# MATH TEACHERS WHO DON'T LIKE MATH: A PHENOMENOLOGICAL STUDY OF ELEMENTARY TEACHERS WHO DISLIKE MATHEMATICS VIEWED THROUGH THE LENS OF MATHEMATICS TEACHER IDENTITY IN THE CONTEXT OF MATHEMATICS EDUCATION REFORM

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## ABSTRACT

Due to the increased expectations for rigorous mathematics instruction demanded by the Common Core Standards, it has become increasingly difficult for elementary teachers who are trained to be generalists to deliver expert instruction in mathematics. This difficulty is compounded by the reality that many elementary teachers self-identify as disliking math. The purpose of this qualitative, interpretive phenomenological study was to explore, investigate, and interpret the lived experiences and perceptions of self-contained elementary teachers who describe themselves as disliking mathematics. The central research question answered by this study is: What are the lived experiences and perceptions of self-contained elementary teachers who dislike mathematics? The following subquestions were also addressed:

1. How have self-contained elementary teachers who dislike mathematics experienced mathematics?
2. How have self-contained elementary teachers who dislike mathematics experienced reform-based approaches for teaching mathematics?
3. How do self-contained elementary teachers who dislike mathematics perceive their own identity as mathematics teachers?

Data was collected via semistructured interviews with nine participants and was viewed through the lens of mathematics teacher identity in the context of mathematics education reform. Five distinct patterns of experience emerged and were mapped together to create a continuum of avoiding, surviving, coping, emerging, and thriving with reform-based mathematics teaching.

The results of this study indicate that the mathematics teacher identity of self-contained elementary teachers who dislike mathematics affects both their willingness and their ability to implement reform-based mathematics teaching.

***Keywords:*** Mathematics teacher identity, elementary mathematics teacher, self-contained elementary teacher, elementary teachers who dislike mathematics, reform-based mathematics instruction, mathematics education reform

DEDICATION

To Mom, Dad, and Mollie, with love.

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# CHAPTER 1: INTRODUCTION

The United States is facing a math crisis (Lazio & Ford, 2019; Luminary Labs, 2017; Math & Movement, 2020; Shiller, 2021; U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, 2017). Only 39% of high school graduates in the United States are prepared for college-level coursework in mathematics, and just 19% are both proficient in mathematics and interested in pursuing a STEM (science, technology, engineering, and math) career (American College Testing, 2019). In an international survey that assessed the numeracy skills of adults ages 16–74, the United States performed well below the international average. Only 10% of Americans ranked in the top two levels, while 62% ranked in the bottom two (U.S. Department of Education, Institute of Education Sciences, National Center for Education Statistics, 2017). American students are also performing well below average on international mathematics exams. In 2012, the United States placed 24th out of 29 industrialized nations on the Programme for International Student Assessment (PISA; Organization for Economic Co-Operation and Development, 2019), an international mathematics exam given every 3 years to 15-year-old students. The United States placed 39th out of 70 participating countries on the 2015 PISA, and in 2018 the United States placed 37th out of 79 participating countries with only 8% of American students achieving at the highest possible level (Organization for Economic Co-Operation and Development, 2019).

Innumeracy, the mathematical equivalent of illiteracy, has become a trend in American schools (Math & Movement, 2020), and only 40% of fourth-grade students in the United States are deemed to be proficient in mathematics (National Assessment of Educational Progress, 2019). Mathematics learning during the earliest years of elementary school is critical for future success in mathematics (Huinker, 2020), however many students experience difficulties with mathematics at a young age that negatively affect their entire mathematics career (Math & Movement, 2020).

Instructional practices which have traditionally been used to teach mathematics in elementary schools (e.g., those that focus on memorization and timed testing) cause many students to develop mathematics anxiety and to disengage with mathematics at a very young age (Boaler et al., 2015). This is of concern because college and career readiness are significantly jeopardized if a student is not on target by middle school (American College Testing, 2019).

A major cause of mathematics innumeracy is the approaches that have traditionally been used to teach it (Math & Movement, 2020). In the United States, the traditional approach to mathematics education is characterized by a teacher-centered model of instruction and an emphasis on the rote memorization of facts and procedures (Kartal & Tillett, 2021). Reformers advocate for a shift away from the traditional approach toward a reform-based approach, which is characterized by a student-centered, problem-based model of instruction that focuses on the development of deep conceptual understanding and mathematical reasoning (Kartal & Tillett, 2021). Efforts to replace traditional mathematics instruction with reform-based mathematics instruction have been underway for several decades, but these efforts have met with heavy resistance and have been largely unsuccessful (Epstein & Miller, 2011). The New Math reform movement of the 1960s failed to accomplish this objective largely because of resistance from elementary teachers and parents; and resistance of a similar nature to the Standards-Based Reform Movement of the 1980s led to the bitter and controversial "Math Wars" of the 1990s (Epstein & Miller, 2011). At the present time the United States is in the midst of the Common Core era, a third such reform movement.

Since the 1980s, the movement to reform school mathematics instruction in the United States has been driven largely by the National Council of Teachers of Mathematics (NCTM; n.d.-a,b; Herrera & Owens, 2001). The NCTM's vision has slowly gained traction over the decades and has now been incorporated into the Common Core Standards for Mathematics (CCSS-M), a

set of world-class standards that were released in 2010 with the goal of improving student learning in mathematics (Huinker & Bill, 2017). During the decade that has followed their release, the NCTM has published guidance for elementary teachers regarding how to change their teaching practices to meet the rigorous demands of the CCSS-M (Huinker & Bill, 2017; NCTM, 2014). According to Huinker and Bill (2017), meeting the raised expectations for student learning as set forth in the CCSS-M requires teachers to implement a reform-based approach to mathematics instruction referred to as "ambitious math teaching" (p. 3).

Ambitious mathematics teaching has been linked to increased student achievement in mathematics, particularly on assessments requiring high levels of cognitive demand (Huinker & Bill, 2017). However, many elementary teachers in the United States have struggled to teach the CCSS-M effectively (Ostashevsky, 2016), and ambitious mathematics teaching has not been widely embraced (Huinker & Bill, 2017). Huinker (2020) noted that "change is hard because mathematics teaching and learning is a cultural activity and, as such, is resistant and slow to accept new ideas" (p. 5). Ambitious mathematics teaching represents an approach to both learning and teaching mathematics that is very different from what most elementary teachers experienced as mathematics students (Huinker & Bill, 2017). In addition, teachers who implement ambitious mathematics instruction often face resistance from other teachers, administrators, parents, and community members. As a result, many elementary teachers revert back to teaching mathematics in more traditional ways (Neumayer-Depiper, 2013). According to Huinker (2020), "an implementation gap persists between the calls for change and the comprehensive actions needed to ensure that high levels of mathematics learning become a reality in the lives of each and every child" (p. 3). The intent of this study is to help bridge this gap.

## Definition of Key Terms

*Generalist:* A teacher trained to teach all core academic subjects, rather than specializing in any particular one (Murphy & Glanfield, 2010).

*Identity:* An individual's beliefs, feelings, thoughts, and behaviors (Ladd, 2018).

*Inservice teacher:* A teacher currently employed in a Kindergarten-Grade 12 (K-12) school (IGI Global, 2022a).

*Mathematics teacher identity:* The "cache of capacity and understanding" which includes a teacher's knowledge, beliefs, commitments, and intentions specific to mathematics along with all of the ways they have learned to think, act, and interact socially within their teaching communities in the context of mathematics teaching (Van Zoest & Bohl, 2005, p. 338).

*Preservice teacher:* Students who are enrolled in college-level teacher preparation programs and are working toward teacher certification (IGI Global, 2022b).

*Traditional mathematics instruction:* Approaches to mathematics teaching that are characterized by a teacher-centered model of instruction and an emphasis on the rote memorization of facts and procedures rather than the development of conceptual understanding. Examples include "skill-a-day," the "I do-we do-you do" routine, and other directive teaching approaches (Kartal & Tillett, 2021).

*Reform-based mathematics instruction:* Approaches to mathematics teaching that are characterized by student-centered, problem-based models of instruction that focus on the development of deep conceptual understanding and mathematical reasoning. Examples include problem-based learning; teaching through problem solving; discovery, investigatory, and exploratory approaches, and ambitious mathematics teaching (Kartal & Tillett, 2021).

*Self-contained elementary teacher:* A teacher who teaches multiple subjects throughout the day, typically at the elementary level, to the same group of students (California Commission on Teacher Credentialing, 2016).

## Statement of the Problem

The predominant model of elementary instruction in the United States is the self-contained classroom (Markworth et al., 2016). In a self-contained classroom, one teacher is responsible for delivering core academic instruction in all subject areas (Markworth et al., 2016). As a result, most elementary teachers in the United States are trained to be generalists (NCTM, 2010). A generalist is a teacher trained to teach all core academic subjects rather than specializing in any particular one (Murphy & Glanfield, 2010).

Due to the increased expectations for rigorous instruction demanded by the CCSS-M, it has become increasingly difficult for elementary teachers who are trained to be generalists to deliver expert instruction in mathematics (Markworth et al., 2016). As a result, many elementary teachers have struggled to teach the CCSS-M effectively (Ostashevsky, 2016). This problem is compounded by the reality that many elementary teachers dislike mathematics (Johnson, 2018), as research indicates that elementary teachers who have a negative relationship with mathematics are less likely to implement reform-based approaches for teaching it (Wilkins, 2008). It is now more than a decade since the release of the CCSS-M, but traditional mathematics instruction is still prevalent in elementary schools and reform-based mathematics instruction has not been widely embraced (Boaler, 2019; Huinker, 2020; Spillane et al., 2018).

## Purpose of the Study

In phenomenological research, “the essence of a purpose statement is that the research project has a phenomenon that it wants to explore” (Alase, 2017, p. 18). Therefore, the “ultimate goal” of a phenomenological study is to “explore, investigate, and interpret the lived experiences

of the research participants" (Alase, 2017, p. 12). The purpose of this qualitative, interpretive phenomenological study was to explore, investigate, and interpret the lived experiences and perceptions of elementary mathematics teachers. Specifically, this study was designed to explore the experiences and perceptions of elementary mathematics teachers (a) who are trained to be generalists; (b) who teach all core academic subjects, including mathematics, in a self-contained classroom setting; and (c) who would describe themselves as either disliking or having disliked mathematics. The lived experiences and perceptions of these teachers were viewed through the lens of mathematics teacher identity in the context of mathematics education reform. A more thorough understanding of the lived experiences and perceptions of elementary teachers who dislike mathematics will enable mathematics educators to develop professional development experiences designed to help both preservice and inservice elementary teachers (a) improve their relationship with mathematics, and (b) increase both their willingness and their ability to implement reform-based mathematics teaching.

## Research Questions and Design

According to Creswell and Poth (2018), a qualitative study should contain one central research question that is subdivided into a small number of subquestions. The central research question addressed in this study is: What are the lived experiences and perceptions of self-contained elementary teachers who dislike mathematics? The following subquestions were also addressed:

1. How have self-contained elementary teachers who dislike mathematics experienced mathematics?
2. How have self-contained elementary teachers who dislike mathematics experienced reform-based approaches for teaching mathematics?

3. How do self-contained elementary teachers who dislike mathematics perceive their own identity as a mathematics teacher?

A qualitative research design was deemed most appropriate for this study because it "is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem" (Creswell & Creswell, 2018, p. 4). Although there are several different types of research designs within the broad category of qualitative research, the specific qualitative research design used for this study was phenomenology. According to Creswell and Creswell (2018):

> Phenomenological research is a design of inquiry coming from philosophy and psychology in which the researcher describes the lived experiences of individuals about a phenomenon as described by participants. This description culminates in the essence of the experiences for several individuals who have all experienced the same phenomenon. This design has strong philosophical underpinnings, and typically involves conducting interviews. (p. 13)

Phenomenology is both a philosophy and a research methodology. Descriptive phenomenological research focuses on "the common structure of (the phenomenon being studied) as an experience," while interpretive phenomenological research focuses on "personal meaning and sense-making in a particular context, for people who share a particular experience" (Smith et al., 2022, p. 39). The purpose of this study was not to describe the basic structure of reform-based mathematics teaching as an experience, but to reveal how self-contained teachers who dislike mathematics have experienced reform-based mathematics teaching. This required the use of an interpretive phenomenological approach.

# Conceptual and Theoretical Framework

## Conceptual Framework

The conceptual framework for this study was informed by two existing frameworks for mathematics teacher identity: Van Zoest and Bohl (2005) and Bennison (2015). These frameworks were purposefully selected to inform the development of this study because they take into account the influence of both individual (psychological) and cultural (sociological) factors on the development of mathematics teacher identity. This is consistent with recommendations that mathematics teacher identity research should take a "psycho-social" approach, rather than one that is purely psychological or purely sociological (Lutovac & Kaasila, 2014).

Van Zoest and Bohl's (2005) framework is based on the premise that forms of learning and knowing lie on a continuum between purely "in-the-brain" and purely "social." Within that continuum there are two components that interact and overlap to form an individual's mathematics teacher identity: "aspects of self-in-mind," and "aspects of self-in-community." At the extreme in-the-brain end of the continuum is knowledge (Van Zoest & Bohl, 2005). Knowledge is cognitive in nature; therefore, it is considered to be entirely self-in-mind (Van Zoest & Bohl, 2005). On the extreme social end of the continuum are what Van Zoest and Bohl (2005) termed "dimensions of competence." Dimensions of competence explain how being a member of and engaging in the practices of a community contribute to the formation of mathematics teacher identity. Dimensions of competence are entirely social in nature; therefore, they are considered to be entirely "aspects of self-in-community." In between "aspects of self-in-mind" and "aspects of self-in-community" on the continuum is a third component consisting of beliefs, commitments, and intentions (Van Zoest & Bohl, 2005). Beliefs, commitments, and intentions involve in-the-brain cognition, but are considered more socially responsive than

knowledge. As a result, they fall within both "aspects of self-in-mind" and "aspects of self-in-community" (Van Zoest & Bohl, 2005).

Bennison (2015) supported and expanded Van Zoest and Bohl's (2005) Mathematics Teacher Identity Framework. According to Van Zoest and Bohl (2005), mathematics teacher identity is influenced by cognitive, affective, and social factors. Bennison (2015) also accounted for the influence of cognitive, affective, and social factors on mathematics teacher identity, but argued that Van Zoest and Bohl (2005) failed to recognize the impact of two additional factors on mathematics teacher identity: past experiences and external factors. As a result, Bennison (2015) identified five "domains of influence" that affect mathematics teacher identity: the knowledge domain, the affective domain, the social domain, the life history domain, and the context domain.

**Theoretical Framework**

The theoretical framework of this study was Ladd's (2018) Holistic Identity and Personal Change Model. This model was developed for use by mental health practitioners to describe the levels of personal change that occur when counseling clients. Ladd (2018) informed this study of self-contained elementary teachers who dislike mathematics by providing a holistic conceptualization of identity as consisting of an individual's behaviors, thoughts, feelings, and beliefs. Ladd (2018) also theorized that identity controls the entire structure of personal change, which can help to explain why efforts to enact behavioral change are not always effective. The successful implementation of reform-based mathematics instruction requires elementary teachers to make significant changes to their teaching practice, and many elementary teachers have struggled to achieve this change. Ladd's (2018) Holistic Identity and Personal Change Model, along with Van Zoest and Bohl's (2005) and Bennison's (2015) Mathematics Teacher Identity Frameworks, enabled the lived experience and perceptions of the self-contained elementary

teachers who dislike mathematics that participated in this study to be viewed through the lens of mathematics teacher identity in the context of mathematics education reform.

## Assumptions, Limitations, and Scope

Assumptions are defined by Bloomberg and Volpe (2019) as "those ideas that you believe to be true but do not have evidence to support" (p. 10), and by Roberts and Hyatt (2019) as "what you take for granted relative to your study" (p. 111). Several assumptions exist in this study that must be acknowledged. First, any phenomenological study is based on the premise that the participants have a shared experience with the phenomenon that is being explored (Creswell & Poth, 2018). The participants in this study were purposefully selected because they self-identified as disliking mathematics, but to ensure the integrity of the study it was assumed that this self-identification was accurate. And for the findings of the study to be valid, it was also assumed that the information provided by the participants was a true and honest reflection of their perceptions and their experiences.

Limitations are defined by Bloomberg and Volpe (2019) as "potential weaknesses of the study and the scope of the study; that is, the external conditions that restrict or constrain the study's scope or potential outcome" (p. 13). Limitations are factors that are not within the control of the researcher (Roberts & Hyatt, 2019), and may include weaknesses or flaws that are inherent to the research design (Bloomberg & Volpe, 2019). One limitation of this study that must be acknowledged is that the findings are not generalizable to other populations, settings, or contexts. This is due to many factors that are inherent to both qualitative research and phenomenology, including the use of a small sample size and the fact that the participants are not intended to be a representative sample (Peoples, 2021).

A second limitation of this study that must be acknowledged is that it was difficult to recruit participants that both met the inclusion criteria and were willing to talk about their

experiences. This limitation is inherent to phenomenological research, because the participants of any phenomenological study are limited to those who (a) have experienced the phenomenon being investigated, and (b) are able to articulate their experience (Van Manen, 2014 as cited in Creswell & Poth, 2018). To be included in this study, participants had to be willing to discuss how their negative past experiences and dislike of mathematics have impacted their identity as a mathematics teacher. It is possible that this may have caused emotional discomfort or distress. To mitigate this potential risk, participants were advised that they had the option of skipping any questions they did not wish to answer during the interview. They were also advised that they had the option of withdrawing from the study at any time. In addition, it is also possible that participants may have feared negative repercussions from their employers or feared that damage to their professional reputations might occur if their participation in this study were to be discovered. To mitigate this potential risk, steps were taken to ensure that the privacy and confidentiality of the participants was protected. These steps are explained in detail in chapter three.

Delimitations are intentional decisions made by the researcher that narrow the scope of a study (Roberts & Hyatt, 2019). One delimitation of this study was the intentional limiting of participants to inservice elementary teachers. For the purposes of this study, inservice elementary teachers are defined as those who currently teach in any grade ranging from Kindergarten through Grade 5 (K–5). The findings of this study are therefore not generalizable to middle school teachers, high school teachers, or preservice elementary teachers; or to inservice elementary teachers who are trained to be mathematics specialists, those who teach in departmentalized rather than self-contained classrooms, or those who do not self-identify as disliking mathematics.

A second delimitation of this study was the intentional limiting of the research site to public schools located within one county in northern New York State. This limitation was

consistent with the assertion made by Creswell and Poth (2018) that, in phenomenological studies, “the more diverse the characteristics of the individuals, the more difficult it will be for the researcher to find common experiences, themes, and the overall essence of the experience for all participants” (p. 153). However, intentionally limiting the research site in this manner meant that the findings of this study would not be generalizable either to (a) teachers in private schools, or (b) teachers in public schools located in other areas of New York State and the United States.

The standard used to evaluate the quality and rigor of qualitative research is trustworthiness (Bloomberg & Volpe, 2019). According to Bloomberg and Volpe (2019),

> Trustworthiness means that the community of researchers and scholars will trust your analysis and interpretation of what others said and did in the field, thereby supporting the credibility and dependability of your research and the transferability of your findings. (p. 47)

The key to establishing trustworthiness is transparency (Bloomberg & Volpe, 2019). According to Bloomberg and Volpe (2019), criteria used to evaluate the trustworthiness of qualitative research include credibility, dependability, confirmability, and transferability. Strategies used to strengthen the trustworthiness of this study included having participants member-check the transcripts of their interviews, creating a detailed audit trail of methods and procedures used for data collection and data analysis, convening a review panel review to review and approve the findings, and providing a rich, thick description of the results (Bloomberg & Volpe, 2019; Creswell & Creswell, 2018).

## Rationale and Significance

This study contributed to the construct of elementary mathematics teacher identity. Viewing the lived experiences and perceptions of self-contained elementary teachers who dislike mathematics through the lens of mathematics teacher identity, in the context of mathematics

education reform, advanced understanding of how these teachers have experienced reform-based mathematics teaching. It also provided insight into the nature of resistance to reform-based mathematics teaching by elementary teachers.

A more thorough understanding of the lived experiences and perceptions of elementary teachers who dislike mathematics will enable mathematics educators to develop professional learning experiences designed to help both preservice and in-service elementary teachers (a) improve their relationship with mathematics, and (b) increase both their willingness and their ability to implement reform-based mathematics teaching. This information gained from this study is of value to elementary teachers, mathematics coaches, curriculum coordinators, principals and school administrators, and other members of K-12 school communities. It is also of value to mathematics education researchers, mathematics education reformers, those who design educational programming for preservice and inservice teachers, professors of mathematics education and other mathematics teacher educators, and members of higher education communities. It is the hope of the researcher that the knowledge gained from this study will enable more elementary teachers to overcome their dislike of mathematics and embrace reform-based mathematics teaching.

## Summary

Due to the increased expectations for rigorous mathematics instruction demanded by the CCSS-M, it has become increasingly difficult for elementary teachers who are trained to be generalists to deliver expert instruction in mathematics (Markworth et al., 2016). As a result, many elementary teachers have struggled to teach the CCSS-M effectively (Ostashevsky, 2016). This problem is compounded by the reality that many elementary teachers have a negative personal relationship with mathematics (Johnson, 2018), because elementary teachers who dislike mathematics are less likely to implement reform-based approaches for teaching it (Wilkins,

2008). It is now more than a decade since the release of the CCSS-M, but traditional mathematics instruction is still prevalent in elementary schools and reform-based mathematics instruction has not been widely embraced (Boaler, 2019; Huinker, 2020; Spillane et al., 2018).

Chapter 1 included an overview of this research study. First, a brief introduction to efforts to improve elementary mathematics instruction in the United States was provided. The problem and purpose statements were then introduced, along with the central research question and three subquestions. A description of the research methodology for this interpretive, phenomenological analysis (IPA) study was given, and the conceptual and theoretical frameworks that informed the design of this study were explained. Chapter 1 concluded with a discussion of the assumptions, limitations, and scope of this study, as well as its rationale and significance.

The remainder of this study is organized into four additional chapters. Chapter 2 provides a detailed discussion of the conceptual and theoretical frameworks of this study, along with the findings of a review of existing literature. Topics include a historical context for efforts to reform elementary mathematics education in the United States, the evolution of a reform-based approach for teaching mathematics, identity and mathematics teacher identity, and the factors that influence the development of mathematics teacher identity. Chapter 3 provides an explanation of the methodology used to conduct this study, including a description of the research design, the selection of participants, and the procedures used for both data collection and data analysis. In Chapter 4 the participants of this study are introduced and the findings are presented in detail. Chapter 5 includes a summary of the results, along with implications, recommendations for action, and recommendations for future research.

