teaching practices, emphasizing the joy, beauty, and wonder of mathematics, recognizing sociocultural influences on students' mathematics identities, and promoting engagement in mathematics-related activities. Recommendations for my school and district include task selection for a district mathematics curriculum that lends itself to equitable teaching practices and the exploration of joy, beauty, and wonder in mathematics, professional development on equitable teaching practices, and promoting inclusive extracurricular mathematics activities such as MATH Club. Future research could explore the long-term effects of participation in MATH Club, examine the framework's applicability in diverse settings, investigate mathematics identity development in the regular classroom with similar interventions, study the differences in how students at various achievemement levels respond to MATH Club, and take a closer look at how students in a program like MATH Club experience mathematics outside the club. In conclusion, my facilitation of MATH Club not only fostered positive mathematics identity development in the student participants but also holds the potential for creating more inclusive and empowering mathematics communities in schools and districts beyond my own.

APPENDIX A: IRB APPROVAL

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

APPROVAL

August 17, 2023

Dear Kayla Blankenship:

On 8/17/2023, the IRB reviewed the following submission:

The IRB approved the protocol on 8/17/2023. Continuing review is not required.

Type of Review:	Initial Study , Category 7a, b
Title:	Mindful approaches, transforming hearts: Cultivating elementary students' positive mathematics identity development through an equity-based morning mathematics club
Investigator:	Kayla Blankenship
IRB ID:	STUDY00005746
Funding:	None
Documents Reviewed:	• HRP-251 - Blankensip - FORM - Faculty Advisor Scientific-Scholarly Review.pdf, Category: Faculty Research Approval; • 6.2 Math Tasks Bank.docx, Category: Other; • Example Student Reflection Prompts.pdf, Category: Debriefing Form; • HRP-502 Consent Forms for Adults, Category: Consent Form; • HRP-502b Consent for Children by Parents, Category: Consent Form; • MATH Club Application Rev2.docx, Category: Recruitment Materials; • Pre- and Post- Teacher Interview Protocol.pdf, Category: Interview / Focus Questions; • Site Administrator Approval, Category: Letters of Support; • Student Math Survey.pdf, Category: Survey / Questionnaire; • Study 5746 Child Assent Letter Rev2.pdf, Category: Consent Form; • Study 5746 Flyer Rev3.docx, Category: Recruitment Materials; • Study 5746 Protocol Rev6.docx, Category: IRB Protocol; • Teacher Email Rev2.docx, Category: Recruitment

Page 1 of 2

	Materials;

In conducting this protocol, you are required to follow the requirements listed in the Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system. Guidance on submitting Modifications and a Continuing Review or Administrative Check-in is detailed in the manual. If continuing review is required and approval is not granted before the expiration date, approval of this protocol expires on that date. If this protocol includes a consent process, use of the time-stamped version of the consent form is required.

When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Kristin Badillo
Designated Reviewer

APPENDIX B: TEACHER INTERVIEW PROTOCOL

Pre- and Post- Teacher Interview Protocol

1. What grade do you teach?
2. How many classes do you teach? How many students are in your class(es)?
3. Do you group students based on mathematics ability in the classroom? Can you describe how, when, and why students are grouped, if so?
4. How frequently would you say that students work collaboratively on mathematics in your class, if at all? Can you describe what this looks like?
5. How frequently, if at all, do you assign mathematics homework? Please describe what the homework is like.
6. Do you have any students who participate in MATH Club? How many are in each class? (The following questions are about each of those students, so they will be repeated if there are multiple MATH Club students in this teacher's class(es).)
    a. How would you describe the student's overall academic habits?
    b. How would you describe the student in relation to mathematics?
    c. If yes to question 3, how would you describe the group that this student is in? Why is the student in this group?
    d. If yes to question 4, how would you describe this student's participation regarding mathematics homework?
    e. If yes to question 5, can you describe how the student participates in collaborative mathematics discussions?
    f. Do you perceive that the student enjoys mathematics?
    g. Can you describe the strengths of this student in relation to mathematics?
    h. What do you think this student needs to be successful in mathematics?

APPENDIX C: EXAMPLE STUDENT REFLECTION PROMPTS

Example Student Reflection Prompts

“Describe a mistake or misconception that you or a classmate had in class today. What did you learn from this mistake or misconception?” (p. 218)

“How did you or your group approach today’s problem or problem set? Was your approach successful? What did you learn from your approach?” (p. 218)

“Describe in detail how someone else in [MATH Club] approached a problem. How is their approach similar or different to the way you approached the problem?” (p. 219)

“What was the big mathematical debate about in [MATH Club] today? What did you learn from the debate?” (p. 219)

“How is ________ similar to or different from __________?” (p.219)

“What were some of your strengths and weaknesses with today’s task? What is your plan to improve in your areas of weakness?” (p. 219)

“How could the ideas from today’s [MATH club session] be used in real life?” (p. 233)

“What is something you are struggling with or have questions about?” (p. 233)

“What was the main idea you learned today?” (p.233)

“What good ideas did [you] have today?” (p.251)

Adapted from Boaler (2016, pp. 218-219, 233, 251)

APPENDIX D: TASK BANK

Task Bank

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages, and innovative teaching*. Jossey-Bass.

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Estimation 180. https://www.estimation180.com

Fun Factor. https://www.funfactor.org

Inside Mathematics. https://insidemathematics.org

Julia Robinson Mathematics Festival. https://www.jrmf.org/puzzle

Math for Love. https://www.mathforlove.com

Mensa for Kids. https://www.mensaforkids.org/

National Council of Teachers of Mathematics. https://www.nctm.org

NRICH. https://nrich.maths.org

Open Middle. https://www.openmiddle.com

Youcubed. https://www.youcubed.org

APPENDIX E: DEDUCTIVE CODES FOR ANALYSIS OF REFLEXIVE JOURNALING

Deductive Codes for Analysis of Reflexive Journaling

- Joy, beauty, and wonder (NCTM, 2020)
- Equitable teaching practices (NCTM, 2020)
- Aguirre et al.'s (2013) five equity-based practices
    - Going deep with mathematics
    - Leveraging multiple mathematics competencies
    - Affirming mathematics learners' identities
    - Challenging spaces of marginality
    - Drawing on multiple resources of knowledge
- Communities of Practice (Wenger, 1998)
- Challenges
- Successes

APPENDIX F: CODES FOR ANALYSIS OF TEACHER INTERVIEWS

Codes for Analysis of Teacher Interviews

Preliminary Codes	Final Codes
Ability	Barriers
Academic Habits	Confidence
Barriers	Engagement and Participation
Collaboration	Mathematics Performance
Confidence	Strengths
Effort	Transformation
Exceptionalities	
Focus	
Joy	
Leadership	
Mathematical Areas for Growth	
Mathematical Strengths	
Mathematical Vocabulary	
Mood	
Needs Practice/ Instruction	
Organization	
Parent Support	
Participation	
Peer Relationships	
Productive Struggle	
Reading	
Seeking Assistance	
Transformation	
Writing	

APPENDIX G: CODES FOR ANALYSIS OF STUDENT REFLECTIONS

Codes for Analysis of Student Reflections

Preliminary Codes	Final Codes
Agency	Agency
Beauty	Collaboration
Challenges	Joy, Beauty, and Wonder
Collaboration	Productive Struggle
Complex Problems	Transformation
Cultural Connections	
Discourse	
Exploration	
Joy	
Making Connections	
Mistakes	
Multiple Entry Points	
Play	
Problem-Solving	
Productive Struggle	
Strengths	
Transformation	
Various Strategies	

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