# CHAPTER 2: LITERATURE REVIEW

The predominant model of elementary instruction in the United States is the self-contained classroom (Markworth et al., 2016). In a self-contained classroom, one teacher is responsible for delivering core academic instruction in all subject areas (Markworth et al., 2016). As a result, most elementary teachers in the United States are trained to be generalists (NCTM, 2010). A generalist is a teacher trained to teach all core academic subjects rather than specializing in any particular one (Murphy & Glanfield, 2010).

Due to the increased expectations for rigorous mathematics instruction demanded by the CCSS-M, it has become increasingly difficult for elementary teachers who are trained to be generalists to deliver expert instruction in mathematics (Markworth et al., 2016). As a result, many elementary teachers have struggled to teach the CCSS-M effectively (Ostashevsky, 2016). This problem is compounded by the reality that many elementary teachers dislike mathematics (Johnson, 2018), as elementary teachers who have a negative relationship with mathematics are less likely to implement reform-based approaches for teaching it (Wilkins, 2008). It is now more than a decade since the release of the CCSS-M, but traditional mathematics instruction is still prevalent in elementary schools and reform-based mathematics instruction has not been widely embraced (Boaler, 2019; Huinker, 2020; Spillane et al., 2018).

The purpose of this qualitative, interpretive phenomenological study was to explore, investigate, and interpret the lived experiences and perceptions of elementary mathematics teachers. Specifically, this study was designed to explore the experiences and perceptions of elementary mathematics teachers (a) who are trained to be generalists; (b) who teach all core academic subjects, including mathematics, in a self-contained classroom setting; and (c) who would describe themselves as either disliking or having disliked mathematics. The central

research question is: What are the lived experiences and perceptions of self-contained elementary teachers who dislike mathematics? The following subquestions were also addressed:

1. How have self-contained elementary teachers who dislike mathematics experienced mathematics?
2. How have self-contained elementary teachers who dislike mathematics experienced reform-based approaches for teaching mathematics?
3. How do self-contained elementary teachers who dislike mathematics perceive their own identity as a mathematics teacher?

The lived experiences and perceptions of these teachers were viewed through the lens of mathematics teacher identity in the context of mathematics education reform. A more thorough understanding of the lived experiences and perceptions of elementary teachers who dislike mathematics will enable mathematics educators to develop professional learning experiences designed to help both preservice and inservice elementary teachers (a) improve their relationship with mathematics and (b) increase both their willingness and their ability to implement reform-based mathematics teaching.

Chapter 2 includes a detailed discussion of the conceptual and theoretical frameworks used to guide the development of this study, followed by the findings of a review of existing literature regarding elementary mathematics teacher identity in the context of mathematics education reform. Topics include a historical context for efforts to reform elementary mathematics education in the United States, the evolution of reform-based mathematics teaching, identity and mathematics teacher identity, and factors that influence the development of mathematics teacher identity.

## Conceptual and Theoretical Frameworks

The purpose of a conceptual framework is to guide the development of a research study by informing both its design and direction (Ravitch & Riggan, 2017). According to Bloomberg and Volpe (2019), a researcher formulates a conceptual framework by "bringing together a number of related concepts to provide a broader understanding of a phenomenon of interest or of a research problem" (p. 165). The conceptual framework for this study was informed by two existing frameworks for mathematics teacher identity: Van Zoest and Bohl (2005) and Bennison (2015). These frameworks were purposefully selected to inform the development of this study because they account for the influence of both individual (psychological) and cultural (sociological) factors on the development of mathematics teacher identity. This is consistent with recommendations that mathematics teacher identity research should take a "psycho-social" approach, rather than one that is purely psychological or purely sociological (Lutovac & Kaasila, 2014).

### Conceptual Framework

Van Zoest and Bohl's (2005) Mathematics Teacher Identity Framework provides the foundation for the conceptual framework of this study. This framework accounts for the influence of cognitive, affective, and social factors on mathematics teacher identity, and is based on the premise that forms of learning and knowing lie on a continuum between purely "in-the-brain" and purely "social" (Van Zoest & Bohl, 2005). Within this continuum there are two components that interact and overlap to form an individual's mathematics teacher identity, "aspects of self-in-mind," and "aspects of self-in-community."

#### *Aspects of Self-In-Mind*

Aspects of self-in-mind include the individual factors that contribute to the development of mathematics teacher identity. Aspects of self-in-mind are cognitive in nature and consist of

pure knowledge. Van Zoest and Bohl (2005) defined knowledge as "ideas that are universally socially accepted, or nearly so, and not open for public debate" (p. 334). As a result, knowledge is placed on the furthest in-the-brain end of the learning and knowing continuum.

**Knowledge.** Included within aspects of self in mind are three categories of knowledge that a mathematics teacher must develop, which Van Zoest and Bohl (2005) termed domains of cognition and action. The domains of cognition and action were formed by consolidating the seven categories of knowledge and teaching as identified by Shulman (1987, as cited in Van Zoest & Bohl, 2005) into three categories: Content and curricular knowledge, pedagogical knowledge, and professional participation.

### *Overlap Between Aspects of Self-in-Mind and Aspects of Self-in-Community*

Van Zoest and Bohl (2005) theorized that the three categories of knowledge also have a parallel consisting of beliefs. Knowledge and beliefs both contribute to the development of mathematics teacher identity and are related yet distinct. This is evidenced by the fact that it is possible for two teachers to have the same mathematical knowledge but have very different beliefs about how to teach it (Van Zoest & Bohl, 2005).

**Beliefs, Commitments, and Intentions.** Van Zoest and Bohl's (2005) model consolidates beliefs, commitments, and intentions into one category. Beliefs are defined as "conceptions that are not universally held and thus are subject to public debate" (p. 334). Beliefs are founded on values, which provides an explanation for why people with the same knowledge and in the same situation might act in very different ways. According to Van Zoest and Bohl (2005), commitments and intentions "encompass one's desires to either act or not in response to particular situations and the reasons for doing so" (p. 334). Beliefs, along with commitments and intentions, contribute to the development of mathematics teacher identity. The development of beliefs is often based on the belief system of others, as a result they are considered more socially

responsive than knowledge and are placed further toward the social end of the learning and knowing continuum. However, beliefs, commitments, and intentions also involve in-the-brain cognition. As a result, they fall within both aspects of self-in-mind and aspects of self-in-community.

### *Aspects of Self-In-Community*

Aspects of self-in-community include the purely social factors that contribute to the development of mathematics teacher identity (Van Zoest & Bohl, 2005). One component of mathematics teacher identity that is purely social in nature is perceptions. Van Zoest and Bohl (2005) defined perceptions as "the individual's and other's perceptions of each other" within a particular community (p. 336), including the perceptions others in the community have of the individual, the individual's perceptions of others in the community, and the individual's perceptions of the perceptions of the other people in the community. Individuals develop personal beliefs, commitments, and intentions according to the expectations of a particular community and their sense of belonging to it. As a result, these different types of perceptions interact to influence how the individual views themselves and their practice in relation to others.

The second component of mathematics teacher identity that is purely social in nature is dimensions of competence. According to Van Zoest and Bohl (2005), "competence, or lack thereof, with modes of participation can make teachers either good or bad at what they do regardless of how much knowledge they have in their heads about what they are trying to do" (p. 336). The three dimensions of competence in the model include mutuality of engagement, accountability to a joint enterprise, and negotiability of a shared repertoire.

Mutuality of engagement relates to a teacher acting in a way that is accepted and expected within a given community. Teachers learn it through interactions with students in their classrooms, with other teachers in their school, or within larger professional communities (Van

Zoest & Bohl, 2005). Accountability to an enterprise relates to how a teacher determines when they are doing what is considered by the community to be good work. It is based on the standards for performance, implicit and explicit, that are established within a community. As a result, major reform-based initiatives might be seen as challenging accountability to enterprise because they "consist of a body of reformed visions of beliefs, commitments, and intentions regarding what, how, to whom, and why mathematics should be taught" (Van Zoest & Bohl, 2005, p. 337). Negotiability of a repertoire explains that teachers base their actions on the knowledge, experience, and history of practice that has been accumulated by the community to which they belong. As a result, an individual's mathematics teacher identity is shaped by the collective expertise of the community as a whole. Major reform initiatives can be seen as a challenge to the existing body of collective expertise and history of practice, which is often deeply entrenched within mathematics teachers and even within society as a whole. This makes it difficult for teachers who are attempting to change their practice (Van Zoest & Bohl, 2005).

According to Van Zoest and Bohl (2005), the three dimensions of competence explain how membership in a community and engaging in the practices of a community contributes to the development of mathematics teacher identity. Competence is learned and determined solely through interactions with others in a community; therefore, it is placed on the extreme social end of the knowing and learning continuum.

The Bennison (2015) Mathematics Teacher Identity Framework was selected to inform the development of this study because it expanded the framework previously developed by Van Zoest and Bohl (2005). Van Zoest and Bohl (2005) theorized that mathematics teacher identity is influenced by cognitive, affective, and social factors. However, Bennison (2015) argued that Van Zoest and Bohl's (2005) framework failed to recognize two additional factors that also influence mathematics teacher identity: past experiences, and external factors.

As a result, the Bennison (2015) Mathematics Teacher Identity Framework identified five "domains of influence" that affect mathematics teacher identity: the knowledge domain, the affective domain, the social domain, the life history domain, and the context domain. The knowledge domain included three types of teacher knowledge that affect mathematics teacher identity: mathematical content knowledge, curricular knowledge, and pedagogical knowledge (Bennison, 2015). The affective domain includes factors that influence a teacher's relationship with mathematics, including mathematics anxiety and mathematics teaching self-efficacy (Bennison, 2015). The social domain recognizes the impact of relationships with students, other teachers, administrators, and professional learning communities on mathematics teacher identity, along with normative practices that might exist within teaching communities (Bennison, 2015). The life history domain acknowledges that past experiences with mathematics as a student (e.g., those that occurred in K–12 schooling or teacher preparation programs) influences the development of a teacher's identity as both a learner and a teacher of mathematics (Bennison, 2015). Finally, the context domain includes external factors that might influence mathematics teacher identity (e.g., school policies, professional development opportunities, time provided for planning, and mandated assessments; Bennison, 2015).

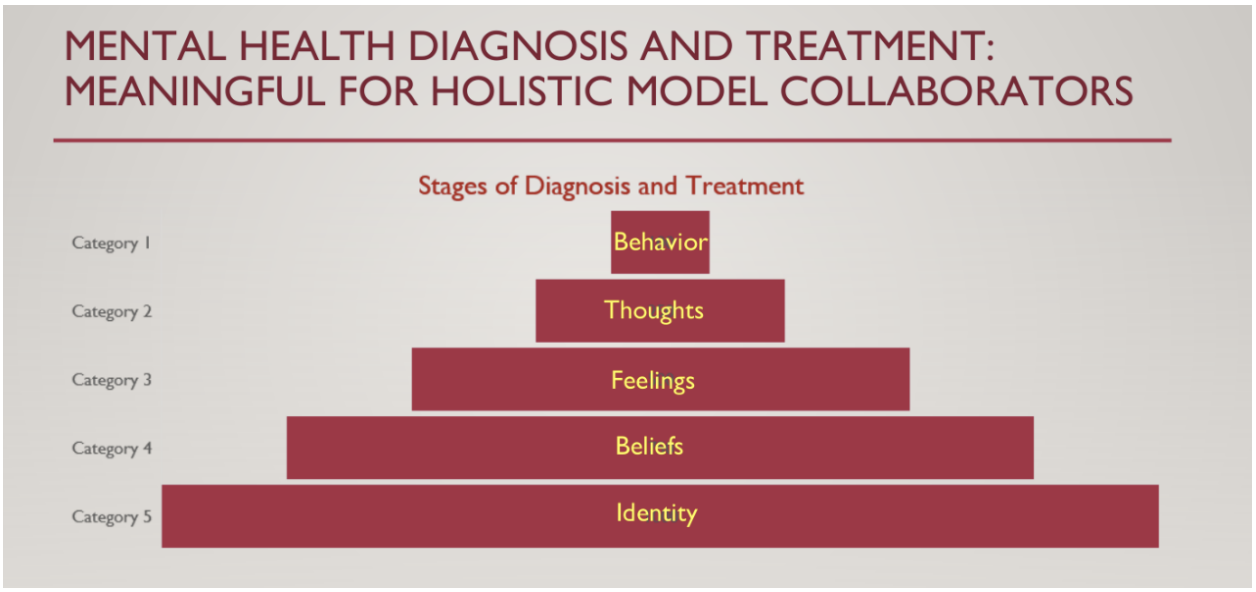
**Theoretical Framework**

A theoretical framework is the formal theory used to support the conceptual framework of a research study (Ravitch & Riggan, 2017). According to Bloomberg and Volpe (2019), "a conceptual framework is derived from concepts, and a theoretical framework is derived from theory" (p. 166). The theoretical framework used to support the conceptual framework of this study is the Ladd (2018) model of holistic identity and personal change. This model was developed for use by mental health practitioners to describe the levels of personal change that occur when counseling clients. It originated as a holistic model of personal change (Ladd &

Churchill, 2012), and was later expanded by Ladd (2018) to include a holistic model of identity (see Figure 1).

**Figure 1**

*Model of Holistic Identity and Personal Change*




*Note*. Ladd, P. D. (2018). *Mental Health Diagnosis and Treatment: Meaningful for Whom?* [PowerPoint slides]. St. Lawrence University.

Ladd (2018) explained that, in the field of mental health therapy, identity can be seen to control the entire structure of personal change. Interventions designed to help individuals achieve a desired personal change traditionally target the lower levels of the Holistic Identity and Personal Change Model (thoughts and behaviors). It is easier for an individual to achieve change at the lower levels of the model (thoughts and behaviors); however, changes made at the lower levels of the model (thoughts and behaviors) do not result in lasting changes to the higher levels of the model (identity and beliefs). Therefore, it is likely that these changes would be temporary and that permanent changes to the desired behavior would not be achieved.

Ladd (2018) theorized that, to achieve lasting personal change, interventions must instead target the highest levels of the Holistic Identity and Personal Change Model (identity and beliefs). An individual's identity affects their beliefs, their beliefs affect their feelings, their feelings affect their thoughts, and their thoughts affect their behavior. Therefore, when an individual's identity is changed first, changes to their beliefs, feelings, thoughts, and behaviors will follow. It is likely, in this case, that the desired behavioral change would become permanent.

Ladd's (2018) Holistic Identity and Personal Change Model informed this study of self-contained elementary teachers who dislike mathematics in two important ways. First, it provided a holistic conceptualization of identity as consisting of an individual's behaviors, thoughts, feelings, and beliefs. Second, it provided a theory that could help to explain why efforts to enact personal change are not always effective. The successful implementation of reform-based mathematics instruction requires elementary teachers to make significant changes to their teaching practice, and many elementary teachers have struggled to achieve this change. Ladd's (2018) Holistic Identity and Personal Change Model, along with Van Zoest and Bohl's (2005) and Bennison's (2015) Mathematics Teacher Identity Frameworks, enabled the lived experiences and perceptions of the self-contained elementary teachers who dislike mathematics that participated in this study to be viewed through the lens of mathematics teacher identity in the context of mathematics education reform.

## Related Literature

This literature review provides a synthesis of relevant literature regarding elementary mathematics teacher identity in the context of mathematics education reform. The opening section provides a historical context for this study by tracing the history of mathematics education reform efforts in the United States. The second section traces the evolution of reform-based mathematics instruction and clarifies the difference between traditional and reform-based approaches. The

third section explores the body of existing research within the construct of mathematics teacher identity, and the fourth and final section explores the cognitive, affective, and social factors that influence mathematics teacher identity.

## Historical Efforts to Improve Mathematics Education in the United States

In the United States, the traditional approach to mathematics education is characterized by a teacher-centered model of instruction and an emphasis on the rote memorization of facts and procedures (Kartal & Tillett, 2021). Reformers have advocated for a shift away from the traditional approach toward a reform-based approach, which is characterized by a student-centered, problem-based model of instruction that focuses on the development of deep conceptual understanding, mathematical reasoning, and number sense (Kartal & Tillett, 2021). Efforts to replace traditional mathematics instruction with reform-based mathematics instruction have been underway for several decades, but these efforts have met with heavy resistance and have been largely unsuccessful (Epstein & Miller, 2011). The New Math Reform Movement of the 1960s failed to accomplish this objective largely because of resistance from elementary teachers and parents, and resistance of a similar nature to the Standards-Based Reform Movement of the 1980s led to the bitter and controversial "Math Wars" of the 1990s (Epstein & Miller, 2011). At the present time, educators are in the midst of the Common Core era, a third such reform movement.

### *The New Math Reform Movement*

Concerns about mathematics education in the United States began to surface as early as the 1940s, but it took the launch of Sputnik by the Soviet Union and the resulting National Defense Education Act to initiate the first large-scale mathematics education reform movement (Herrera & Owens, 2001). This reform effort, nicknamed the "New Math" movement, took place during the 1960s and aimed to shift the emphasis of mathematics education away from the rote memorization of procedures and arithmetic toward the development of a deep conceptual

understanding of mathematics (Knudson, 2015). Although it was largely successful in reforming mathematics instruction at the high school level, the New Math Reform Movement ultimately met its demise in elementary schools (Isabrucker, 2021). Efforts to change the way mathematics was taught in elementary school were met with high levels of resistance both from parents, who could no longer understand their child's homework, and from teachers, who were not adequately prepared to teach it (Isabrucker, 2021; Knudson, 2015). As a result, elementary teachers, the majority of whom were trained to be generalists and not mathematics specialists, "did not cope well with the New Math Reform Movement and failed to develop the skills to teach it successfully" (Epstein & Miller, 2011, p. 6). By the 1970s, the New Math Reform Movement had fallen into disfavor and was considered a failure. A "back to the basics" movement resulted, which advocated for a return to teaching mathematics in traditional ways (Knudson, 2015).

### *The Standards-Based Mathematics Reform Movement*

By the late 1980s, it had become clear that the United States was facing a mathematics education crisis (Herrera & Owens, 2001). The federal government was no longer willing to intervene in matters of curriculum reform because of the failure of the New Math Reform Movement, so the NCTM stepped in to fill the void (Herrera & Owens, 2001). Between 1989 and 1995, the NCTM released a series of three policy documents regarding mathematics instruction in grades K-12. Collectively, these three documents established the NCTM's vision for what changes needed to be made to achieve high quality mathematics instruction. Nicknamed "The Standards," these three documents provided the foundation for what became known as the Standard-Based Reform Movement (Herrera & Owens, 2001).

In 1989, the NCTM issued a new set of standards for curriculum and evaluation intended to improve student learning in mathematics. This document established five essential goals for student learning in every grade, K–12: (a) students must learn to value mathematics, (b) students

must become confident in their ability to do mathematics, (c) students must become mathematical problem solvers, (d) students must learn to communicate mathematically, and (e) students must learn to reason mathematically. To meet these goals, NCTM called for mathematics instruction to become more student centered and discovery based. In 1991, the NCTM released a new set of professional standards for teaching mathematics intended to improve the quality of mathematics teaching. This document called for mathematics teachers at all grade levels to make significant pedagogical changes to meet the ambitious new goals for student learning established by NCTM (1989). NCTM (1991) called for mathematics teachers in all grades, K-12, to "alter their role from the accepted position of transmitter of knowledge to a new, therefore, uncomfortable position as facilitator - one who engages the class in mathematical investigations, orchestrates classroom discourse, and creates a learning environment that is mathematically empowering" (Herrera & Owens, 2001, p. 90). In 1995, the NCTM added a new set of standards designed to improve the quality of mathematics assessment. Together, these three documents established NCTM's vision of the changes needed to achieve high quality teaching in learning in K–12 mathematics and launched the Standard-Based Reform Movement (Herrera & Owens, 2001).

**The Math Wars**. The NCTM's launch of the Standards-Based Reform Movement ignited a period of heated controversy and intense debate during the 1990s known as the "Math Wars" (Epstein & Miller, 2011). The Math Wars were characterized by a division between those who supported the NCTM's Standards-Based Reform Movement and those who favored teaching mathematics with the traditional approach. Those who supported the Standards-Based Reform Movement believed in a student-centered approach to mathematics instruction in which students gain a deeper understanding of mathematical concepts by engaging with real-world situations, struggling with complex problems, comparing different strategies and solution paths, and engaging in trial and error (Kuhn & Dempsey, 2011). Those who opposed the Standards-Based

Reform Movement favored the traditional, teacher-centered approach to mathematics instruction which emphasized the development of computational skills and the rote memorization of procedures, algorithms, and facts (Kuhn & Dempsey, 2011).

Many of the same mistakes that had led to the demise of the New Math Reform Movement were repeated in the Standard-Based Reform Movement (Kuhn & Dempsey, 2011). Resistance was driven in large part by parents and teachers who had only experienced traditional mathematics instruction and wanted to return to the ways of doing mathematics that they knew, just as it had been with the New Math Reform Movement (Kuhn & Dempsey, 2011). In addition, the logistics of implementing standards-based mathematics teaching were underestimated. Teachers who had only learned mathematics in traditional ways themselves did not have the level of conceptual understanding required to teach standards-based mathematics effectively (Isabrucker, 2021). They were also expected to implement new and innovative instructional practices, but little training or support was provided to help them learn how to do so (Schoenfeld, 2004). In addition, many parents who felt alienated by the "new" approaches to mathematics instruction sought legal assistance to fight the reform effort (Schoenfeld, 2004). The future of the Standards-Based Reform Movement was at risk.

In 2001, the National Research Council (NRC) released *Adding It Up: Helping Children Learn Mathematics*, a landmark publication that supported the NCTM's efforts and helped to revive the Standards-Based Reform Movement. This publication was significant because it expanded and deepened the definition of what it means to be mathematically proficient given the increased expectations of the standards-based era. Traditionally in the United States, mathematical proficiency had been considered to have only one component: computational and procedural fluency. The NRC (2001) expanded the definition of mathematical proficiency to include not only computational and procedural fluency, but also strategic competence, conceptual

understanding, adaptive reasoning, and productive disposition (NRC, 2001). This marked a significant turning point in the history of mathematics education reform because it established, for the first time, a vision of mathematical proficiency based not only on a student's skills and abilities, but also on their knowledge, attitudes, and beliefs (NRC, 2001).

### *The Common Core Mathematics Reform Movement*

In 2010, the Common Core State Standards Initiative (CCSSI; 2010a,b) once again elevated the mathematics education reform movement into the national spotlight. The CCSSI, a joint effort of the National Governors Association Center for Best Practices and the Council of Chief State School Officers, established uniform national K–12 content standards in both English language arts and mathematics. The CCSS-M were informed by research conducted on countries that perform at high levels in mathematics (CCSSI, 2010a). The CCSS-M contain mathematical content standards for Grades K-12 which called for increased levels of rigor compared to previous standards. According to CCSSI (2016), increasing rigor does not mean making mathematics harder or introducing topics at earlier grades, but instead means fostering a deeper conceptual understanding of mathematics by focusing on conceptual understanding, procedural fluency, and real-word application "with equal intensity" (para. 6).

In addition to the mathematical content standards, the CCSS-M also established standards for mathematical practice. According to CCSSI (2010b), the eight standards for mathematical practice describe what a mathematically proficient student in any grade level must be able to do. They include (a) make sense of problems and persevere in solving them, (b) reason abstractly and quantitatively, (c) construct viable arguments and critique the reasoning of others, (d) model with mathematics, (e) use appropriate tools strategically, (f) attend to precision, (g) look for and make use of structure, and (h) look for and express regularity in repeated reasoning (CCSSI, 2010b).

The release of the CCSS-M in 2010 marked the first time that national standards mandated a shift from traditional to reform-based mathematics instruction. As a result, the CCSS-M provides an unprecedented opportunity to achieve systematic improvement in mathematics education (NCTM, 2014). Since their release, however, many elementary teachers in the United States have struggled to teach the CCSS-M effectively (Ostashevsky, 2016). According to the NCTM (2014), an "unproductive reality" exists because too many classrooms, schools, and districts continue to emphasize learning mathematical algorithms and procedures without making connections to meaning, understanding, or application (NCTM, 2014, p. 3). As a result, too many students are still not achieving high levels of learning in mathematics (NCTM, 2014).

## The Evolution of Reform-Based Mathematics Instruction

In the current era, mathematics instruction in the United States is driven by the CCSS-M, a set of national standards for Grades K–12 designed with the goal of improving mathematics achievement. The CCSS-M differ from previous standards in that they provide not only content standards that detail the mathematical content to be taught at each grade level, but also provide standards for mathematical practice which describe what a mathematically proficient student at any grade level should be able to do (CCSSI, 2010).

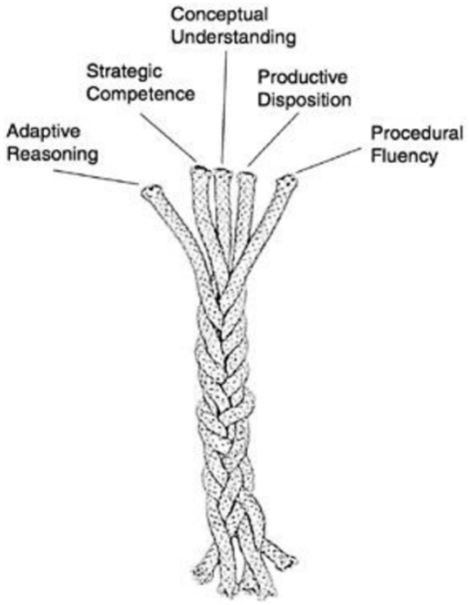
### *Mathematical Proficiency*

Prior to the Standards-Based Reform Movement, mathematical proficiency in the United States had been equated with computational and procedural fluency. In 2001, however, the NRC released *Adding It Up: Helping Children Learn Mathematics*, a landmark publication which significantly broadened and deepened the view of mathematical proficiency. The NRC (2001) marked a monumental shift within the mathematics education community because it established a new, multidimensional view of mathematical proficiency as being composed of five interwoven components, or "strands." The five strands, which were identified and defined from research in

the field of cognitive science, "provide a framework for discussing the knowledge, skills, abilities, and beliefs that constitute mathematical proficiency" (NRC, 2001, p. 16; see Figure 2).

**Figure 2**

*Interwoven Strands of Mathematical Proficiency*




*Note*. From *Adding It Up: Helping Children Learn Mathematics*, by the National Research Council, 2001, National Academies Press.

The release of NRC (2001) and the expanded vision of mathematical proficiency it provided marked a monumental shift within the mathematics education community. The following section will provide a detailed description of each of the five strands.

**Conceptual Understanding**. Conceptual understanding refers to a deep understanding of mathematical concepts that goes beyond knowing how to apply facts and procedures in isolation (NRC, 2001). According to NRC (2001), it is important for students to develop a strong conceptual understanding of mathematics because "knowledge that has been learned with understanding provides the basis for generating new knowledge and for solving new and

unfamiliar problems" (p. 119). Students who possess strong conceptual understanding do not rely on rote memorization, mnemonics, or other tricks to remember mathematical facts and procedures. Although such approaches might enable students to perform mathematical operations more quickly in the short-term, they are not connected to conceptual understanding so can be easily forgotten. Students who develop a deep conceptual understanding of why the mathematical procedures work are more likely to remember them correctly than those who simply memorize without understanding. Therefore, conceptual understanding significantly enhances long-term retention (NRC, 2001).

**Procedural Fluency**. Prior to the release of the strands of mathematical proficiency framework (NRC, 2001), successful learning in mathematics was equated with the development of procedural fluency. Procedural fluency is defined as "skill in carrying out procedures flexibly, accurately, efficiently, and appropriately" (NRC, 2001, p. 116). According to the NRC (2001), procedural fluency and conceptual understanding should not be viewed in opposition to each other, but as strands of mathematical proficiency that are mutually dependent. Students are still expected to perform calculations accurately and efficiently, but shifting the focus of procedural fluency from an emphasis on rote memorization to an emphasis on the development of a deep conceptual understanding of why the procedures work leads to increased long-term retention and higher levels of skill. In addition, NRC (2001) stated, "It is not as critical as it once was, for example, that students develop speed or efficiency in calculating with large numbers by hand, and there appears to be little value in drilling students to achieve such a goal" (p. 121). Students who understand why procedures work are more likely to use them correctly and are better able to apply them to problem-solving situations (NRC, 2001).

**Strategic Competence**. Strategic competence is defined as "the ability to formulate, represent, and solve mathematical problems" which is often referred to as "problem solving"

(NRC, 2001, p. 124). According to the NRC (2001), students who possess strategic competence approach problem solving situations by first constructing a mental representation of the problem and then using their model to determine how the problem might be solved. This contrasts with a superficial, "number grabbing" approach that is often employed by students who lack strategic competence, in which they first focus on the numbers in the problem then attempt to use keywords to determine which operation to use. According to the NRC (2001), "flexibility of approach is the major cognitive requirement for solving non-routine problems" (p. 127). Strategic competence enables students to devise a solution path for nonroutine problems, which are problems that the student does not immediately know how to solve based on their past experience. To develop strategic competence, students must practice constructing models to represent problem solving situations (NRC, 2001).

**Adaptive Reasoning**. Adaptive reasoning is defined as "capacity for logical thought, reflection, explanation, and justification" (NRC, 2001, p. 116). Students who possess adaptive reasoning can see the relationship between concepts, facts, and procedures. They can determine appropriate strategies to employ in different problem-solving situations, and can justify their decisions, can determine if the solutions they arrive at make sense, and can generate alternative strategies if necessary. Adaptive reasoning includes "not only informal explanation and justification, but also intuitive and inductive reasoning based on pattern, analogy, and metaphor" (NRC, 2001, p. 129). According to the NRC (2001), adaptive reasoning "is the glue that holds everything together, the lodestar that guides learning" in mathematics (p. 129). Because proficiency with adaptive reasoning develops over an extended period of time, it must be a focus of mathematics instruction beginning at the youngest elementary grades (NRC, 2001).

**Productive Disposition**. Productive disposition is defined as "a habitual inclination to see mathematics as sensible, useful, and worthwhile, coupled with a belief in diligence and one's own

efficacy" (NRC, 2001, p. 131). According to the NRC (2001), students with a productive disposition in mathematics have positive beliefs both about mathematics as a subject and about themselves as mathematics learners. They identify mathematics as being valuable and important and believe that their ability in mathematics can grow and develop over time through hard work and effort. They are more likely to challenge themselves and persevere through nonroutine and difficult problem-solving situations (NRC, 2001).

According to the NRC (2001), a student's disposition toward mathematics "is a major factor in determining their educational success" (NRC, 2001, p. 131). Students who lack a productive disposition in mathematics have a tendency to believe that their ability in mathematics is fixed, and that no amount of hard work and effort will change it (NRC, 2001). These students quickly lose confidence in their ability to solve problems, so they avoid challenging situations and are easily frustrated by mistakes. They develop a negative relationship with mathematics and often avoid taking higher-level mathematics classes when they reach high school, which precludes them from careers in STEM and other fields that require mathematical proficiency (NRC, 2001).

Productive disposition is interdependent with the other strands of mathematical proficiency (NRC, 2001). According to the NRC (2001), students must have a productive disposition toward mathematics to develop conceptual understanding, procedural fluency, strategic competence, and adaptive reasoning. Conversely, as students become increasingly proficient with the other strands over time, their confidence grows, and their productive disposition increases along with it. The NRC (2001) was significant because it expanded the previously held definition of mathematical proficiency to include an affective component—productive disposition—for the first time. This established productive disposition as a new construct within the field of mathematics education (NRC, 2001).

### *Standards for Mathematical Practice*

In 2000, the NCTM released *Principles and Standards for School Mathematics*, which contained new mathematical content and process standards designed to inform mathematics instruction in Grades P–12. The intent of the mathematical process standards was to describe what mathematics instructional programs at every grade level, P–12, should provide students the opportunity to do. The five mathematical process standards included (a) problem solving, (b) reasoning and proof, (c) communication, (d) connections, and (e) representation (NCTM, 2000).

In 2010, the CCSS-M were released. The CCSS-M included standards for the specific mathematical content to be taught in Grades P–12, along with standards for mathematical practice that describe what a mathematically proficient student at any grade level should be able to do (CCSSI, 2010b). The standards for mathematical practice were created by combining the mathematical process standards (NCTM, n.d.), with the strands for mathematical proficiency (NRC, 2001). They include (a) make sense of problems and persevere in solving them, (b) reason abstractly and quantitatively, (c) construct viable arguments and critique the reasoning of others, (d) model with mathematics, (e) use appropriate tools strategically, (f) attend to precision, (g) look for and make use of structure, and (h) look for and express regularity in repeated reasoning (CCSSI, 2010b). The intent of the standards for mathematical practice was to ensure that students at every grade level have the opportunity to engage with mathematics in meaningful ways (CCSSI, 2010b).

### *Ambitious Mathematics Teaching*

The CCSS-M are a set of world-class standards released in 2010 with the goal of improving mathematics achievement in the United States (Huinker & Bill, 2017). However, since their release, many elementary teachers have struggled to teach the CCSS-M effectively

(Ostashevsky, 2016) According to NCTM (2014), successful implementation of the CCSS-M has been hampered by the existence of dominant cultural beliefs about the teaching and learning of mathematics. Many parents and teachers believe that students should be taught mathematics as they were, with the use of instructional practices that emphasize the rote memorization of facts and procedures through repetitive practice. Such beliefs have perpetuated the use of traditional models of mathematics instruction, which are still pervasive in many elementary classrooms (NCTM, 2014).

In response, the NCTM has provided guidance for teachers regarding how to change their teaching practices to meet the rigorous demands of the CCSS-M (Huinker & Bill, 2017; NCTM, 2014). In 2017, the NCTM published Huinker & Bill's (2017) *Taking Action: Implementing Effective Mathematics Teaching Practices*. In this publication, Huinker and Bill (2017), explained that meeting the raised expectations for student learning as set forth in the CCSS-M requires teachers to implement a reform-based approach referred to as "ambitious mathematics teaching" (p. 3). Ambitious mathematics teaching is characterized by the use of eight effective teaching practices and five practices for equity-based instruction designed to support mathematics learning (Huinker & Bill, 2017).

According to Huinker and Bill (2017), ambitious mathematics teaching uses a set of eight effective teaching practices that support student learning and engagement. Collectively, these practices represent "a core set of high-leverage practices and essential teaching skills necessary to promote deep learning of mathematics" (NCTM, 2014, as cited in Huinker & Bill, 2017, p. 4). The eight effective teaching practices were developed by the NCTM from decades of research, and were published in *Principles to Action: Ensuring Mathematical Success For All* (NCTM, 2014). They include (a) establish mathematics goals to focus on learning, (b) implement tasks that promote reasoning and problem solving, (c) use and connect mathematical representations,

(d) facilitate meaningful mathematical discourse, (e) pose purposeful questions, (f) build procedural fluency from conceptual understanding, (g) support productive struggle in learning mathematics, and (h) elicit and use evidence of student thinking (Huinker & Bill, 2017).

Ambitious mathematics teaching also uses a set of five equity-based practices to ensure that mathematics instruction is equitable for all students (Huinker & Bill, 2017). These practices are also informed by decades of research, and collectively have been shown to "strengthen mathematical learning and cultivate positive student mathematical identities" (Huinker & Bill, 2017, p.6). The five equity-based practices for mathematics instruction include (a) go deep with mathematics, (b) leverage multiple mathematical competencies, (c) affirm mathematics learners' identities, (d) challenge spaces of marginality, and (e) draw on multiple resources of knowledge (Huinker & Bill, 2017, p. 6).

Research has linked ambitious mathematics teaching to increased student achievement in mathematics, particularly on assessments requiring high levels of cognitive demand (Huinker & Bill, 2017). However, ambitious mathematics teaching is challenging and complex and represents an approach to teaching mathematics that is very different from what most teachers experienced as elementary students (Huinker & Bill, 2017). It has now been more than a decade since the release of the CCSS-M, but ambitious mathematics teaching has not been widely embraced (Huinker & Bill, 2017).

**Identity, Teacher Identity, and Mathematics Teacher Identity**

Ladd's (2018) Holistic Identity and Personal Change Model provided the theoretical framework for this study and was discussed in detail earlier in this chapter. In this model, identity is conceptualized as an individual's beliefs, feelings, thoughts, and behaviors (Ladd, 2018). Ladd (2018) also explained that, in the field of mental health therapy, identity can be seen to control the entire structure of personal change. Interventions designed to help individuals achieve a desired

personal change traditionally target the lower levels of the Holistic Identity and Personal Change Model (thoughts and behaviors). It is easier for an individual to achieve change at the lower levels of the model (thoughts and behaviors); however, changes made at the lower levels of the model (thoughts and behaviors) do not result in lasting changes to the higher levels of the model (identity and beliefs). Therefore, it is likely that these changes will be temporary and that permanent changes to the desired behavior will not be achieved.

Gee (2000) defined identity as "what it means to be a certain kind of person in a given context" (p. 100). This perspective connects a person's identity to their performance in society rather than their internal state. Gee (2000) theorized that there are four different but interrelated ways to view identity, which are differentiated by the power that determines them and the source of this power. They include nature identity, institutional identity, discourse identity, and affinity identity.

Gee (2000) described nature identity as a state of mind that is not something that an individual accomplishes or does (e.g., being a twin). Nature identity is determined by forces outside the control of both the individual and society (e.g., genetics), and the source of this power is nature. Gee (2000) described institutional identity as a position that is not given by nature and is not something that a person can accomplish on their own (e.g., being a professor). Institutional identity is determined by a set of authorities (e.g., a board of trustees), and the source of this power is an institution (e.g., a university). Gee (2000) described discourse identity as an individual trait that is not given by nature or an institution but cannot be accomplished by an individual on their own (e.g., being charismatic). Discourse identity is determined by a discourse or dialogue among others, and the source of this power is other rational people. Finally, Gee (2000) described affinity identity as a social experience where an individual is choosing to be part of a group that participates in a set of specific practices and experiences. Affinity identity is not

determined either by nature, an institution, or the discourse of others, but by the practices of the affinity group. Therefore, the source of this power is the affinity group itself. Gee (2000) considered the four different perspectives of identity separately to account for the different factors that influence identity development but explained that an individual's actions in any given context might in fact reflect all four of the views (Gee, 2000).

From Gee (2000), it can be seen that another example of institutional identity is being a teacher. According to Sachs (2005),

> Teacher professional identity stands at the core of the teaching profession. It provides a framework for teachers to construct their own ideas of "how to be," "how to act" and "how to understand" their work and thelace in society. Importantly, teacher identity is not something that is fixed nor is it imposed; rather it is negotiated through experience and the sense that is made of that experience. (p. 15)

Hodgen and Askew (2006) theorized that significant professional change is emotionally difficult for teachers because it can be perceived as "deeply emotionally threatening" to a teacher's identity. According to Hodgen and Askew (2007),

> The notion of identity provides a way of understanding this difficulty. Fundamental changes in teachers' beliefs and knowledge necessitate fundamental changes to teachers' identities involving far more than "fixing" or "topping up" teachers' "inadequate" knowledge. Professional change, then, involves at least in part becoming a "different" teacher and a "different" person. Becoming "different" involves letting go of what one has been at the same time as maintaining the more fundamental aspects of one's identity (p. 474).

Although it is difficult to achieve teacher change in any subject, it is even more difficult in mathematics because mathematics generates more emotions than any other subject (Hodgen &

Askew, 2007). Hodgen and Askew (2007) used a qualitative approach to explore how elementary teachers who have a negative relationship with mathematics engaged in professional development designed to improve mathematics instruction. Findings of this study indicate that professional development, which attempts to improve mathematics instruction by focusing only on teacher knowledge, is doomed to fail and that professional development must address the emotional development necessary for change by giving teachers the opportunity to explore their identities as both mathematics learners and mathematics teachers (Hodgen & Askew, 2007).

There is a lack of consensus regarding how identity is conceptualized within the construct of mathematics teacher identity (Darragh, 2016; Lutovac & Kaasila, 2018; Willis et al., 2021). This is largely because mathematics teacher identity research has come from two very distinct theoretical paradigms: the psychological perspective and the sociological perspective (Darragh, 2016; Lutovac & Kaasila, 2018). From a psychological perspective, identity is viewed as a noun—something we "have" that is understood to be an individual acquisition. However, from a socio-cultural perspective, identity is viewed as a verb—something we "do," that is affected by ongoing activity or processes influenced by social context (Lutovac & Kaasila, 2018). This "action-acquisition" divide" between the psychological and socio-cultural perspectives (Darragh 2016, p. 27) has led to the use of different theoretical frameworks and different definitions of mathematics teacher identity within the field (Darragh, 2016; Lutovac & Kaasila, 2018; Willis et al., 2021).

Darragh (2016) cataloged the body of mathematics teacher identity research and found that five different definitions of identity have been used. The definitions differ according to whether identity is viewed as being participative, as narrative, as discursive, as psychoanalytic, or as performative (Darragh, 2016). Research that reflects a participative view of identity (Bennison, 2015; Sun, 2017; Van Zoest & Bohl, 2005) emphasized "the ways in which identity is constructed

through participation and engagement in a social group" (p. 24). Much research in this line has come from Wenger's (1998) community of practice theory, in which an individual's identity is said to be affected by their participation within a community of practice (Darragh, 2016). Research that reflects a narrative view of identity (Lutovac & Kaasila, 2014, Norman, 2021) "refers to a view of identity that makes use of the stories people tell, about mathematics for example" (p. 25). Much research in this line has been developed from Sfard and Prusak's (2005) theory in which identity is defined as "the set of stories people tell about themselves and others tell about them, specifically narratives that are reifying, endorsable and significant" (p. 16). Research that reflects a discursive view of identity (Gee, 2000) emphasizes "the spoken and written words, semiotic systems, representations, and gestures of participants as they use language to communicate, interact and act" (Bishop, 2012, p. 44, as cited in Darragh, 2016, p. 25). Much research in this line has come from the work of Foucault (Darragh, 2016). Research that reflects a psychoanalytic view of identity (Brown & McNamara, 2011) incorporates psychoanalysis into the study of identity, which often serves to deepen and critique the other views of identity (Darragh, 2016). Finally, research that reflects a performative view of identity (Gutiérrez, 2013; Neumayer-Depiper, 2013) emphasizes "the stylised repetition of acts over time that works to constitute one's identity" (Darragh, 2016, p. 26). Much research in this line has come from the theory of Butler (1988), which states, "Identity does not exist prior to the performance, rather it is constituted through performance" (Darragh, 2016, p. 26). These different definitions of identity are not distinct, and there is much overlap between them (Darragh, 2016). As a result, many researchers have chosen to use multiple perspectives of identity within a single study (Darragh, 2016).

The majority of research on mathematics teacher identity has taken a sociological perspective rather than a psychological one, and in doing so defines identity as an action or

process rather than something to be acquired (Darragh, 2016, Lutovac & Kaasila, 2018). Darragh (2016) advocated the use of a sociological perspective in mathematics teacher identity research. Darragh (2016) acknowledged the importance of teacher affect but cautioned that affect alone does not constitute identity and expressed concerns that defining identity as merely psychological could result in it becoming a catch-all for research in the affective domain. Darragh (2016) also warned researchers to avoid using a contradictory approach to mathematics teacher identity research, which occurs when researchers "discuss identity as if it were an acquisition despite having defined identity using a theoretical frame that views identity as an action" (p. 28), or when a sociological theory is used to define identity, but a psychological theory is used to analyze the participants and data.

Lutovac and Kaasila (2018) called for more research that views mathematics teacher identity from a psychological perspective. Although acknowledging the role that social context plays in shaping mathematics teacher identity, Lutovac and Kaasila (2018) argued the need for research to link both teacher cognition and teacher affect to mathematics teacher identity. According to Lutovac and Kaasila (2018),

> Both socio-cultural and post-structural perspectives focus more on social practices and structures, thereby considering an individual's inner world to be of minor importance. In our view, this highlights the misunderstanding of the social turn in mathematics education research (Lerman, 2013). Although an individual's identity is greatly shaped by the social contexts in which he or she evolves, we believe that by neglecting the individual, i.e., how one thinks and feels and who one is, is at odds with the core concept of identity itself (p. 767).

Lutovac and Kaasila (2018) also argued that failing to consider an individual's identity from a psychological perspective raises the question of "to what extent can such findings inform us about

how to assist pre- and in-service teachers in their identity development?" (p. 767). As a result, Lutovac and Kaasila (2018) called for future research to balance the psychological and socio-cultural perspectives of identity by taking what they term a "psycho-social" approach to the study of mathematics teacher identity.

**Factors that Influence Mathematics Teacher Identity**

Van Zoest and Bohl's (2005) and Bennison's (2015) Mathematics Teacher Identity Frameworks guided the development of the conceptual framework for this study and were discussed in detail earlier in this chapter. Each of these frameworks takes a psycho-social perspective of mathematics teacher identity by accounting for the contribution of both individual (psychological) and cultural (sociological) factors. Van Zoest and Bohl's (2005) framework is based on the premise that mathematics teacher identity is influenced by cognitive, affective, and social factors, and Bennison (2015) expanded Van Zoest and Bohl's (2005) framework by accounting for the influence of past experiences and external factors on mathematics teacher identity.

Bennison's (2015) framework includes five components, or domains of influence, that affect mathematics teacher identity. They include the knowledge domain, the affective domain, the social domain, the life history domain, and the context domain. According to Bennison (2015), the knowledge domain addresses three types of teacher knowledge that affect mathematics teacher identity, including mathematical content knowledge, curricular knowledge, and pedagogical knowledge. The affective domain includes factors that influence a teacher's relationship with mathematics, including mathematics anxiety and self-efficacy. The social domain recognizes the impact of relationships with students, other teachers, administrators, and professional learning communities on mathematics teacher identity, along with normative practices that might exist within teaching communities. The life history domain acknowledges

that past experiences with mathematics as a student (e.g., those that occurred in K–12 schooling or teacher preparation programs) influences the development of a teacher's identity as both a learner and a teacher of math. Finally, the context domain includes external factors that might influence mathematics teacher identity (e.g., school policies, professional development opportunities, time provided for planning, and mandated assessments; Bennison, 2015). In the remaining section of this literature review, the researcher synthesizes existing research regarding the cognitive, affective, and social factors that impact mathematics teacher identity.

### *Cognitive Factors That Impact Mathematics Teacher Identity*

The cognitive component of mathematics teacher identity consists of knowledge (Bennison, 2015; Van Zoest & Bohl, 2005). Effective mathematics teaching requires two types of knowledge, content knowledge, which is knowledge of mathematics, and pedagogical knowledge, which is knowledge about how to teach it (Ball et al, 2008; Ernest, 1989; Shulman, 1986). According to Ernest (1989), content knowledge is composed of several factors, including (a) extent and depth, (b) structure and unifying concepts, (c) knowledge of procedures and strategies, (d) links with other subjects, and (e) knowledge about mathematics as a whole and its history. Content knowledge "provides a foundation for the pedagogical knowledge and skills for teaching mathematics" because it "underpin(s) the teacher's explanations, demonstrations, diagnosis of misconceptions, acceptance of children's own methods, curriculum decisions (such as emphasizing central concepts), and so on" (Ernest, 1989, p. 4). As a result, content knowledge is a critical component of effective mathematics teaching.

The term "pedagogical knowledge" was first introduced by Shulman (1986), who described it as "the ways of representing and formulating the subject that make it comprehensible to others . . . [and an] understanding of what makes the learning of specific topics easy or

difficult" (p. 9). Pedagogical knowledge consists of both practical knowledge and curricular knowledge. Practical knowledge includes

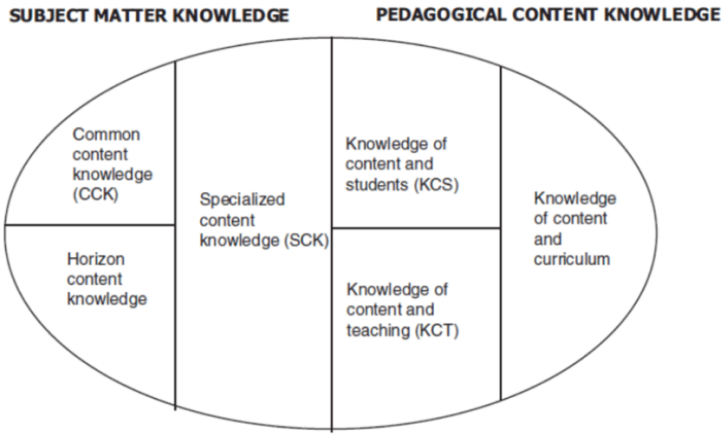
> knowledge of approaches to school mathematics topics; different ways of presenting mathematics including problem solving; knowledge of children's methods, conceptions, difficulties and common errors; knowledge of mathematical tasks, activities, explanations, test items, and so on (Ernest, 1989, p. 5)

and curricular knowledge is an understanding of the materials and resources that are used to carry out mathematics instruction and assessment. According to Ernest (1989), pedagogical knowledge is "vital to the planning and carrying out of mathematics teaching" because it "forms the essential bridge between academic subject matter knowledge and the teaching of subject matter" (p. 5). Teachers acquire pedagogical knowledge from their experiences of how they were taught mathematics as students, from their experiences gained in teacher-preparation programs, and from their experiences gained as practicing mathematics teachers.

The seminal work of Ball et al. (2008) built on the work of Shulman (1986) to develop a practice-based theory of "the mathematical knowledge required to carry out the work of teaching mathematics" (p. 395). In the Mathematical Knowledge for Teaching (MKT) framework, Ball et al. (2008) subdivided each of the two main categories of teacher knowledge as established by Shulman (1986)—subject matter knowledge and pedagogical content knowledge—into two three domains (Figure 3).

**Figure 3**

*Mathematical Knowledge for Teaching*




*Note*. From "Content Knowledge for Teaching: What Makes It Special?" by D. L. Ball, M. H. Thames, & G. Phelps, (2008). *Journal of Teacher Education, 59*(5), 389–407.

Ball et al. (2008) divided subject matter knowledge into three domains: Common content knowledge (CCK), specialized content knowledge (SCK), and horizon content knowledge (HCK). Common content knowledge is mathematical knowledge that is not unique to mathematics teaching and is used in other settings beyond the mathematics classroom. It is necessary because a teacher must understand the mathematics in the curriculum and be able to perform the mathematical work that they assign to their students. Examples include knowing the material, using mathematical terms and notations currently, completing calculations accurately, and recognizing whether a student gives a correct or incorrect response (Ball et al., 2008).

Specialized content knowledge is mathematical knowledge that is unique to mathematics teaching and not needed in other settings (Ball et al., 2008). It is important because mathematics teachers routinely perform tasks that require specialized mathematical understanding and reasoning that goes beyond what they are teaching to their students. Examples include appraising and adapting the mathematical content of textbooks, connecting a topic being taught to topics

from prior or future years, giving or evaluating mathematical explanations, responding to "why" questions from students, and asking productive mathematical questions (Ball et al., 2008).

Horizon content knowledge is knowledge of how mathematical concepts are related through the duration of an entire curriculum (Ball et al., 2008). For example, a first-grade teacher teaching about the nature of subtraction needs to understand how this will establish the foundation necessary to subtract multidigit whole numbers, fractions, decimals, and integers in later years. Horizon content knowledge would prevent this teacher from telling students that you always start with the bigger number and take away the smaller one. This is mathematically incorrect and would lead to confusion when students are later taught that you can in fact subtract 2 minus 5 and the answer is negative 3.

Ball et al. (2008) divided pedagogical content into three domains:
(a) knowledge of content and students (KCS), (b) knowledge of content and teaching (KCT), and (c) knowledge of content and curriculum (KCC). Knowledge of content and students can be understood as knowledge at the intersection of mathematics and students. This includes understanding patterns of emergent student thinking, including knowing and anticipating common student errors and misconceptions, choosing examples according to knowledge of what students will find interesting and motivating, and predicting what students will find challenging or easy (Ball et al., 2008). Knowledge of content and teaching can be understood as knowledge at the intersection of mathematics and teaching. Teaching mathematics requires a coordination of mathematical knowledge and an understanding of the available pedagogical options for teaching mathematical content and how they affect student learning. This includes knowledge of instructional design, how to sequence content to deepen understanding, and the ability to evaluate the advantages and disadvantages of the variety of methods, procedures, and representations that can be used to teach mathematical content (Ball et al., 2008). Knowledge of content and

curriculum is the equivalent of what Shulman (1986) had previously termed curricular knowledge. It refers to an understanding of the materials and resources that are used to carry out mathematics instruction and assessment.

Ball et al. (2008) acknowledged that a limitation of the MKT framework is that the divisions between the domains of knowledge are not distinct. As a result, it is often difficult to discern one type of knowledge from another given the "natural messiness and variability of teaching and learning" (p. 403). Ball et al. (2008) also acknowledged the need for research in the field of mathematics education to address not only knowledge, but also the "skills, habits, sensibilities, and judgments" that underlie the instructional decisions and practice of a mathematics teacher (p. 403).

### *Affective Factors that Impact Mathematics Teacher Identity*

It is possible for two teachers to have the same mathematical knowledge, but to take very different approaches to teaching it (Ernest, 1989, Van Zoest & Bohl, 2005). Therefore, to account for the differences in the instructional practices of mathematics teachers, it is necessary to consider not only their knowledge of mathematics, but also their beliefs about how it should be taught (Ernest, 1989). During the 1980s, the construct of teacher beliefs arose within the mathematics education community in response to the continued, prevalent use of instructional practices that were not aligned with a reform-based approach (Skott et al., 2013). Beliefs can be defined as "conceptions held with enough personal conviction to be considered true" (Fives & Buehl, 2016, p. 114). Beliefs are less cognitive than attitudes or emotions so are felt less intensely, but can be seen as lenses through which to view one's disposition to act (Philipp, 2007). Beliefs "underpin personal thought and behavior" and "underlie dispositions to engage in certain practices and not others" (Swan, 2006, p. 59). As a result, they can be difficult to change (Swan, 2006).

Beliefs have a greater impact on a teacher's willingness to implement reform-based approaches for teaching mathematics than either attitudes or knowledge (Wilkins, 2008). A mathematics teacher's beliefs affect their instructional practices (Askew et al., 1997; Ernest, 1989; Polly et al., 2013) and can either support or undermine their willingness to use reform-based approaches (Fives & Buehl, 2016; Schoen & LaVenia, 2019). Beliefs that are specific to mathematics teachers can be divided into three categories: (a) beliefs about the nature of mathematics, also known as epistemic beliefs; (b) beliefs about the teaching of mathematics, also known as pedagogical beliefs; and (c) beliefs about the learning of mathematics, also known as ability beliefs (Ernest, 1989, Fives & Buehl, 2016).

**Beliefs About the Nature of Mathematics**. What a teacher believes about the nature of mathematics as a subject influences their instructional practices (Ernest, 1989; Fives & Buehl, 2016). Ernest (1989) identified three basic philosophies regarding the nature of mathematics that are commonly observed in teachers: problem solving, Platonist, and instrumentalist. Those with a problem-solving philosophy view mathematics as problem-driven, dynamic, and continually expanding. The existing body of mathematical knowledge is not deemed to be a finished product, but as being subject to human inquiry and in a constant process of revision driven by creation. Those with a Platonist philosophy regard mathematics as static and unchanging. The existing body of mathematical knowledge is believed to consist solely of structures and truths, and mathematics is seen as something to be discovered rather than something to be created. Finally, those with an "instrumentalist" philosophy view mathematics as a set of facts, rules, and skills that are useful in isolation, but are unrelated. These different beliefs result in different outcomes in the classroom (Ernest, 1989, Fives & Buehl, 2916). For example, teachers with a Platonist or instrumentalist view of mathematics typically insist that students use what is considered the one correct method for solving a problem, whereas teachers with a problem-solving view of

mathematics will encourage and accept a variety of different student-invented approaches (Ernest, 1989).

Past efforts to reform mathematics instruction in the United States have reflected these different beliefs. The New Math Reform Movement of the 1960s called for a decreased emphasis on calculations and procedures and an increased emphasis on developing understanding of the laws, structures, and concepts that underlie mathematics. This was an effort to shift mathematics education in the United States from an instrumentalist to a Platonist view (Ernest, 1989). The resulting "Back to Basics" movement of the 1970s called for a return to the more traditional emphasis on memorizing facts, skills, and procedures without concern for conceptual understanding. This was an effort to shift mathematics education in the United States back to an instrumentalist view. The Standards-Based Reform Movement of the 1980s and 1990s, along with the CCSS-M movement of the current era, call for an increased emphasis on empowering students to become creative and confident problem solvers. This is an effort to shift mathematics education in the United States to reflect a problem-solving view. According to Fives and Buehl (2016), the Common Core State Standards require teachers to "support students in developing the perspective that mathematical knowledge is complex, evolving, and constructed through discipline-specific processes of reasoning and justification" (p. 118). This requires teachers to have similar beliefs about the nature of mathematics (Fives & Buehl, 2016).

**Beliefs About the Teaching of Mathematics**. What a teacher believes about the teaching of mathematics also influences their instructional practices (Ernest, 1989; Fives & Buehl, 2016, Polly et al., 2013). According to Ernest (1989), teachers construct mental models regarding how they believe mathematics should be taught. These "models of teaching" are defined as "a teacher's conception of the type and range of teaching actions and classroom activities contributing to his or her personal approaches to the teaching of mathematics" (Ernest, 1989,

p. 9). Ernest (1989) theorized that the models of teaching fall on a continuum between two opposing perspectives, one that views mathematics teaching as skills-based and the other that views mathematics teaching as creative and exploratory. Along this continuum are six different models of teaching, which include (a) the pure investigational problem posing and solving model, (b) the conceptual understanding enriched with problem-solving model, (c) the conceptual understanding model, (d) the mastery of skills and facts with conceptual understanding model, (e) the mastery of skills and facts model, and (f) the day-to-day survival model (Ernest, 1989).

Models of teaching are influenced by a teacher's beliefs about the nature of mathematics. For example, a Platonist view of mathematics results in a model of teaching in which the teacher is the explainer and the student is the passive receiver of the teacher's knowledge (Ernest, 1989). An instrumental view of mathematics leads to a model of teaching that emphasizes mastery of skills and the strict following of a curriculum or text. A problem-solving view of mathematics leads to a model of teaching in which the teacher is a facilitator and the students actively construct knowledge and understanding (Ernest, 1989).

According to Ernest (1989), models of teaching are "overlooked in many patterns of curriculum dissemination, resulting in innovations being assimilated to teachers' existing models of teaching" (p. 9). As a result, models of teaching have played a significant role in undermining the success of reform efforts (Ernest, 1989). In our current era, the CCSS-M "require practitioners to move away from the centuries-old role of 'a sage on the stage' and become skillful facilitators of a collaborative and rigorous engagement" (Reznitskaya & Wilkinson, 2015, p. 220 as cited in Fives & Buehl, 2016, p. 117). This requires a shift in the existing beliefs that many teachers hold about the teaching of mathematics (Fives & Buehl, 2016).

**Beliefs About the Learning of Mathematics**. What a teacher believes about the learning of mathematics also influences their instructional practices (Ernest, 1989; Fives & Buehl, 2016).

According to Ernest (1989), teachers construct mental models regarding how they believe mathematics should be learned. These "models of learning" are defined as "the teacher's view of the process of learning mathematics, what behaviors and mental activities are involved on the part of the learner, and what constitute appropriate and prototypical learning activities" (Ernest, 1989, p. 10). Ernest (1989) theorized that the differing models of learning fall along on a continuum between two opposing perspectives, one that views learning mathematics as the active construction of knowledge by the learner, and the other that views learning in mathematics as the passive reception of knowledge by the learner. Along this continuum are six different models of learning: (a) the child's exploration and autonomous pursuit of own interests model, (b) the child's constructed understanding and interest driven model, (c) the child's constructed understanding driven model, (d) the child's mastery of skills model, (e), the child's linear progress through curricular scheme model, and (f) the child's compliant behavior model (Ernest, 1989).

A teacher's model of learning plays a key role in shaping the learning experiences of their students and the cognitive and affective results of these experiences (Ernest, 1989). According to Ernest (1989), "in the long term these learning experiences can vary in results from a student who is an interested, confident, skilled and autonomous problem solver, at best, to one who is a disenchanted, non-numerate mathephobe, at worst" (p. 10). The CCSS-M require teachers to provide opportunities for students to engage in discussions that support the development of mathematical reasoning, "during which both the products and the processes of a discussion are continually scrutinized by participants, thus creating opportunities for the group to self-correct" (Reznitskaya et al., 2012, p. 289 as cited in Fives & Buehl, 2016, p. 118). This requires the teacher to adhere to the belief that ability is malleable and that all students have the ability to

learn and understand math, which might either be supported or hindered by the teacher's existing beliefs (Fives & Buehl, 2016).

**The Relationship Between Beliefs and Instructional Practice**. Askew et al. (1997) developed a model to explain how beliefs can influence the instructional practices of a mathematics teacher and the effectiveness of their instruction. According to Askew et al. (1997), beliefs "provide some insight into the mathematical and pedagogical purposes behind particular classroom practices and may be more important than the practices themselves in determining effectiveness" of instruction (p. 50). Askew et al. (1997) theorized that mathematics teachers have three different belief orientations: Transmissionist, discovery, and connectionist. The three belief orientations differ in the way they view the learning of math, the teaching of math, and what it means to be mathematically proficient.

Askew et al. (1997) explained that teachers with transmissionist, discovery, and connectionist orientations have different beliefs about what it means to be proficient in mathematics. According to Askew et al. (1997), teachers with a transmissionist orientation believe that students should use standard procedures and algorithms to complete calculations, and emphasize decoding word problems to determine the correct procedure or algorithm to use. Those with a discovery orientation believe that students should invent their own strategies for performing calculations, and emphasize making sense of prior knowledge and understanding. Those with a connectionist orientation believe that students should develop ability and confidence in the use of mental strategies and emphasize developing the skills of mathematical reasoning and justification (Askew et al., 1997).

Askew et al. (1997) also explained that teachers with transmissionist, discovery, and connectionist orientations have different beliefs about the learning of mathematics. According to Askew et al. (1997), teachers with a transmissionist view of mathematics learning believe that

only some students have the ability to become mathematically proficient. These teachers believe that students learn best when they are taught standard algorithms and procedures for performing calculations, and that students learn best when they are given specific directions for performing mathematical procedures and then practice until they remember them. When a student doesn't understand a mathematical concept, it is viewed as a failure on the part of the student, so the teacher responds by reteaching and reinforcing the use of the correct method (Askew et al., 1997).

Teachers with a discovery orientation of mathematics learning believe that most students have the ability to become mathematically proficient (Askew et al., 1997). These teachers believe that students learn best when they invent their own strategies for performing calculations and are allowed to figure things out for themselves. They believe that students must be ready before they can learn mathematical ideas, so when a student does not understand a concept, it is believed that the student is not yet ready to learn it (Askew et al., 1997).

Teachers with a discovery orientation of mathematics learning believe that all students have the ability to become mathematically proficient, but that their ability develops at different rates (Askew et al., 1997). These teachers believe that students develop mathematical proficiency through purposeful interaction with others and by struggling to overcome challenges, and they also believe that students learn best when the teacher helps refine the strategies for performing calculations that they invent on their own. When a student does not understand a mathematical concept, these teachers respond by investigating the source of the misunderstanding and making it explicit to the student (Askew et al., 1997).

Askew et al. (1997) also explained that teachers with transmissionist, discovery, and connectionist orientations have different beliefs about the teaching of mathematics. According to Askew et al. (1997), teachers with a transmissionist view of mathematics teaching view teaching and learning as separate entities with teaching being valued over learning. Their instruction is

teacher-centered, and the emphasis is on students learning to understand the teacher's methods. These teachers believe that students best learn to apply knowledge through word problems that provide opportunities to practice standard algorithms and procedures.

Teachers with a discovery view of mathematics teaching view teaching and learning as separate entities with learning being valued over teaching (Askew et al., 1997). Their instruction is student-centered, and the emphasis is on providing opportunities for students to discover methods for themselves. These teachers believe that students best learn to apply knowledge through activities that place them in practical problem-solving situations (Askew et al., 1997).

Teachers with a connectionist view of mathematics teaching view teaching and learning as complementary. Their instruction is collaborative, and the emphasis is on facilitating a classroom dialogue that explores and deepens understanding of mathematical concepts. These teachers believe that students best learn to apply knowledge by facing mathematical challenges that must be reasoned about.

Swan (2006) developed a framework of mathematics teacher belief orientations that incorporated the models previously developed by Ernest (1989) and Askew et al. (1997). The Ernest (1989) model had previously divided beliefs specific to mathematics teachers into three categories, beliefs about the nature of mathematics (M), beliefs about the teaching of mathematics (T), and beliefs about the learning of mathematics (L). The Askew et al. (1997) model had previously categorized beliefs specific to mathematics teachers as having three different orientations, transmissionist (T), discovery (D), and connectionist (C). Swan (2006) matched each of the three categories of beliefs (M, T, L) with each of the three possible belief orientations (T, D, C) to create nine different belief orientations (see Figure 4).

**Figure 4**

*Mathematics Teacher Belief Orientations*

| | |
|---|---|
| | *Mathematics is:* |
| MT | A given body of knowledge and standard procedures<br>A set of universal truths and rules which need to be conveyed to students |
| MD | A creative subject in which the teacher should take a facilitating role, allowing students to create their own concepts and methods |
| MC | An interconnected body of ideas which the teacher and the student create together through discussion |
| | *Learning is:* |
| LT | An individual activity based on watching, listening and imitating until fluency is attained |
| LD | An individual activity based on practical exploration and reflection |
| LC | An interpersonal activity in which students are challenged and arrive at understanding through discussion |
| | *Teaching is:* |
| TT | Structuring a linear curriculum for the students; giving verbal explanations and checking that these have been understood through practice questions; correcting misunderstandings when students fail to 'grasp' what is taught |
| TD | Assessing when a student is ready to learn; providing a stimulating environment to facilitate exploration; avoiding misunderstandings by the careful sequencing of experiences |
| TC | A non-linear dialogue between teacher and students in which meanings and connections are explored verbally. Misunderstandings are made explicit and worked on |

*Note*. From "Designing and Using Research Instruments to Describe the Beliefs and Practices of Mathematics Teachers," by M. Swan (2006), *Research in Education, 75*, 58–70.

Swan (2006) used these findings to develop and administer an instrument that measured the impact of the beliefs of mathematics teachers on their instructional practices. The teachers held a range of beliefs but the instructional practices they used were almost exclusively teacher-centered, indicating that a teacher's professed beliefs are not always consistent with their instructional practices (Swan, 2006). Factors that prevented teachers from using student-centered

practices included a perceived need to cover a curriculum, lack of resources, social pressures resulting from the school culture, and low expectations of student ability. From these findings, Swan (2006) concluded that professional development must attend to differences between a teacher's professed beliefs and their instructional practice.

Polly et al. (2013) used Swan's (2006) Teacher Belief Questionnaire in a study of elementary teachers designed to determine the relationship between teacher beliefs, instructional practices, and student achievement in mathematics. According to Polly et al. (2013), a significant statistical relationship was found between teacher beliefs and student achievement, and also between instructional practices and student achievement. Teachers with a transmission orientation to mathematics teaching reported using more teacher-centered instructional practices, and teachers with discovery and connectionist orientations reported using more student-centered instructional practices (Polly et al., 2013). The results were similar for beliefs about mathematics learning, with discovery and connectionist orientations also being associated with more frequent use of student-centered instructional practices. Teacher beliefs regarding the nature of mathematics were not found to influence the instructional practices used (Polly et al., 2013).

In a study of elementary teachers, Schoen and LaVenia (2019) identified three constructs of beliefs related to the teaching and learning of mathematics. Each of the three constructs was found to include a continuum of beliefs, and each construct was named for what was found to be the predominant belief. The constructs include Transmissionist, Facts First, and Fixed Instructional Plan (Schoen & LaVenia, 2019).

According to Schoen and LaVenia (2019), the Tranmissionist construct considers the continuum of beliefs regarding "whether—and under what condition—to tell students how to solve mathematics problems" (p. 5). On one end of the Transmissionist continuum is the "direct transmissionist" orientation. Teachers with a direct transmissionist orientation believe that

students must be taught specific procedures to solve problems, and that it is too risky to ask students to solve problems in their own way. These teachers believe that effective teaching involves the teacher demonstrating how to solve a problem and students practicing using the same method that the teacher demonstrated. This is considered a top-down, or teacher-directed model of teaching and learning mathematics (Schoen & LaVenia, 2019). On the other end of the transmissionist continuum is the "cognitive constructivist" orientation (Schoen & LaVenia, 2019). Mathematics teachers with a cognitive constructivist orientation believe that students can figure out ways to solve problems before receiving formal instruction from a teacher. These teachers believe that it is important for students to invent strategies on their own, and they encourage students to solve problems in their own ways. This is considered a bottom-up, or student-centered model of teaching and learning mathematics (Schoen & LaVenia, 2019). According to Schoen and LaVenia (2019), direct transmissionist beliefs are consistent with traditional mathematics instruction, and cognitive constructivist beliefs are consistent with reform-based mathematics instruction.

The Facts First construct considers the continuum of beliefs regarding "the sequence of learning basic facts and solving word problems" (Schoen & LaVenia, 2019, p. 6). On one end of the Facts First continuum is a "facts-before-word-problems" orientation. Teachers with a facts-before-word-problems orientation believe that mastering students must master basic facts before solving word problems because it reduces the cognitive demand required for more complex tasks. They believe that a fast recall of basic facts is a prerequisite for procedural fluency, and also believe that, although it is necessary for students to master computational procedures, it is not important for them to understand why the procedures work. According to Schoen and LaVenia (2019), these teachers are likely to believe that "limited knowledge of basic facts is likely to be the root cause of poor performance in mathematics" (Schoen & LaVenia, 2019, p. 7). On the

other end of the Facts First continuum is the "word-problems-before-facts" orientation (Schoen & LaVenia, 2019). Teachers with a "word-problems-before-facts" orientation believe that students can solve word problems efficiently by using conceptual strategies before they have mastered the basic mathematics facts. They believe that students develop number sense and gain a deeper conceptual understanding of mathematics through the process of solving problems; therefore, they also believe that an understanding of basic facts is the result of solving problems, not a prerequisite for it. According to Schoen and LaVenia (2019), facts-before-word-problems beliefs are consistent with traditional mathematics instruction, and word-problems-before-facts beliefs are consistent with reform-based mathematics instruction.

The Fixed Instructional Plan construct considers the continuum of beliefs regarding "the omnipresent dilemma about whether to adhere to an externally established scope, sequence, and pacing of the curriculum," which is described as "an existential problem faced by nearly all mathematics teachers at every level (Schoen & LaVenia, 2019, p. 7). On one end of the continuum is the "fixed instructional plan" orientation. Teachers with a fixed instructional plan orientation believe in a strict adherence to the scope, sequence, and pacing guide of a curriculum. They believe that mathematics must be taught sequentially, that it is their responsibility to cover the required topics in a designated period of time, and that students will eventually understand mathematics if the prescribed curriculum is taught with fidelity (Schoen & LaVenia, 2019). On the other end of the Fixed Instructional Plan continuum is the "respond-to-the-needs-of-students" orientation (Schoen & LaVenia, 2019). Mathematics teachers with a respond-to-the-needs-of-students orientation believe that students learn most effectively when the scope and sequence of a curriculum is adapted based on the instructional needs of their students. They believe that they should modify the pace of instruction according to student differences (e.g., prior understanding and speed of learning), rather than strictly adhering to a prescribed pacing guide. According to

Schoen and LaVenia (2019), fixed instructional plan beliefs are consistent with traditional mathematics instruction, and respond-to-the-needs-of-students beliefs are consistent with reform-based mathematics instruction.

Schoen and LaVenia (2019) surveyed 200 elementary teachers and found "direct transmissionist" to be the predominant belief in the Transmissionist construct, "facts-before-word-problem" to be the predominant belief in the Facts First construct, and "fixed instructional plan" to be the predominant belief in the Fixed Instructional Plan construct. These results indicate that practicing elementary teachers predominantly hold beliefs consistent with traditional rather than reform-based mathematics instruction in each of the three constructs (Schoen & LaVenia, 2019).

This review of existing literature regarding the impact of teacher beliefs on the instructional practices of mathematics teachers clearly indicates that efforts to reform mathematics education in the United States must attend to teacher beliefs. Fives and Buehl (2016) support these findings with the following statement:

> Sets of beliefs interact to form a teacher's belief system, and the decisions a teacher makes regarding planning, instruction, and assessment are a reflection of these beliefs. Beliefs are often deeply held and change resistant, so reform efforts that require a change in instructional practice must allow teachers to examine and reflect on their beliefs. Policy makers, school leaders, and teacher educators must attend to teachers' beliefs as part of any reform effort (p. 114).

### *Social Factors That Affect Mathematics Teacher Identity*

Mathematics teacher identity is influenced not only by cognitive and affective factors, but by social factors as well (Bennison, 2015, Van Zoest & Bohl, 2005). The following section of this literature review provides a synthesis of existing literature regarding the social component of

mathematics teacher identity. The life history and context domains from the Bennison (2015) Mathematics Teacher Identity Framework will be included in this section.

**Social Factors**. According to Bennison (2015), the social domain recognizes the impact of relationships with students, other teachers, administrators, and professional learning communities on mathematics teacher identity, along with normative practices that might exist within teaching communities. Sun (2017) explored the relationship between mathematics teacher identity and participation in professional development designed to support elementary teachers in developing a vision for and implementing reform-based mathematics teaching. Data collected from life-story interviews, teacher questionnaires, and follow up interviews given to seven inservice elementary teachers was viewed through the lens of Van Zoest and Bohl's (2005) Mathematics Teacher Identity Framework. A variety of different mathematics teacher identities were revealed, spread out along a continuum ranging from "passive ambitious mathematics teacher identity" to "active ambitious mathematics teacher identity." A teacher's mathematics teacher identity was found to play a significant role in their participation and learning during the professional development experience (Sun, 2017).

Sun (2017) shed light on the importance of accounting for mathematics teacher identity when designing and delivering professional development to support teachers transitioning to reform-based mathematics teaching. Sun (2017) recommended identifying the mathematics teacher identity of teachers prior to delivering the professional development, then using the experiences and personal narratives that informed the development of their mathematics teacher identity as tools when designing and delivering the professional development experiences. Sun (2017) also stressed the importance of identifying and accounting for the norms and practices that exist within a community and how they might either support or limit the opportunities for identity growth during the professional development experience.

**Life History Factors**. According to Bennison (2015), the life history domain acknowledges that past experiences with mathematics as a student (e.g., those that occurred in K–12 schooling or teacher preparation programs) influences the development of a teacher's identity as both a learner and a teacher of math. Norman (2021) used a narrative inquiry approach to analyze how the past experiences of preservice elementary teachers informed the development of both their mathematical identity and their emerging mathematics teacher identity. Stories were collected from five preservice elementary teachers regarding their experiences with mathematics as K–12 students. Analysis of the stories revealed that the development of mathematical identity and mathematics teacher identity is dynamic, and that it is affected by factors such as social structures, emotions, narratives and mathematical dispositions. In particular, views of the nature of mathematics, stereotyping, privilege, power dynamics, and deficit thinking were found to play notable roles. Norman (2021) indicated the importance of attending to the mathematics identity of preservice elementary teachers. As a result, Norman (2021) recommended that teacher preparation programs should provide opportunities for preservice elementary teachers to reflect on their past experiences as mathematics students to understand how those experiences shape their mathematics identity and their emerging mathematics teacher identity.

Lutovac and Kaasila (2014) conducted a narrative study designed to compare the future-oriented mathematics identity work of six preservice elementary teachers, all of whom identified as having negative experiences with mathematics as students and as having low confidence in their ability to teach it. Lutovac and Kaasila (2014) defined mathematics identity work as "a process of deep reflection and self-evaluation where past, present and future mathematical identities enter into a dialog that leads to one's awareness of a tension or gap between the actual and the ideal state of mathematical identity" (p. 131). In future-oriented mathematics identity

work, preservice teachers are asked to anticipate their future as mathematics teachers and use their past experiences as tools to help them plan for the future.

Lutovac and Kaasila (2014) found that, although the preservice teachers initially had similar mathematical backgrounds, the identity work they accomplished was very different. Two different types of future-oriented identity work were identified, "decisive" identity work and "irresolute" identity work. According to Lutovac and Kaasila (2014), decisive identity cases used phrases such as "I can," "I want to," or "I will" when speaking about their future selves as mathematics teachers. Although they had negative past experiences with mathematics as students, these preservice teachers chose to distance themselves from their negative pasts. They still had fears about their future as mathematics teachers, but were motivated to rise above these fears and learn more (Lutovac & Kaasila, 2014). However, irresolute identity cases used phrases such as "how can I," "how will I," or "I will" when speaking about their future selves as mathematics teachers. These preservice teachers did not distance themselves from their negative past experiences with math, and their negative pasts dominated their future-oriented talk. They remained focused on their fears about their future as mathematics teachers, and were not motivated to rise above them and learn more (Lutovac & Kaasila, 2014).

**Contextual Factors**. Mathematics teacher identity is influenced by contextual factors such as school policies, professional development opportunities, time provided for planning, and mandated assessments (Bennison, 2015). It is also shaped by the social, political, and institutional dynamics that exist within school communities (Neumayer-Depiper, 2013). Neumayer-Depiper (2013) highlighted the difficulties and challenges faced by novice elementary teachers when transitioning from a teacher-preparation program that emphasized a reform-based approach for teaching mathematics into an actual elementary classroom. Dynamics (e.g., test-driven school cultures and taken-for-granted ideas and ways of practice) acted as barriers to the use of reform-

based approaches and complicated the relationship between a teacher's identity as a mathematics teacher and their enacted practice. According to Neumayer-Depiper (2013),

> Developing a repertoire of effective mathematics teaching practices is not enough. Teacher education must also prepare teacher candidates to enact these practices while navigating the many social, political, and institutional dynamics in mathematics classrooms and schools. In the US, these dynamics include the pressures of test-driven accountability and deficit perspectives of students. (p. 9)

From these findings, Neumayer-Depiper (2013) recommended that the coursework provided for preservice teachers address social, political, and contextual barriers to reform-based mathematics instruction that exist within schools and should support preservice teachers in developing the agency required to overcome them.

Wenger (1998) theorized that a teacher's identity is shaped by their membership in communities of practice and by how they make sense of their participation within these communities. Teachers are members in many different communities of practice, and the way they instruct students is influenced by many individuals, including school principals, district administrators, professional development coaches, and other teachers. Often these individuals have conflicting beliefs about the teaching and learning of mathematics and how best to increase student achievement. As a result, the reality of implementing reform-based approaches for teaching mathematics is more complex than a teacher simply deciding to make changes within their own classroom (Hodges & Cady, 2012).

Hodges and Cady (2012) used a single case study approach to examine the mathematics teacher identity of an elementary teacher attempting to implement a reform-based approach for teaching mathematics in her classroom. The teacher was a member in four different communities of practice, including a district community, a school community, a classroom community, and a

professional development community that was promoting reform-based approaches for teaching mathematics. According to Hodges and Cady (2012), the conflicting views of these communities regarding mathematics instruction resulted in tensions that were difficult for the teacher to navigate. The teacher's desire to implement reform-based instructional practices as promoted by the professional development community conflicted with the district and school community's requirement to use a traditional textbook, and the teacher's desire to use nontraditional methods of assessment as promoted by the professional development community conflicted with the emphasis the district and school community placed on the results of standardized tests. These tensions led to inconsistencies between the teacher's professed identity as a reform-based mathematics teacher and the reality of what she was able to implement in her classroom. Therefore, to create a culture for sustainable reform efforts, there must be alignment between the goals, values, and beliefs of the multiple professional communities to which a teacher belongs (Hodges & Cady, 2012).

The findings of Hodges and Cady (2012) also highlight "the ongoing nature of identity construction" (p. 121). Hodges and Cady (2012) explain that because identity is in part a trajectory, an individual's identity as a mathematics teacher will continue to change and be refined over time. As a result, it is important to consider where individual teachers are on this trajectory, what next steps are necessary, and to provide the professional development experiences necessary for them to develop an identity as a reform-based mathematics teacher (Hodges & Cady, 2012)

## Summary

In the United States, the traditional approach to mathematics education is characterized by a teacher-centered model of instruction and an emphasis on the rote memorization of facts and procedures (Kartal & Tillett, 2021). Reformers advocate for a shift away from the traditional

approach toward a reform-based approach, which is characterized by a student-centered, problem-based model of instruction that focuses on the development of deep conceptual understanding, mathematical reasoning, and number sense (Kartal & Tillett, 2021). Efforts to replace traditional mathematics instruction with reform-based mathematics instruction have been underway for several decades, but these efforts have met with heavy resistance and have been largely unsuccessful (Epstein & Miller, 2011). At the present time we are in the midst of the Common Core era, a third such reform movement.

The CCSS-M are a set of world-class standards released in 2010 with the goal of improving mathematics achievement in the United States (Huinker & Bill, 2017). Since their release, however, many elementary teachers have struggled to teach the CCSS-M effectively (Ostashevsky, 2016). According to NCTM (2014), successful implementation of the CCSS-M has been hampered by the existence of dominant cultural beliefs about the teaching and learning of mathematics. Many parents and teachers believe that students should be taught mathematics as they were, with the use of instructional practices that emphasize the rote memorization of facts and procedures through repetitive practice. Such beliefs have perpetuated the use of traditional models of mathematics instruction, which are still pervasive in many elementary classrooms (NCTM, 2014). Research has linked reform-based approaches (e.g., ambitious mathematics teaching) to increased student achievement in mathematics, particularly on assessments requiring high levels of cognitive demand (Huinker & Bill, 2017). However, ambitious mathematics teaching is challenging and complex and represents an approach to teaching mathematics that is very different from what most teachers experienced as elementary students (Huinker & Bill, 2017). It has now been more than a decade since the release of the CCSS-M, but ambitious mathematics teaching has not been widely embraced (Huinker & Bill, 2017).

Although it is difficult to achieve teacher change in any subject, it is even more difficult in mathematics because mathematics generates more emotions than any other subject (Hodgen & Askew, 2007). Ladd's (2018) Holistic Identity and Personal Change Model provided the theoretical framework of this study. Ladd (2018) conceptualized identity as consisting of an individual's behaviors, thoughts, feelings, and beliefs, and theorized that identity controls the entire structure of personal change. Ladd's (2018) Holistic Identity and Personal Change Model enabled the lived experience and perceptions of the teachers who participated in this study to be viewed through the lens of mathematics teacher identity in the context of mathematics education reform.

Van Zoest and Bohl's (2005) and Bennison's (2015) Mathematics Teacher Identity Frameworks guided the development of the conceptual framework for this study. These frameworks take a psycho-social perspective of mathematics teacher identity by accounting for the contribution of both individual (psychological) and cultural (sociological) factors. Van Zoest and Bohl's (2005) framework is based on the premise that mathematics teacher identity is influenced by cognitive, affective, and social factors, and Bennison (2015) expanded Van Zoest and Bohl's (2005) framework by accounting for the influence of past experiences and external factors on mathematics teacher identity.

Chapter 3 provides a detailed explanation of the methodology used to conduct this study. Topics include the research design, the research setting, the recruitment and selection of participants, and the procedures used for both data collection and data analysis. Limitations, delimitations, and ethical issues are also discussed, along with steps that were taken to ensure the trustworthiness of this study.

# CHAPTER 3: METHODOLOGY

The predominant model of elementary instruction in the United States is the self-contained classroom (Markworth et al., 2016). In a self-contained classroom, one teacher is responsible for delivering core academic instruction in all subject areas (Markworth et al., 2016). As a result, most elementary teachers in the United States are trained to be generalists (NCTM, 2010). A generalist is a teacher trained to teach all core academic subjects rather than specializing in any particular one (Murphy & Glanfield, 2010).

Due to the increased expectations for rigorous mathematics instruction demanded by the CCSS-M, it has become increasingly difficult for elementary teachers who are trained to be generalists to deliver expert instruction in mathematics (Markworth et al., 2016). As a result, many elementary teachers have struggled to teach the CCSS-M effectively (Ostashevsky, 2016). This problem is compounded by the reality that many elementary teachers dislike mathematics (Johnson, 2018), as elementary teachers who have a negative relationship with mathematics are less likely to implement reform-based approaches for teaching it (Wilkins, 2008). It is now more than a decade since the release of the CCSS-M, but traditional mathematics instruction is still prevalent in elementary schools and reform-based mathematics instruction has not been widely embraced (Boaler, 2019; Huinker, 2020; Spillane et al., 2018).

The purpose of this qualitative, interpretive phenomenological study was to explore, investigate, and interpret the lived experiences and perceptions of elementary mathematics teachers. Specifically, this study was designed to explore the experiences and perceptions of elementary mathematics teachers (a) who are trained to be generalists; (b) who teach all core academic subjects, including mathematics, in a self-contained classroom setting; and (c) who would describe themselves as either disliking or having disliked mathematics. The central

research question is: What are the lived experiences and perceptions of self-contained elementary teachers who dislike mathematics? The following subquestions were also addressed:

4. How have self-contained elementary teachers who dislike mathematics experienced mathematics?
5. How have self-contained elementary teachers who dislike mathematics experienced reform-based approaches for teaching mathematics?
6. How do self-contained elementary teachers who dislike mathematics perceive their own identity as a mathematics teacher?

The lived experiences and perceptions of these teachers were viewed through the lens of mathematics teacher identity in the context of mathematics education reform. A more thorough understanding of the lived experiences and perceptions of elementary teachers who dislike mathematics will enable mathematics educators to develop professional learning experiences designed to help both preservice and inservice elementary teachers (a) improve their relationship with mathematics and (b) increase both their willingness and their ability to implement reform-based mathematics teaching.

This chapter provides a thorough explanation of the methodological approach that was used to conduct this research study. The chapter begins with an explanation of and rationale for the research design and is followed by a description of the research setting. A discussion of the methods used to recruit and select participants follows, along with a presentation of the procedures used for both data collection and data analysis. Limitations, delimitations, and potential ethical considerations are addressed, and the chapter closes with a discussion of the steps taken to ensure the trustworthiness of this study.

## Research Design and Rationale

A qualitative research design was used for this study. According to Levitt et al. (2018), qualitative research is "a set of approaches that analyze data in the form of natural language (i.e., words) and expressions of experiences (e.g., social interactions and artistic presentations)" (p. 27). Creswell and Creswell (2018) captured the essence of qualitative research with the following statement:

> Qualitative research is an approach for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures, data typically collected in the participant's setting, data analysis inductively building from particulars to general themes, and the researcher making interpretations of the meaning of the data. The final written report has a flexible structure. Those who engage in this form of inquiry support a way of looking at research that honors an inductive style, a focus on individual meaning, and the importance of reporting the complexity of a situation. (p. 4)

Within the broad category of qualitative research there are several different types of research designs. The specific type of qualitative research design used for this study is phenomenology. According to Creswell and Creswell (2018),

> Phenomenological research is a design of inquiry coming from philosophy and psychology in which the researcher describes the lived experiences of individuals about a phenomenon as described by participants. This description culminates in the essence of the experiences for several individuals who have all experienced the same phenomenon. This design has strong philosophical underpinnings, and typically involves conducting interviews. (p. 13)

The foundation of phenomenology is philosophy (Peoples, 2021). There are different types of phenomenological research methodologies, which differ in terms of their philosophical underpinnings and assumptions (Bloomberg & Volpe, 2019). The two major phenomenological traditions are descriptive, or transcendental phenomenology, which is based on the philosophy of Edmund Husserl (1999), and interpretive, or hermeneutic phenomenology, which is based on the philosophy of Martin Heidegger (1962/1927; as cited in Peoples, 2021).

In descriptive phenomenology, which is based on the philosophy of Husserl (1999), the focus is not on the interpretations of the researcher but on the descriptions of the participants (Creswell & Poth, 2018). This requires the researcher to suspend or "bracket" all biases, understandings, and experiences to describe the phenomenon being studied as if it were being experienced "as a stranger in a strange land" for the first time (Peoples, 2021, p. 30). In doing so, the researcher "bracket(s) himself or herself out of the study" by setting aside their own personal experiences and biases to focus on the experiences of the participants "without bringing himself or herself into the picture" (p. 77). This is also known as epoché (Creswell & Poth, 2018). According to Giorgi (2009, as cited in Creswell & Poth, 2018), bracketing is not a matter of forgetting what you have experienced, but of not allowing your past experiences to be engaged while examining the experiences of your participants.

Heidegger (1962/1927), who was a student of Husserl (1999), elevated phenomenology from a purely descriptive endeavor to an interpretive one (Bloomberg & Volpe, 2019). Interpretive phenomenology is based on the premise that it is not possible for one to truly bracket their experiences because "human existence is always embedded within a work of meanings" (Bloomberg & Volpe, 2019, p. 54). As a result, interpretive phenomenology permits the researcher to view the phenomenon being studied through "lenses" of preconceived knowledge about the phenomenon (Peoples, 2021).

Phenomenology is both a philosophy and methodology (Peoples, 2021). Descriptive phenomenology focuses on "the common structure of (the phenomenon being studied) as an experience," while interpretive phenomenology focuses on "personal meaning and sense-making in a particular context, for people who share a particular experience" (Smith et al., 2022, p. 39). The purpose of this study is not to describe the basic structure of reform-based mathematics teaching as an experience, but to reveal how self-contained teachers who dislike mathematics have experienced reform-based mathematics teaching. This requires the use of an interpretive phenomenological approach.

The specific methodological approach used by this study is IPA. According to Bloomberg and Volpe (2019),

> IPA targets how particular people in particular contexts make meaning and interpret their experiences. The focus is on research participants' perspectives on their own experiences rather than attempting to describe their transcendental experience (that is, experiences that cut across all people). IPA therefore critically questions the concept of participants bracketing their demographic, cultural, and personal characteristics. (p. 54)

Smith et al. (2022) stated that "while Husserl was concerned to find the essence of experience, IPA has the more modest ambition of attempting to capture particular experiences as experienced for particular people" (p. 11). This distinction further illuminates the difference between descriptive and interpretive phenomenology and provides additional justification for the use of IPA as the methodological approach for this study. In this IPA study, the researcher sought to capture the essence of how self-contained elementary teachers who dislike mathematics have experienced reform-based mathematics teaching.

## Site Information and Demographics

Phenomenological research methodology does not require a study to be site-specific (Creswell & Poth, 2018). As a result, the pool of potential participants for this study included all self-contained elementary teachers currently teaching in a public school district located within one county in northern New York State. For the purposes of this study, elementary teachers were defined as those who teach in Grades K–5.

The goal of phenomenological research is to identify the overall essence of the lived experiences of the participants. This is more difficult to achieve when the participants have diverse characteristics (Creswell & Poth, 2018); therefore, the group of participants selected should be relatively homogeneous (Smith et al., 2022). This method provides justification for the decision to limit the research setting of this study to one county located in northern New York State. All of the public school districts located within this county have a very similar demographic makeup. As a result, it is likely that the group of participants selected from these schools will be relatively homogeneous. However, to protect the confidentiality of the participants and their school districts, no specific demographic information about this county will be revealed.

## Participants and Sampling Method

According to Creswell and Poth (2018), qualitative research studies should have a small number of participants but collect extensive detail about each one. In particular, IPA studies are conducted on small sample sizes because of the length of time it takes to analyze individual interview transcripts and write in detail about the experiences and perceptions of each participant. In IPA research, the participants of a study represent a perspective rather than a population. As a result, a small number of participants are purposely selected because they can offer insight into the phenomenon being explored (Smith et al., 2022). In this IPA study, a purposeful sampling

strategy was used to identify participants who met the following inclusion criteria: (a) currently teaching in any Grade K–5; (b) trained to be a generalist, not a mathematics specialist; (c) teach all core academic subjects, including mathematics in a self-contained classroom setting; and (d) self-identify as either disliking or having disliked math.

Following approval from the Institutional Review Board (IRB; see Appendix A), a recruitment letter (see Appendix B) stating the purpose of this research study and the inclusion criteria for participation was posted in two local educator groups on a social-media platform. It was also sent to local educators known by the researcher via email, each of whom then forwarded the email on to other local educators. Following these efforts, 10 teachers responded with interest in participating in this study. Three of the 10 potential participants were identified by the researcher through prior acquaintance, and the remaining seven were previously unknown to the researcher. Of these seven, two had encountered the recruitment letter via a social media post and five had received the recruitment letter via email.

Ten teachers responded to these recruitment efforts, and nine were selected for participation in this study. One potential participant was eliminated because she described herself as liking mathematics rather than disliking it. Seven of these nine potential participants met all of the required inclusion criteria and expressed a willingness to talk about their experiences. The remaining two expressed an interest in talking about their experiences, but failed to meet one of the inclusion criteria. Both had moved from a self-contained to a departmentalized classroom this school year, so they were no longer teaching all core academic subjects. However, following a discussion with each teacher, the decision was made to include them in the study. Both teachers had met all of the inclusion criteria during the previous school year, so had information to share that was both valuable and relevant to this study.

## Instrumentation and Data Collection

The instrument used to collect data for this IPA was the research interview. A research interview is "a process in which a researcher and participant engage in a conversation focused on questions related to a research study" (deMarris, 2004, as cited Merriam & Tisdell, 2016, p. 108). The advantage of using a research interview as a data collection instrument is that it enables a researcher to "enter into the other person's perspective" and to find out what is "in and on someone else's mind" (Patton, 2015, as cited in Merriam & Tisdell, 2016, p. 108). According to Patton (2015, as cited in Merriam & Tisdell, 2016):

> We interview people to find out from them those things we cannot directly observe… We cannot observe feelings, thoughts, and intentions. We cannot observe behaviors that took place at some previous point in time. We cannot observe situations that preclude the presence of an observer. We cannot observe how people have organized the world and the meanings they attach to what goes on in the world. We have to ask people questions about those things. (p. 108)

Research interviews differ according to (a) the amount of structure they provide, and (b) their philosophical orientation (Merriam & Tisdell, 2016). For this IPA study, the researcher used phenomenological interviews with a semistructured format. According to Merriam and Tisdell (2016), a semistructured interview typically contains a mixture of structured and unstructured questions. Although part of the interview contains structured questions specifically designed to obtain information required from all participants, the majority of the interview consists of a series of open-ended questions regarding the issue to be explored. The advantage of a semistructured interview format is that it gives the researcher the flexibility to guide the direction of each interview according to the responses of the participant. It also enables the researcher to respond to any new information, insights, or understandings that might emerge (Merriam & Tisdell, 2016).

According to Marshall and Rossman (2015, as cited in Merriam & Tisdell, 2016), a phenomenological interview enables the researcher to "focus on the deep, lived meanings that events have for individuals" (p. 113); therefore, it is the most appropriate choice when the goal of the research is "to uncover the essence of an individual's lived experience" (Seidman, 2013, as cited in Merriam & Tisdell, 2016, p. 113).

The development of the interview protocol (see Appendix C) for this IPA study was guided by the Interview Protocol Refinement (IPR) Framework (Castillo-Montoya, 2016). The IPR Framework is a four-phase process used to develop and refine an interview protocol to increase its reliability as a research instrument and to improve the quality of data obtained. Together, these four phases ensure the development of "a well-vetted interview protocol that can help a researcher obtain robust and detailed interview data necessary to address research questions" (Castillo-Montoya, 2016, p. 812).

The first phase of the IPR Framework (Castillo-Montoya, 2016) was ensuring that the interview questions would align with the research questions. This was achieved by creating a matrix that mapped the questions from the interview protocol onto the three research subquestions that this study was designed to address. Edits made during this process confirmed both the purpose and the necessity of each interview question, and also ensured that each of the research questions was sufficiently addressed.

The second phase of the IPR Framework (Castillo-Montoya, 2016) was ensuring that the questions in the interview protocol constructed an inquiry-based conversation. To do so, the interview protocol must strike a balance between promoting a conversation about the interviewee's ideas and experiences and obtaining information related to the purpose of the study. This was accomplished by writing interview questions that differed from the research

subquestions, organizing the interview questions into a script according to social rules of ordinary conversations, and writing follow-up questions and prompts that were anticipated to be necessary.

According to Castillo-Montoya (2016), obtaining feedback from multiple sources, including both practice participants and peers, enhances the reliability and trustworthiness of an interview protocol as a data collection instrument. As a result, the third phase of the IPR Framework (Castillo-Montoya, 2016) was receiving feedback from peers. In this phase, the interview protocol was shared with a review panel consisting of two practicing mental health professionals who were also experienced phenomenologists. Revisions to the interview protocol were made according to feedback from the review panel.

The fourth and final phase of the IPR Framework (Castillo-Montoya, 2016) was to pilot the interview protocol. A pilot interview is a practice interview conducted by the researcher. During this phase, one pilot interview was conducted with a practice participant who mirrored the characteristics of the participants to be targeted for this study. The pilot interview was conducted and recorded in Zoom, and real interview conditions were simulated to the greatest extent possible. Final revisions to the interview protocol were made according to the experience gained from conducting this pilot interview.

Following successful completion of the pilot interview, individual interviews were conducted with each of the nine participants. The interviews were recorded in Zoom and sent to Rev Transcription, a professional transcription service, to be transcribed into written text. Once the written transcripts were received, the member-checking process began. Each participant was sent the transcript of their interview via email and given 7 days to verify the accuracy of their transcript or to request that changes be made. The participants were notified that, if they did not respond within 7 days, the researcher would assume that they felt their transcript was accurate

and did not wish to make any changes. All nine transcripts were accepted during the member-checking process, and no requests for changes were made.

## Data Analysis

The data analysis was conducted manually using the procedure for IPA data analysis set forth by Smith et al. (2022). This is a seven-phase process that entails (a) conducting an initial reading of the first case, (b) taking exploratory notes, (c) constructing experiential statements, (d) searching for connections across experiential statements, (e) clustering the experiential statements into personal experiential themes (PETs; see Appendix D), (f) repeating the process for all other cases, and (g) developing group experiential themes (GETs; see Appendix E) that represent patterns of shared experience across all cases (Smith et al., 2022).

Phase 1 of data analysis in IPA is reading and re-reading the first case (Smith et al., 2022). I began this phase by listening to the audio recording of the first interview and recording my recollections of the interview along with any initial observations that emerged. I then began the process of actively engaging with the data by reading and then re-reading the transcript of the interview. According to Smith et al. (2022), actively engaging with the data in this fashion ensures that the participant becomes the focus of the analysis and enables the researcher to "begin the process of entering the participant's world" (p. 78).

Phase 2 of data analysis in IPA is exploratory noting (Smith et al., 2022). During this phase, I explored the content and language of the first transcript and recorded anything of interest. While doing so, I was mindful to "stay focused on what is important to the participant, and not to describe, judge, or diagnose the participant" in any way (Smith et al., 2022, p. 86). The end product for this phase was a set of provisional notes recorded in the right margin of the transcript.

Phase 3 of IPA data analysis is constructing experiential statements. An experiential statement relates directly either to the participant's experience or to their attempt to make sense of

that experience (Smith et al., 2022). During this phase, my analysis shifted from the original transcript to the exploratory notes that had been recorded in the previous phase. This enabled me to further reduce the volume of information by capturing what I deemed to be most important. The end product for this phase was a set of experiential statements recorded in the left margin of the transcript.

Phase 4 of IPA data analysis is searching for connections across experiential statements (Smith et al., 2022). During this phase, I examined the experiential statements that had been generated in the previous stage closely to allow patterns, or themes, to emerge. The end product of this phase was clusters of experiential statements based on the emergent patterns and themes. I was mindful that these clusters should represent "all of the most interesting and important aspects of your participant's account" (Smith et al., 2022, p. 91).

Phase 5 of IPA data analysis is determining the participant's PETs. The acronym PET stands for "personal" because the themes are derived from and are at the level of a particular person, "experiential" because the themes relate directly to a person's experience or how they make sense of that experience, and "themes" because the analysis now reflects the transcript as a whole rather than specific instances that occur within the transcript (Smith et al., 2022). I determined the PETs by giving each cluster of experiential statements that had been generated in the previous phase a title that describes its characteristics. The end product for this phase was a table that displayed the PETs for the participant along with their experiential statements.

Phase 6 of this IPA data analysis was to repeat Phases 1–5 for each of the remaining eight participants. I was mindful during this phase to "treat the next case on its own terms, to do justice to its own individuality, to treat each case as a complete universe of inquiry" (Smith et al., 2022, p. 99). To accomplish this, I strove to allow new insights to emerge from within each individual

case rather than simply reproducing the same ideas. The end product for this phase was a table that displayed the PETs for each of the nine participants in this study (see Appendix D).

Phase 7 of IPA data analysis is to create a set of GETs. The GETs describe "the essence of the experiences for several individuals who have all experienced the same phenomenon" and as such are the culmination of an IPA study (Creswell & Creswell, 2018, p. 13). To accomplish this, I first scanned the tables of PETs that had been generated for each participant in the previous phase to look for similarities and differences at a broad level. Next, I examined the individual PETs more closely to allow patterns to emerge, being mindful of "emphasizing both convergence and divergence, commonality and nuance" (Smith et al., 2022, p. 75). Following this analysis, nine emergent GETs were identified. To ensure validity of the findings and reduce the possibility of the researcher's bias entering into the analysis, the nine GETs were shared with a review panel consisting of two practicing mental health professionals who were also experienced phenomenologists. Revisions to the GETs were made according to feedback from the review panel. A table was generated to display the GETs, including both themes and subthemes, which represent the findings of this research study (see Appendix E).

## Limitations, Delimitations and Ethical Issues

### Limitations

The limitations of a research study are "potential weaknesses of the study and the scope of the study; that is, the external conditions that restrict or constrain the study's scope or potential outcome" (Bloomberg & Volpe, 2019, p. 13). Limitations include factors that are not within the control of the researcher (Roberts & Hyatt, 2019) such as weaknesses or flaws that are inherent to the research design (Bloomberg & Volpe, 2019). Qualitative research methodologies, including phenomenology, use a small number of participants who are not intended to be a representative sample (Peoples, 2021). As a result, Limitation 1 of this study was that the findings are not

transferable to other populations, settings, or contexts. According to Bloomberg and Volpe (2019):

> The goal of qualitative research is therefore not to produce "truths" that can be generalized to other people or settings, but rather to develop descriptive context-relevant findings that can be applicable to broader contexts while still maintaining their content-specific richness. Although qualitative researchers do not expect their findings to be generalizable to all other settings, it is likely that the lessons learned in one setting might be useful to others. (p. 205)

Limitation 2 of this study was the potential that teachers who have experienced the phenomenon being studied most negatively and most intensely might not have volunteered to participate in this study. To be included in this study, potential participants had to describe themselves as disliking mathematics. They also had to be willing to talk about the experiences that led them to develop a dislike of mathematics and how these experiences have impacted their experience as a mathematics teacher. It is possible that, for some potential participants, recalling and talking about their negative past experiences with mathematics might cause emotional discomfort or distress. As a result, it is possible that such teachers might not have responded to recruitment efforts or volunteered to participate because they were not willing to talk about their experiences.

Limitation 3 of this study is the potential that participants either failed to give honest accounts of their experiences or failed to disclose relevant information. The phenomenon being studied is sensitive in nature; therefore, it is possible that participants might have feared negative repercussions from their employers and colleagues or feared that damage to their professional reputations might occur if their participation in this study were to be discovered. As a result, it is possible that, even though they volunteered to participate in this study, participants might have

chosen to either be dishonest about or withhold information that they considered to be personally damaging. To address this potential limitation ahead of time, potential participants were informed of these risks prior to the interview. They were also informed that their participation in this study was voluntary, that they could decline to answer any questions that made them uncomfortable, and that they could choose to withdraw from the study at any time. Potential participants were also notified of the steps taken to ensure that their participation was anonymous and that both their privacy and the confidentiality of their data were protected. More detailed information on these steps can be found in the "Ethical Considerations" section later in this chapter.

**Delimitations**

Delimitations are intentional decisions made by the researcher that narrow the scope of a study (Roberts & Hyatt, 2019). To ensure transparency, a qualitative researcher must both acknowledge these decisions and explain the rationale behind them (Peoples, 2021). According to Bloomberg and Volpe (2019),

> Delimitations are those conditions or parameters that the researcher intentionally imposes to limit the scope of the study (e.g., using participants of certain ages, genders, or groups; conducting the research in a single setting)—that is, the boundaries set by the researcher, often to increase the feasibility of the study. (p. 13)

The research setting of the study was intentionally limited to public school districts located within one county in northern New York State. The rationale for this decision is a desire to limit the participants to those that are required to adhere to the standards and policies of the New York State Education Department, and a desire to limit the participants to those who teach in schools located in communities with similar geographic, demographic, cultural, and socio-economic characteristics. This is consistent with the assertion made by Creswell and Poth (2018) that in phenomenological studies, "the more diverse the characteristics of the individuals, the more

difficult it will be for the researcher to find common experiences, themes, and the overall essence of the experience for all participants" (p. 153). However, this means that the findings of this study are not generalizable either to private schools or to public schools located in other regions of New York State or the United States.

The participants of this study were intentionally limited to in-service, self-contained elementary teachers (a) who are trained to be generalists; (b) teach all core academic subjects; and (c) describe themselves as disliking mathematics. For the purposes of this study, inservice elementary teachers are defined as those who teach at any grade level ranging from Kindergarten through Grade 5. As a result, the findings of this study are not generalizable either to preservice elementary teachers or to in-service teachers in Grades 6–12. In addition, this study will not address K–5 elementary teachers who are trained to be mathematics specialists, those who teach in departmentalized rather than self-contained classrooms, or those who do not describe themselves as disliking mathematics.

**Ethical Issues**

This research study was approved by the IRB at the University of New England, and the researcher obtained certification to conduct human subject research by completing all required Collaborative Institutional Training Initiative (CITI) Training. In addition, this study adhered to the standards for conducting ethical human subject research set forth in the *Belmont Report* (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1978). The *Belmont Report* established three basic ethical principles that must be adhered to any research study that involves human subjects: (a) respect of person, which means that the researcher must acknowledge the autonomy of the participants and protect those who have diminished autonomy; (b) beneficence, which means that the researcher must respect the decisions of the participants, make efforts to secure their well-being, and protect them from harm;

and (c) justice, which means that the researcher must ensure that those who are entitled to the benefits of the research are not denied them without good reason, and that no burdens are unduly imposed on the participants of the study (National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research, 1978).

There are many potential ethical issues in qualitative research that must be acknowledged and addressed (Creswell & Poth, 2018). One such consideration is the privacy of the participants. In this study, steps were taken to ensure that the privacy of the participants was protected during the recruitment process, during the consent process, and during the research interview. These steps included informing participants of the option to leave their camera off during the interview, and that the interview would be conducted in a private setting to ensure that others could not overhear. Participants were also ensured that no private data would be collected without their knowledge and consent.

Steps were also taken to protect the confidentiality of information provided by the participants. All personally identifiable information was stripped from the interviews during the transcription process. Pseudonyms were used instead of participant names, and a master key was used to retain identifiers linked to study data. This included participant names, email addresses, phone numbers, and the name of the school districts where they teach. The master list was stored in a locked file cabinet in the residence of the researcher. Only the researcher had access to this file cabinet. Electronic data collected during this study was stored on a password-protected laptop computer, which was stored in a locked desk in the residence of the researcher. Data collected and recorded on paper was stored in the same locked desk. Only the researcher had access to this computer and this desk.

When the member checking process was completed and the accuracy of the transcripts was verified, the recordings of the interviews were destroyed. The remaining study data will be

retained for the length of time required by the IRB of the University of New England, then will be destroyed at that time.

## Trustworthiness

The standard used to evaluate the quality and rigor of qualitative research is trustworthiness (Bloomberg & Volpe, 2019). Trustworthiness means "that the community of researchers and scholars will trust your analysis and interpretation of what others said and did in the field, thereby supporting the credibility and dependability of your research and the transferability of your findings" (Bloomberg & Volpe, 2019, p. 47). The criteria used to evaluate the trustworthiness of a qualitative research study are credibility, dependability, confirmability, and transferability (Bloomberg & Volpe, 2019).

### Credibility

Credibility is achieved when the researcher has accurately represented the thoughts, feelings, perceptions, and actions of the participants (Bloomberg & Volpe, 2019). One strategy used to strengthen the credibility of this study was providing a detailed description of the entire research process. A second strategy used to strengthen credibility was the use of a member checking process, in which participants reviewed and confirmed the accuracy of their interview transcripts. A third strategy used to strengthen credibility was a peer debriefing process, in which a review panel consisting of two experienced phenomenologists examined researcher's interpretations and findings (Bloomberg & Volpe, 2019).

### Transferability

Transferability refers to "the fit or match between the research context and other contexts as judged by the reader" (Bloomberg & Volpe, 2019, p. 205). To achieve transferability, a researcher must provide detailed information about both the context of the study and the participants. This information enables the reader to determine "whether similar processes will be

at work in their own settings and communities by understanding in depth how they occur at the research site" (Bloomberg & Volpe, 2019, p. 205). Strategies used to strengthen the transferability of this study included providing the inclusion criteria, explaining the procedure used to recruit and select participants, providing rich and thick descriptions of the experiences of the participants, and providing detailed information regarding the context, data, and findings of the study so that they can be taken into account when transferring aspects of this study design to a different study.

**Dependability**

Dependability refers to "the stability and consistency of data over time" (Bloomberg & Volpe, 2019, p. 204). Dependability is achieved when the procedures used to collect and analyze data are documented in a logical fashion that enables them to be adequately traced (Bloomberg & Volpe, 2019). Strategy 1 used to strengthen the dependability of this study was providing an audit trail, which involved "including detailed and thorough explanations of how the data were collected and analyzed, as well as maintaining clear record of field notes and transcripts" Bloomberg & Volpe, 2019, p. 204). Strategy 2 used to strengthen dependability included providing a rationale for all methodological choices. Strategy 3 used to strengthen dependability was using a peer evaluation process to reduce the potential of bias occurring when one researcher is performing all of the data collection and analysis. (Bloomberg & Volpe, 2019).

**Confirmability**

Confirmability means establishing that (a) the findings of the study are grounded in the data, and (b) the interpretation of data is not affected by the bias and assumptions of the researcher (Bloomberg & Volpe, 2019). To achieve confirmability, "reasons must be provided for all methodological, theoretical, and analytic choices throughout the entire study so that readers can understand how and why decisions were made" (Bloomberg & Volpe, 2019, p. 205). The

strategies of creating an audit trail and using a peer review process that were previously explained also served to strengthen the confirmability of this study.

## Summary

In this qualitative research study, the researcher used IPA to explore, investigate, and interpret the lived experiences and perceptions of self-contained elementary teachers who dislike mathematics in the context of mathematics education reform. The pool of potential participants for this study included all self-contained elementary teachers currently teaching in a public school district located within one county in northern New York State. For the purposes of this study, elementary teachers were defined as those who teach in Grades K–5.

A purposeful sampling strategy was used to identify participants who met the following inclusion criteria: (a) currently teaching in any Grades K–5; (b) trained to be a generalist, not a mathematics specialist; (c) teach all core academic subjects, including mathematics, in a self-contained classroom setting; and (d) self-identify as either disliking or having disliked mathematics. Following recruitment efforts, nine participants were identified. Semistructured, phenomenological interviews were conducted and recorded in Zoom and then transcribed into written text. All nine transcripts were accepted during the member-checking process, and no requests for changes were made.

The data analysis was conducted manually, using the procedure for IPA data analysis set forth by Smith et al. (2022). This is a seven-phase process that entails (a) conducting an initial reading of the first case, (b) taking exploratory notes, (c) constructing experiential statements, (d) searching for connections across experiential statements, (e) clustering the experiential statements into PETs, (f) repeating the process for all other cases, and (g) developing GETs that represent patterns of shared experience across all cases (Smith et al., 2022).

Ethical considerations were acknowledged and addressed throughout the duration of this research study. Steps were taken to protect both the privacy of participants and the confidentiality of the information that was collected. Steps were also taken to strengthen the credibility, dependability, confirmability, and transferability of this study to ensure its trustworthiness.

In the two chapters that follow, the findings and results of this IPA research study are presented. In Chapter 4, the participants of this study are introduced along with a detailed discussion of the findings. In Chapter 5 an interpretation of the results of this study is presented, followed by implications, recommendations for action, and recommendations for future research.

# CHAPTER 4: RESULTS

The predominant model of elementary instruction in the United States is the self-contained classroom (Markworth et al., 2016). In a self-contained classroom, one teacher is responsible for delivering core academic instruction in all subject areas (Markworth et al., 2016). As a result, most elementary teachers in the United States are trained to be generalists (NCTM, 2010). A generalist is a teacher trained to teach all core academic subjects rather than specializing in any particular one (Murphy & Glanfield, 2010).

Due to the increased expectations for rigorous mathematics instruction demanded by the CCSS-M, it has become increasingly difficult for elementary teachers who are trained to be generalists to deliver expert instruction in mathematics (Markworth et al., 2016). As a result, many elementary teachers have struggled to teach the CCSS-M effectively (Ostashevsky, 2016). This problem is compounded by the reality that many elementary teachers dislike mathematics (Johnson, 2018), as elementary teachers who have a negative relationship with mathematics are less likely to implement reform-based approaches for teaching it (Wilkins, 2008). It is now more than a decade since the release of the CCSS-M, but traditional mathematics instruction is still prevalent in elementary schools and reform-based mathematics instruction has not been widely embraced (Boaler, 2019; Huinker, 2020; Spillane et al., 2018).

The purpose of this qualitative, interpretive phenomenological study was to explore, investigate, and interpret the lived experiences and perceptions of elementary mathematics teachers. Specifically, this study was designed to explore the experiences and perceptions of elementary mathematics teachers (a) who are trained to be generalists; (b) who teach all core academic subjects, including mathematics, in a self-contained classroom setting; and (c) who would describe themselves as either disliking or having disliked mathematics. The central

research question is: What are the lived experiences and perceptions of self-contained elementary teachers who dislike mathematics? The following subquestions were also addressed:

7. How have self-contained elementary teachers who dislike mathematics experienced mathematics?
8. How have self-contained elementary teachers who dislike mathematics experienced reform-based approaches for teaching mathematics?
9. How do self-contained elementary teachers who dislike mathematics perceive their own identity as a mathematics teacher?

The lived experiences and perceptions of these teachers were viewed through the lens of mathematics teacher identity in the context of mathematics education reform. A more thorough understanding of the lived experiences and perceptions of elementary teachers who dislike mathematics will enable mathematics educators to develop professional learning experiences designed to help both preservice and inservice elementary teachers (a) improve their relationship with mathematics and (b) increase both their willingness and their ability to implement reform-based mathematics teaching.

This chapter contains three sections. The first section provides an overview of the steps used for data collection and data analysis. The second section introduces the participants of this study, each of whom has experienced the phenomenon of being a self-contained elementary teacher who dislikes mathematics. A detailed description of the data collected from each participant is also provided. The third section discusses the themes and subthemes that emerged from an analysis of this data.

## Analysis Method

Approval from the IRB marked the commencement of the data collection phase of this research project. The pool of potential participants was self-contained, K–5 teachers currently

teaching in a public school district located within one county in northern New York State. Criteria for inclusion in this research project study included: (a) currently teaching in any Grade K–5; (b) trained to be a generalist, not a mathematics specialist; (c) teach all core academic subjects including mathematics in a self-contained classroom setting; and (d) self-identify as either disliking or having disliked mathematics.

A recruitment letter stating the purpose of this research project and the inclusion criteria for participation was posted in two local educator groups on a social-media platform. It was also sent to local educators via email, each of whom then forwarded the email on to other local educators. Following these efforts, 10 teachers responded with interest in participating in this study. Three out of the 10 potential participants were identified by the researcher through prior acquaintance, and the remaining seven were previously unknown to the researcher. Of these seven, two had encountered the recruitment letter via a social media post and five had received the recruitment letter via email.

Nine of the 10 teachers who responded with interest were selected for participation in this study. Seven of these participants met all of the required inclusion criteria and expressed a willingness to talk about their experiences. Two of the participants expressed an interest in talking about their experiences but failed to meet one of the inclusion criteria. Both had moved from a self-contained to a departmentalized classroom this school year, so were no longer teaching all core academic subjects. However, following a discussion with each teacher, the decision was made to include them in the study. Both teachers had met all of the inclusion criteria during the previous school year, so had information to share that was both valuable and relevant to this study. However, one potential participant was eliminated because she met all of the inclusion criteria with the exception of one—she self-identified as having a positive relationship with mathematics. The researcher decided that this criterion was nonnegotiable.

An individual, semistructured phenomenological interview was conducted over Zoom with each of the nine participants. The use of a semistructured format enabled the researcher to ask a combination of specific questions designed to collect demographic information, and open-ended questions designed to encourage the participants to talk freely about their experiences and perceptions. This format also enabled the researcher to ask follow-up or probing questions as necessary according to the individual responses of each participant. A pseudonym was assigned to each participant and used instead of real names to protect confidentiality.

The interviews were recorded in Zoom and sent to Rev Transcription, a professional transcription service, to be transcribed into written text. Once the written transcripts were received, the member-checking process began. Each participant was sent the transcript of their interview via email and given 7 days to verify the accuracy of their transcript or request that changes be made. The participants were notified that, if they did not respond within 7 days, the researcher would assume that they felt the transcript was accurate and that they did not wish to make any changes. All nine transcripts were accepted during the member-checking process, and no requests for changes were made.

The completion of the member-checking process marked the end of the data collection phase of this study and the beginning of data analysis. The data analysis in IPA is an iterative and inductive cycle in which the focus is on the participants' attempts to make sense of their experiences (Smith et al., 2022). According to Smith et al. (2022),

> IPA can be characterized by a set of common processes (e.g. moving from the particular to the shared, and from the descriptive to the interpretive) and principles (e.g. a commitment to an understanding of the participants' point of view, and a psychological focus on personal meaning-making in particular contexts) which are applied flexibly, according to the analytic task. (p. 75)

The data analysis was conducted manually using the procedure for IPA data analysis set forth by Smith et al. (2022). This is a seven-phase process that entails (a) conducting an initial reading of the first case, (b) taking exploratory notes, (c) constructing experiential statements, (d) searching for connections across experiential statements, (e) cluster the experiential statements into PETs, (f) repeating the process for all other cases, and (g) developing GETs that represent patterns of shared experience across all cases (Smith et al., 2022).

Phase 1 of data analysis in IPA was reading and re-reading the first case (Smith et al., 2022). First, I listened to the audio recording of the first interview and recorded my recollections of the interview along with any initial observations that emerged. I then began the process of actively engaging with the data by reading and then re-reading the interview transcript. According to Smith et al. (2022), actively engaging with the data in this fashion ensures that the participant becomes the focus of the analysis and enables the researcher to "begin the process of entering the participant's world" (p. 78).

Phase 2 of data analysis in IPA was exploratory noting (Smith et al., 2022). During this phase, I explored the content and language of the first transcript and recorded anything of interest. While doing so, I was mindful to "stay focused on what is important to the participant, and not to describe, judge, or diagnose the participant" in any way (Smith et al., 2022, p. 86). The end product for this phase was a set of provisional notes recorded in the right margin of the transcript.

Phase 3 of IPA data analysis was constructing experiential statements. An experiential statement relates directly either to the participant's experience or to their attempt to make sense of that experience (Smith et al., 2022). During this phase, my analysis shifted from the original transcript to the exploratory notes that had been recorded in the previous phase. This enabled me to reduce further the volume of information by capturing what I deemed to be most important.

The end product for this phase was a set of experiential statements recorded in the left margin of the transcript.

Phase 4 of IPA data analysis was searching for connections across experiential statements (Smith et al., 2022). During this phase, I closely examined the experiential statements that had been generated in the previous phase to allow patterns, or themes, to emerge. The end product of this phase was hand-written mind maps which represented clusters of experiential statements according to the emergent patterns and themes. I was mindful that these clusters should represent "all of the most interesting and important aspects of your participant's account" (Smith et al., 2022, p. 91).

Phase 5 of IPA data analysis was determining the participant's PETs. The acronym PET stands for "personal" because the themes are derived from and are at the level of a particular person, "experiential" because the themes relate directly to a person's experience or how they make sense of that experience, and "themes" because the analysis now reflects the transcript as a whole rather than specific instances that occur within the transcript (Smith et al., 2022). I determined the PETs by giving each cluster of experiential statements that had been generated in the previous phase a title that describes its characteristics. The end product for this phase was a table that displayed the PETs for the participant along with their experiential statements.

Phase 6 of this IPA data analysis was to repeat Phases 1–5 for each of the remaining eight participants. I was mindful during this phase to "treat the next case on its own terms, to do justice to its own individuality, to treat each case as a complete universe of inquiry" (Smith et al., 2022, p. 99). To accomplish this, I strove to allow new insights to emerge from within each individual case rather than simply reproducing the same ideas. The end product for this phase was a table that displayed the PETs for each of the nine participants in this study (see Appendix D).

Phase 7 of IPA data analysis was to create a set of GETs. The GETs describe "the essence of the experiences for several individuals who have all experienced the same phenomenon," and as such are the culmination of an IPA study (Creswell & Creswell, 2018, p. 13). To accomplish this, I first scanned the tables of PETs that had been generated for each participant in the previous phase to look for similarities and differences at a broad level. Next, I examined the individual PETs more closely to allow patterns to emerge, being mindful of "emphasizing both convergence and divergence, commonality and nuance" (Smith et al., 2022, p. 75). Following this analysis, nine emergent GETs were identified. To ensure validity of the findings and reduce the possibility of the researcher's bias entering into the analysis, the nine GETs were shared with a review panel consisting of two practicing mental health professionals who were also experienced phenomenologists. Revisions to the GETs were made according to feedback from the review panel. A table was generated to display the GETs, including both themes and subthemes, which represent the findings of this research study (see Appendix E). The nine themes were then mapped together to provide a visual representation of the lived experiences and perceptions of elementary teachers who dislike mathematics in the context of mathematics education reform. This concept map will be presented in the following section.

## Presentation of Results and Findings

This section contains two parts. In Part 1 of this section, the nine participants of this study are introduced. Years of teaching experience and the grade level that they currently teach are provided, along with a brief narrative that highlights each participant's" PETs. In Part 2 of this section, the nine GETs are presented in detail.

### Participants

Nine elementary teachers representing seven different public school districts were interviewed for this research study. All seven of these school districts are located within one

county in northern New York State. Three of the participants were second-grade teachers, three were fifth-grade teachers, and one each was teaching Kindergarten, Grade 1, and Grade 4. The years of teaching experience for the participants ranged from a minimum of 2 years to a maximum of 20 years.

### *Annie*

Annie is a self-contained Kindergarten teacher with 6 years of teaching experience. She is trained to be a generalist and, as a self-contained teacher, she is currently responsible for teaching reading, phonics, writing, social studies, science, a social–emotional learning curriculum, and mathematics. Annie's dislike of mathematics began in elementary school. "I was definitely a person who did not like math," Annie recalled. "It was something that was always very hard for me. When I was a kid, I felt like my brain just didn't understand math." Annie vividly remembers fifth grade being the turning point in her relationship with math. She attributes her dislike of mathematics to teaching practices that caused her to feel anxiety and embarrassment (e.g., mad minutes, mathematics fact kickball, and being forced to do problems on the board in front of her peers). "From then on out, I did not like math," Annie shared. "That's been my story with math, it brought me a lot of anxiety growing up."

Now, as a self-contained teacher, Annie is responsible for teaching all core academic subjects including reform-based mathematics. Annie has embraced reform-based mathematics teaching. She associates it with teaching more of the conceptual ideas behind mathematics, and with teaching multiple strategies and then allowing students to choose which way works best for them. Annie believes that reform-based mathematics teaching has been beneficial for her students and observes that more students are understanding mathematics and making connections with mathematics because of reform-based mathematics teaching. Annie also believes that the experience of teaching reform-based mathematics has changed her own mindset about

mathematics. She enjoys mathematics more now and finds teaching mathematics this way to be much more fun both for her and her students. She described this evolution in her mathematics teacher identity as a "huge personal change" that has helped her to feel better about herself.

Annie credits the negative experiences with mathematics from her childhood with motivating her to change her identity as a mathematics teacher. As a result, she now feels grateful that she had these experiences. "At times, they were detrimental to me," she explained. "But they've really shaped and helped me grow as an educator, in particular in math." Annie also credits empathy for her students for helping her to overcome both her dislike of mathematics and her fear of teaching it. When asked what her mathematics teacher identity means to her, Annie replied, "The fact that I've made that change in my identity of how I feel about teaching math, it makes me really excited that I can do better for someone else."

***Beth***

Beth is a self-contained second-grade teacher in her ninth year of teaching. She is trained to be a generalist, and as a self-contained teacher is responsible for teaching reading, writing, phonics, social studies, science, and mathematics. Beth's dislike of mathematics began when she was in elementary school, and she describes her relationship with mathematics as "an up and down kind of thing." Beth particularly remembers having a difficult time understanding fractions, and as an adult she still does not like fractions to this day. "I'm not even really sure why I don't like fractions," Beth mused. "I don't know if it just didn't click? I just don't understand it the right way." Beth associates her dislike of mathematics with the "one-way-fits-all" approach to teaching mathematics that she experienced as a student. "Back then you just had to know it," Beth recalled. "There wasn't a why. There was just, you have to do it. So, mathematics was boring I guess."

Now, as a self-contained teacher, Beth is responsible for teaching all core academic subjects, including reform-based math. She believes that reform-based mathematics is founded on the idea that there is more than one way to learn mathematics, and associates reform-based mathematics teaching with teaching students multiple strategies for solving problems. At first, Beth found that teaching reform-based mathematics was very difficult. It is a very different approach to teaching mathematics than what she experienced as a student, and she remembers trying to teach herself the mathematics at home each night so that she could teach it to her students. She had a hard time understanding the math, and she did not feel confident teaching it. However, since that time, Beth has embraced reform-based mathematics teaching. She uses manipulatives. Her students play fluency games instead of doing "drill and kill" worksheets. She uses instructional routines (e.g., number talks) to build number sense, instead of focusing on the memorization of basic facts. Her students work in groups, instead of sitting at their desks and working alone. They have conversations about mathematics, they talk about "the why," and she exposes her students to multiple strategies instead of just teaching them one.

Beth's identity as a mathematics teacher has changed in a positive way. She enjoys teaching mathematics now and says that last year was her most favorite year of teaching mathematics. She credits expanding her knowledge about mathematics and learning new ways to teach it with helping her to overcome her dislike of mathematics and become more comfortable teaching it. When talking about reform-based mathematics teaching and her growth as a mathematics teacher, Beth frequently mentioned professional development experiences that she has chosen to undertake and research about teaching mathematics that she had been exposed to. She feels as though she is becoming a stronger mathematics teacher every year, and said, "The more I learn, the more I grow, the more I love it."

When asked what her identity as a mathematics teacher means to her, Beth replied, “It makes me excited to teach mathematics because, now that I love it and I understand it more, I feel like I can bring that out in my classroom to let the students do the same and be able to have fun with it.” She added, “I do enjoy it now, a lot more than I ever have. Especially with my small class last year, we were able to explore it and fall in love with math as a class.”

***Carly***

Carly is a fifth-grade teacher in her sixth year of teaching. She is trained to be a generalist and was a self-contained teacher for the first 5 of these years, during which time she was responsible for teaching reading, writing, social studies, science, and math. This year Carly’s school decided to departmentalize at the fifth-grade level, so she is now teaching reading, writing, and social studies. Although Carly no longer teaches mathematics, she was chosen to participate in this study because she met all of the inclusion criteria during each of the previous 5 years.

Carly’s dislike of mathematics began in high school. She described herself as being “strong in math” from elementary school until early high school, at which time a teacher that she “didn’t jive with” caused her to turn away from mathematics. She recalled, “I didn’t comprehend how he or she was teaching at that time, so I just lost interest.” Following this experience, Carly chose not to take calculus in high school. She did take calculus in college, but says “it wasn’t intriguing to me,” “I wasn’t really interested in it,” and “I just didn’t see a point.”

Carly has not embraced the philosophy of reform-based mathematics teaching. She believes that reform-based mathematics is “not necessary,” that it is confusing for both the students and their parents, and stated that she is “not a fan.” Teaching reform-based mathematics was not a good experience for Carly. She did not feel prepared to teach reform-based mathematics and had to spend extra time teaching it to herself before she could teach it to her students. She was “not confident enough” and “felt anxiety when teaching” reform-based

mathematics because she was unsure whether she was doing the problems correctly. She remembers feeling embarrassed about doing problems wrong on the board in front of her students and then "having them call me out on it." When asked to describe how she perceives her identity as a mathematics teacher, Carly replied, "You have to fake it to make it." Eventually, Carly decided to stop teaching reform-based mathematics and reverted back to teaching mathematics in a more traditional way.

Carly believes that using mathematics specialists to teach mathematics at every grade level would be beneficial for students. Regarding elementary teachers teaching math, Carly said, "I believe that it's not for everybody. I don't think that every teacher should be teaching math. I believe that it should be specialized. I believe that each teacher, no matter what grade level, should have a specialized mathematics teacher that is fully focused on it." When Carly's school decided to departmentalize at the fifth-grade level for this school year, she chose to stop teaching math.

***Donna***

Donna is a second-grade teacher with 3 years of teaching experience. She is trained to be a generalist, and she co-teaches reading and is the primary teacher for writing, science, social–emotional learning, and mathematics. Donna's dislike of mathematics began in elementary school. "I was never good at math," Donna recalled. "I really struggled to get through it. That was my hardest subject all the time." Donna attributes her dislike of mathematics to practices used to teach mathematics when she was in elementary school (e.g., mathematics facts Around the World, sprints, and being forced to memorize the multiplication facts). These practices caused her to feel "stressed out" because she felt as though she was not good enough at mathematics and was not as smart as her peers. Donna believes that "there was no development of the love of math"

when she was younger, and states that mathematics "got too far away from me where I couldn't catch up."

Now, as a self-contained teacher, Donna is responsible for teaching all core academic subjects including reform-based math. She associates reform-based mathematics teaching with teaching multiple strategies, but believes that teaching mathematics this way is not beneficial either for her or for her students. As a result, she has had a difficult time teaching reform-based mathematics. It is a very different approach to teaching mathematics than what she experienced as a mathematics student; therefore, she has to try to understand the lessons herself before she can teach them to her students. This has been a frustrating experience for Donna, and she believes that her students are frustrated, too. "I get so frustrated with some of the lessons when it comes to math," Donna said. "I'm like, here we go. We've just got to get through this lesson. We'll move on to an easier one tomorrow."

Since she has implemented reform-based mathematics teaching, Donna's mathematics teacher identity has remained negative. "I think I've carried it with me since probably elementary school Around the World," Donna shared. She still does not consider herself to be a mathematics person, she does not look forward to teaching math, she lacks confidence in herself as a mathematics teacher, and does not want to be observed while teaching mathematics. As a result, Donna has decided to move away from reform-based mathematics teaching and is reverting back to teaching mathematics in a way that is easier for her. To Donna, this means deviating from the existing curriculum and teaching mathematics in a way that "makes more sense" (e.g., "teaching adding and subtracting in a way that they understand and then working from there, instead of throwing five different strategies at them and then expecting them to get one that sticks").

***Elle***

Elle is a second-grade teacher in her 9th year of teaching. She is trained to be a generalist and, as a self-contained teacher, she is responsible for teaching reading, writing, phonics, handwriting, social studies, science, a social–emotional learning curriculum, and mathematics. Elle's dislike of mathematics began in elementary school. She attributes her dislike of mathematics to practices that were used to teach it (e.g., being forced to do problems on the board and play mathematics facts Around the World, which caused her to feel embarrassed in front of her peers). She remembers feeling "totally stupid every day" in fourth grade, and recalled, "That's where it really was evident that I don't like it and it's not comfortable for me, it's not safe." Even now, as an adult, just the mention of the word "math" immediately triggers anxiety and an intense emotional reaction.

As a self-contained elementary teacher, Elle is responsible for teaching all core subjects including reform-based mathematics. However, the negative experiences that she had with mathematics in elementary school have stayed with her and have affected her identity as a teacher. Elle describes teaching reform-based mathematics as scary and intimidating. She is afraid of teaching it wrong, and vividly remembers the embarrassment she felt when she made a mistake in front of her students. During the pandemic, when they were required to teach remotely, Elle and her coworker departmentalized because she was not comfortable having parents watch her teaching mathematics. However, when remote learning ended, Elle chose to resume teaching mathematics. This was the turning point for Elle and, since that time, she has embraced reform-based mathematics teaching. She is working hard to implement reform-based approaches that are designed to build a conceptual understanding of mathematics, and for the first time in her career she believes that the way she is teaching mathematics is in alignment with her overall philosophy about teaching.

Since that time, Elle's mathematics teacher identity has undergone a positive change. She believes that the use of a reform-based approach to teaching mathematics plays to her strengths and has enabled her to find her niche as a mathematics teacher; as a result, she now feels much more confident teaching it. However, Elle admits that her identity as a mathematics teacher is dependent on what grade level she is teaching. Her "fear factor" of teaching mathematics increases as the grade levels get higher, and she described the thought of having to teach multiplication in the future as "my line in the sand." Elle credits the support of colleagues who love mathematics and are excited about teaching it with helping her to become more comfortable teaching reform-based mathematics. She spoke highly of the support she has received from both the district mathematics coach and a mathematics interventionist who pushes into her mathematics class this year, and also credits the district mathematics coach for changing her mindset about teaching mathematics. She attributes the empathy she feels for her students with motivating her to make this change.

***Imelda***

Imelda is a fourth-grade teacher in her 18th year of teaching. She is trained to be a generalist, and as a self-contained teacher she is currently responsible for teaching reading, writing, social studies, science, and mathematics. Imelda's dislike of mathematics began in elementary school, and she credits the stereotype that only some people are smart enough to be good at mathematics for turning her away from mathematics at a young age. She referred to the approach used to teach mathematics at that time as "weaponized mathematics instruction" because "its main goal was to sort out the kids who were 'smart enough' to do mathematics well from the kids who were 'too dumb' to do mathematics well, and that there was no attempt to meet the two together." Therefore, much of her experience in mathematics "really has an emotional hit to it."

Now, as a self-contained teacher, Imelda is responsible for teaching all core academic subjects, including reform-based mathematics. At first, teaching reform-based mathematics was very difficult. She attributes this to the fact that reform-based mathematics is very different from the way mathematics had previously been taught, which meant that neither teachers nor students possessed the prior knowledge that was required and expected. The negativity and resistance she received from parents just compounded the difficulty she had teaching it.

Now, many years later, Imelda has embraced reform-based mathematics teaching. She associates reform-based mathematics teaching with trying to explain the why of mathematics (not just the how), which she believes is beneficial for both teachers and students. During the years that Imelda has been teaching reform-based mathematics, her relationship with mathematics has undergone a complete transformation. Imelda credits reform-based mathematics with changing both her relationship with mathematics and her identity as a mathematics teacher. “I really don’t think I started getting over my aversion to mathematics until I started teaching it,” Imelda said. Now, Imelda looks forward to teaching mathematics with excitement and pleasure. She enjoys teaching mathematics now and loves showing students multiple strategies for solving problems and talking to them about the “elegance of math.”

Imelda believes that “the process of learning how to be a better mathematics teacher” marked the turning point in her relationship with mathematics. She is adamant about the importance of being a continuous learner and says that the more she learned as both a mathematics learner and a mathematics teacher the more excited she felt about teaching it. She credits professional development experiences she undertook as an inservice teacher with helping her to become more comfortable teaching mathematics, and she also takes the initiative to stay abreast of current research by reading books and other professional literature about teaching mathematics.

Imelda described herself as “a mindful mathematics teacher” and is working hard to “eliminate the emotional response to math” in her students. Her “mindful approach” to mathematics teaching has three components, which include doing “mindfulness work” with her students before mathematics class, not allowing her students to use the word “easy” in mathematics class and encouraging students to be brave when doing mathematics. “As long as you are asking questions and doing your part by engaging in the lesson, working with your group partners, making sure that I know when you don’t understand something, then it’s all going to be fine,” Imelda tells her students. “And who knows, you may even like math in the end.”

***Jane***

Jane is a first-grade teacher with 20 years of experience. She is trained to be a generalist, and is responsible for teaching reading, writing, phonics, social studies, science, and mathematics. Jane’s dislike of mathematics began in elementary school. She associates her dislike of mathematics with teaching practices (e.g., being forced to memorize the multiplication facts and playing mathematics facts Around the World) that led her to feel she was not good at mathematics because she was not as fast as her peers. Jane also associates her dislike of mathematics with the stereotype that girls are not as good at mathematics as boys, which she believes was part of the educational culture when she was in school. The negative experiences Jane had with mathematics in elementary school affected the rest of her career as a mathematics student. Even though she took mathematics classes in high school, she did not believe she was good at mathematics and did not see herself as a mathematics person.

Now, as a self-contained teacher, Jane is responsible for teaching all core subjects including reform-based math. She agrees with the philosophy of reform-based mathematics teaching. “I would describe it as more strategy-based and less memorization,” Jane explained. “I think that it’s teaching children to have number sense and strategies for thinking things out rather

than just memorizing it." Although Jane agrees with the philosophy behind reform-based mathematics teaching, she has not fully embraced teaching it. She has found teaching reform-based mathematics to be a big learning curve and admits that it is more difficult than she expected it to be. Having students use manipulatives and play games during mathematics class can be chaotic. It also takes more preparation time, which is overwhelming when a teacher must also prepare to teach every other subject. "It's only one blip on what I do in the day," Jane explained. "To try and make it fun and hands-on, I realized that I needed more hours in the day."

Now, later in her career, Jane is still not enthusiastic about teaching math. Teaching reform-based mathematics is out of her comfort zone, and she admits that she has a tendency to revert back to teaching mathematics in ways that are easier for her. She described herself as a "simplistic" mathematics teacher, and said "I try to put on my game face for the kids." Jane does credit her district's mathematics coaches who are enthusiastic and excited about teaching mathematics with helping her to become more comfortable with reform-based mathematics teaching, and having an administration that understands and supports reform-based mathematics teaching has also helped.

Jane believes that departmentalizing at the primary level and having specialists teach mathematics would be beneficial to both students and teachers. "It almost feels like a race that can never be finished as an elementary school teacher," Jane explained. The realist in me just realizes that there's no way we can all feel masters of everything." She believes that all students would benefit from having a mathematics teacher who is passionate and enthusiastic about teaching mathematics.

***Janice***

Janice is a fifth-grade teacher in her 5th year of teaching. She is trained to be a generalist, and is responsible for teaching reading, writing, science, and math. Janice's dislike of

mathematics began in elementary school, and she remembers hating mathematics by the time she was in fifth grade. She did what she needed to get by throughout high school, and even remembers hiding in the bathroom to avoid mathematics class. Janice associates her dislike of mathematics with the approaches that were used to teach it. In particular, she attributes being made to memorize formulas instead of being taught to understand the mathematics with turning her away from the subject. She also associates her dislike of mathematics with the emphasis on getting the correct answer, and remembers feeling like you either got it right or you got it wrong and there was nothing in between. Even now, as an adult, Janice still lacks confidence in her mathematical ability.

Now, as a self-contained teacher, Janice is responsible for teaching all core academic subjects including reform-based mathematics. Janice has embraced the philosophy of reform-based mathematics teaching. She associates it with building a conceptual understanding of mathematics rather than emphasizing formulas and memorization, and believes her relationship with mathematics might be different now if she had been taught reform-based mathematics as a student. However, teaching reform-based mathematics has been a very difficult experience. Reform-based mathematics is different from the way she learned mathematics in school, and she does not feel that she was adequately prepared in college to teach it. As a result, she had to spend a significant amount of extra time trying to teach herself the mathematics lessons before she could teach them to her students. This was especially difficult because she also had to plan for teaching every other subject.

Janice still lacks confidence when teaching mathematics and thinks she always will. She feels embarrassed when she makes mistakes in front of her students. She feels insecure while teaching math, and just the thought of being observed while teaching it triggers a negative emotional reaction. She admits that she looks forward to the days that she doesn’t have to teach

mathematics. Janice credits the support of a colleague who is confident teaching mathematics with helping her to become more comfortable teaching it. This year, after 5 years of teaching mathematics, Janice finally took the initiative to ask her administration for help. As a result, a retired mathematics teacher comes into her mathematics class twice per week. She also credits a new curriculum, that has videos that she can watch and show her students, with helping her to become more comfortable teaching it.

Janice is working to create an environment where her students feel safe to make mistakes and get wrong answers in mathematics. She believes in the importance of "getting them to know it's okay to make a mistake" and she also believes that "getting them to know that you're not always going to get the right answer is really important. My classroom is very calm, and we make mistakes," Janice explained. "We're very vulnerable."

***Lucy***

Lucy is a fifth-grade teacher in the 2nd year of her teaching career. Last year Lucy taught in a self-contained classroom and was responsible for teaching reading, writing, social studies, science, and mathematics. This year she is teaching in a departmentalized classroom and is only responsible for teaching mathematics and science. Lucy's dislike of mathematics developed during her childhood. "All throughout high school, I was always that kid that got put in the AIS mathematics classes," Lucy recalled.

> I always had that extra help with mathematics because my brain just couldn't comprehend what was being taught to me." She continued, "It took me longer than it took the other kids. So, I just felt like I was behind and I didn't know what I was doing. Everybody knew I didn't know what I was doing. So, it was mostly an embarrassment for me.

Now, as a fifth-grade teacher, Lucy is responsible for teaching reform-based mathematics. However, she has not embraced the philosophy behind reform-based mathematics and has found

teaching it to be a very difficult experience. Lucy does not feel confident teaching reform-based mathematics and attributes this in part to her past experiences with mathematics from her childhood. “It’s my whole inner piece to it where I always struggled with math.” Lucy explained. “So I don’t have that self-confidence or that self-esteem to teach it.”

Moving to a departmentalized classroom model this year has helped Lucy to become more comfortable teaching reform-based mathematics. Having to teach reform-based mathematics in addition to all the other subjects was overwhelming, but now she is only responsible for teaching mathematics and one other subject. “It’s a huge difference. It’s a time saver. I can focus more” Lucy explained. “I have more time to focus on that one content compared to four at a fifth-grade level. So, yeah, it is a lot easier” she added.

Despite the difficulties she has faced, Lucy is trying to develop a positive outlook on reform-based mathematics teaching. She is open to learning, and is trying to take what she knows and how she feels about mathematics and turn it into a positive experience for both herself and her students. “I'm more concerned about the children and how they're doing. So, if I have a negative outlook on it, my kids are going to as well because they can see that through my teaching,” Lucy explained.

> So, my goal for myself is to just try to figure out what I'm doing, figure out strategies for the kids, figure out some positive ways I can go about looking at math, reaching out to other people, looking at resources. I think if I have a more positive outlook on it, then my students will start to do well too.

**Emergent Themes**

The central question answered by this research study was: What are the lived experiences and perceptions of self-contained elementary mathematics teachers who describe themselves as disliking mathematics? This study also answered the following subquestions:

1. How have self-contained elementary teachers who dislike mathematics experienced mathematics?
2. How have self-contained elementary teachers who dislike mathematics experienced reform-based approaches for teaching mathematics?
3. How do self-contained elementary teachers who dislike mathematics perceive their own identity as a mathematics teacher?

Nine GETs emerged from the data analysis process. The nine GETs were then mapped together to provide a visual representation of the lived experiences and perceptions of elementary teachers who dislike mathematics in the context of mathematics education reform (see Figure 5). The first four themes are referred to as convergent themes because they represent experiences that were shared by the majority of the participants (see Numbers 1–4 in Figure 5). Themes 5–9 are referred to as divergent themes because, after theme 4, clusters of participants went on to have very different experiences (see Numbers 5–9 in Figure 5). The five divergent themes represent five distinct patterns of how elementary teachers that dislike mathematics have experienced reform-based mathematics teaching. When mapped together, these patterns comprise a continuum that ranges from avoiding reform-based mathematics teaching to thriving with it (see Appendices F and G). This continuum can be seen at the bottom of Figure 5.

**Figure 5**

*Lived Experiences and Perceptions of Self-Contained Elementary Teachers Who Dislike Mathematics in the Context of Mathematics Education Reform*


Continuum of Math Teacher Identity in the Context of Reform-Based Math Teaching

### *Convergent Themes*

The first four themes were experienced by the majority of the participants in this study in the same or a very similar way. They are arranged in chronological order and represent a path that

was followed by the majority of the participants. The four convergent themes are presented in detail in the next section.

**GET 1: Dislike of Mathematics Began in Elementary School.** This theme was selected because seven of the nine participants identified elementary school as the turning point with their relationship with mathematics. Three cited fourth grade specifically as the year that they turned away from mathematics, and one cited fifth grade. One could not remember the exact grade, but remembered that, by the time she reached fifth grade, she hated it. Two other teachers spoke of their dislike of mathematics beginning in elementary school, but they did not identify a specific grade.

***Teaching Practices Used.*** Four participants attributed their dislike of mathematics to the instructional practices that their teachers used during the time that they were in elementary school. Annie explained,

> Growing up, I just found mathematics to be very hard. I was a kid that had to use my fingers to count everything. I also went to school at a time where it was a lot of drill and kill. It was a lot of, here's a mathematics fact fluency sheet, the mad minutes. I remember the mad minutes, and I remember the anxiety I felt as soon as that was put down in front of me because I knew I'd only answer two or three, whereas, the kid next to me might fill the whole sheet and be on the backside of the sheet. They might also be onto the subtraction fluency sheets where I was still doing the one-digit addition. So that only got worse as mathematics got harder and more complex.

Annie vividly remembered fifth grade being the turning point in her relationship with math. She recalled,

> I had an older teacher who was very set in her ways. We were working on double-digit multiplication, and I had to go to the board, and I could not leave the board until I

> answered my question. And I remember being up at the board sobbing because everyone around me had answered their questions and gone back to their seats. But I couldn't answer my question because I didn't remember my times tables.

She continued,

> We also had a day where we got to go outside. We played mathematics fact kickball, and you had to answer a mathematics fact before you could kick the ball. And I remember having to sit there or stand there and wait to kick the ball because I couldn't answer my mathematics fact. And I remember the embarrassment that that brought me because all my class was watching and I couldn't do it. It was not coming to me.

Annie credited these and other experiences that happened during her fifth-grade year with turning her away from mathematics. "From then on out, I did not like math," Annie shared. "That's been my story with math, it brought me a lot of anxiety growing up."

Donna also attributed her dislike of mathematics to her teachers and the practices they used to teach it. She explained,

> Going back to middle school time, or even maybe before that, when you'd play mathematics facts Around the World, and you'd have to compete against somebody. That would stress me out because I would almost never win. And when I got one, I was like, whoa! This is awesome! And then I would never get the next one because it didn't, my brain didn't work that fast or in that way, especially with math.

Donna speculated, "I think it's the timed stuff that's like, I'm not good enough at this. And I feel like I'm not as smart as the kids." She continued,

> And then when you get to the sprints where they're timed, and I only got a couple, whereas . . . And even now, my mathematics facts . . . as far as multiplication, I definitely hobbled my way through getting the stars, getting to your tens, to your elevens, your

> twelves. You're getting through each step. That stressed me out. So, I think from then on, I was like, this doesn't click as fast as it does for other people. So, then it just stressed me out from then on out.

Jane also associated her dislike of mathematics with feeling that she was not as fast as her peers. She explained,

> I think it probably started with just noticing other people who were so much quicker and faster. And in your peer group you could just see like, "Oh, Johnny wins the Around the World mathematics facts every day. I'm not even going to try." I do have a little bit of the mindset where I will almost shut down when somebody else is blurting it out and I know they have the answer. And so, I think it kind of just started with that. That I just knew that "Well, that's not my best area."

Elle also attributed her dislike of mathematics to her elementary teachers and the practices they used to teach it. "My earliest memories with mathematics are very negative, which is why I don't feel comfortable with it. I don't have confidence. It's scary to me. It makes me feel panicked." She explained,

> My earliest memory would be fourth grade. It was Around the World, and it was multiplication and that right there was when I . . . Cold turkey. Done. Can't. Even just talking about it, it's yucky feelings, I don't like it.

Elle vividly remembered feeling "totally stupid every day" in fourth grade and believes that her fourth-grade year marked the turning point in her relationship with mathematics. She recalled, "In fourth grade, it started as that's where it really was evident that I don't like it and it's not comfortable for me, it's not safe." She explained,

> I don't remember her specifically working with me or coming up with any strategies or making it fun other than Around the World, which maybe she thought was fun, but

> definitely wasn't for me because it was embarrassing and I always felt called out and shamed in front of my peers. (p. 5)

Elle had the same teacher for both fifth and sixth grade. Although she felt loved and supported by this teacher, her dislike of mathematics was inadvertently reinforced during this time. She especially remembered the strong negative feelings generated by having to go up to the board and do mathematics problems in front of her peers:

> I remember she would make us go up to the board. And even though I was comfortable in that environment, and I felt safe in that environment, I still struggled. And she would always give me positive praise and she would try to work with me, but it was still in front of everybody.

Elle continued,

> Even though I felt very safe and loved in my fifth- and sixth-grade environment, still going up to the board was, I'm not going to say traumatizing because I didn't feel traumatized, but definitely still embarrassed because Rick knew the answers and he could do it in 1–2 minutes and I was going to take 5–8 minutes and I'm the last one standing up there and everyone else has it done.

***Approaches Used to Teach Math.*** Three participants attributed their dislike of mathematics to approaches used to teach mathematics that were prevalent during the time they were elementary students. Beth associated her dislike of mathematics with what she termed the "one-way-fits-all" approach to teaching mathematics that she experienced as a student. "Back then you just had to know it," Beth recalled. "There wasn't a why. There was just, you have to do it. So, mathematics was boring I guess." She explained,

> I felt like we either knew it or we didn't know it. There weren't extra ways. I'm thinking of myself sitting in the high school mathematics class right now, or elementary math, and

> just knowing if you didn't get it and the kid next to you could tell you 2 times 7 is 14, you almost felt worse or awful. What am I doing wrong? Why can't I do that? Because it was one way fits all.

Jane associated her dislike of mathematics with the emphasis her teachers placed on getting the correct answer. To Jane, this meant you either got it right or you got it wrong and there was nothing in between. When speaking about her dislike of mathematics and what caused it, she stated,

> My teachers definitely. I think that they didn't embrace the fact that it was okay if I got it wrong. It was like, nope, you're wrong. There were no second chances. It was just right or wrong and there was no, let's talk about it, or why did you get that?

Janice associated her dislike of mathematics with being expected to memorize and use formulas instead of being taught to understand mathematics for turning her away from the subject. Janice elaborated,

> I didn't understand it. I was just you memorize it, these are flashcards, this is what it is. There was no explanation as to why we do math. So all growing up I was like, Am I going to need this? What is this for? Why are you even teaching me this? And that attitude has stayed for 40–50 years.

**Limiting Ability Beliefs and Stereotypes.** Two teachers attributed their dislike of mathematics to limiting ability beliefs and stereotypes that were prevalent during the time that they were elementary students. Jane associated her dislike of mathematics with the stereotype that girls are not as good at mathematics as boys. She explained,

> Being the timeframe that I went to school, there was somewhat of a perception of a stereotype that males were better at mathematics than females. I'm not saying anyone overtly told me that, but I definitely grew up knowing that the males in my grade were

> looked at as being better mathematicians and better at science. So, I do think I took that on, that, well: I'm a female; I'm probably not going to be as good at math. Which sounds silly now, but it definitely seemed to be part of my educational culture when I went to school.

Imelda attributed her dislike of mathematics to limiting beliefs about mathematical ability that were prevalent during the time she was in elementary school. She shared,

> I would say that mathematics instruction in those days was, I really refer to it as weaponized mathematics instruction. Because I feel like its main goal was to sort out the kids who were "smart enough" to do mathematics well from the kids who were "too dumb" to do mathematics well, and that there was no attempt to meet the two together. And so, so much of my experience in math, and I don't think I'm alone in this, really has an emotional hit to it.

Imelda clearly remembered receiving the message that only some people are smart enough to be good at mathematics from her teachers in elementary school. "I do think, as a youngster, when I was taking math, there was a finality to it." Imelda recalled. "You're good at it or you're not good at it. There's no in between." Imelda also believes that her parents inadvertently reinforced this message at home. She explained,

> My father always said, I'm terrible at math. I hate math, and my mother always said, I'm really good at math. I love math. But she had very little patience for anyone who wasn't good at math. And that's not throwing my parents under the bus. I think a lot of folks, a lot of parents, feel that way, say those words. It's only really in the last few years that we've realized what a positive mindset does to help people.

**Get 2: Dislike of Mathematics Negatively Impacted Their Relationship With Mathematics Throughout Their Time as Mathematics Students.** This theme was selected

because for eight of the nine participants, their dislike of mathematics negatively affected their relationship with mathematics throughout the rest of their school career. Lucy recalled, "All throughout high school, I was always that kid that got put in the AIS mathematics classes. I always had that extra help with mathematics because my brain just couldn't comprehend what was being taught to me." She continued, "It took me longer than it took the other kids. So, I just felt like I was behind and I didn't know what I was doing. Everybody knew I didn't know what I was doing. So it was mostly an embarrassment for me."

Donna's negative experiences with mathematics continued throughout high school and college. She remembered having a mathematics teacher in high school who "was not supportive of how hard it was for me" and feeling as though "there was nobody who could break it down for me." She was required to take one mathematics class in college, but believes that without help, she would not have made it through. "That's all I needed," Donna explained, recalling the one mathematics class she was required to take. "And I didn't do it again." Looking back on her time in school, Donna believes that "there was no development of the love of math" when she was younger and feels that mathematics "got too far away from me where I couldn't catch up."

For Janice, mathematics was always her least favorite subject. She struggled in math and remembered being in remedial mathematics class all the way through school. Janice shared,

> I never liked math. It was forced for me to do it, forced for me to memorize it, and I always had the attitude of I'm not going to need this. I'm not going to use this. This is dumb. So that was ingrained in my head very young. I can't tell you exactly what grade, but I can tell you, by fifth grade, I hated it.

Janice did what she needed to get by in mathematics class throughout high school, and even remembered hiding in the bathroom to avoid it. "My daily time to use the restroom was mathematics class," Janice shared. Even now as an adult, Janice still lacks confidence in her

mathematical ability. She said, “I was not great at fractions . . . the best way for me to learn fractions was on a tape measure, so I could never read a tape measure until I was like 35. And I’m not sure I’m 100% positive that I can now.”

For Jane, the dislike of mathematics that developed in elementary school also affected the rest of her career as a mathematics student. Even though she took mathematics classes in high school and was able to get good grades, “I did not necessarily feel that I was good at math,” Jane shared. “I did not view myself as a mathematics person.” She remembered,

> I was asked to advance in eighth grade to take Regents’ math. And I did okay with it, but I still knew that I was not, even in that class, not the top student. And I did not feel confident. I always went to the Regents’ review courses and my teacher would kind of be surprised to see me there. Like, why are you here? You’re doing great. But I didn’t perceive myself as a mathematician and I did not think I was doing great.

Jane took calculus in high school and did well enough to earn the credit but knew that she didn’t want to take any mathematics courses in college. “Into college, I carried that same attitude,” Jane remembered. “I was a psych and soc major and I wanted to take zero mathematics classes.” But when she decided to enroll in the Master’s in Teaching program, she was required to take one freshman-level mathematics class and one methods class on how to teach it.

The negative experiences Elle had with mathematics in fourth, fifth, and sixth grade also affected her for the rest of her school career. She remembered “just barely passing” mathematics in ninth grade, and says, “I got a 65, but I think he just kind of pushed me through.” She decided to attend a local Career and Technical Education (CTE) center in high school, which she describes as “a huge saving grade for me” because “I know without a shadow of a doubt, I couldn’t do fifth- and sixth-grade math. So, there was a high probability that I was not going to be able to do high school mathematics and what was expected of me.”

**GET 3: The Transition From Traditional to Reform-Based Mathematics Teaching is Very Difficult.** This theme was selected because, for all nine participants, the transition from traditional to reform-based mathematics teaching was very difficult. “In the beginning, it was a hot mess. It was really a nightmare,” Imelda explained. She continued,

> I feel that as a beginning teacher teaching the Common Core, the New York State Mathematics modules, it was very difficult because I feel like the expectation was knowledge prior. And I started in, and boom, fourth-grade Common Core with none of the vocabulary and none of the concepts, the modeling and things like that, that are I feel really helpful, but were really difficult for kids to do right out of the gate in fourth-grade curriculum.

Reform-based mathematics was very different from the way mathematics had previously been taught in schools, which also led many parents to oppose reform-based mathematics teaching. Imelda explained, “From a parent’s standpoint, it’s utterly confusing math. "It’s nothing like I did when I was in school. I don’t know how to help my child. It’s frustrating math." This negative reaction from parents just compounded the difficulty Imelda had teaching it.

Carly felt unprepared to teach reform-based math and had to spend extra time teaching it to herself before she could teach it to her students. She recalled,

> I had to teach myself, because it’s not like I was taught common core in college. “I didn’t have a specific class where it was like, these are the different ways that you’re going to teach certain areas in mathematics to students now because we’re teaching common core. That wasn’t a thing.

For Carly, having to learn how to teach mathematics a different way on top of also having to teach every other subject made the experience even more difficult. She explained,

> As a teacher, on top of trying to learn your curriculum, on top of trying to teach multiple subjects and plan for multiple subjects, you're also either asking someone to show you how to understand the concept, the new concept, or you're teaching yourself how to teach it. You have to learn how to do it and then you have to teach it. And then you're teaching reading, and then you're teaching the writing pieces, social studies, science. So, I mean, it's a lot. And it's not like we get a lot of prep time. I mean, we get one break a day.

Elle described the transition to reform-based mathematics teaching as "scary" and "intimidating." Reform-based mathematics is very different from the way she learned mathematics as a student, and she does not believe that she was adequately prepared in college to teach it. She did not feel comfortable with the mathematics herself and was worried about "teaching it wrong or incorrectly" to her students. Elle recalled,

> When I taught kindergarten, we used common core mathematics and that was when I was first introduced to number bonds, and I had no idea what they were because I didn't learn them in school. So that was a little bit intimidating considering I had no idea.

After she completed her student teaching, Donna was hired to teach second grade. She also recalled having a difficult time teaching reform-based mathematics because it was different from the way she learned it.

> In my first year [of] teaching second grade, I was like, what is the Arrow Way?" I had to go to Embarc and watch the video that he made so that I could understand how to explain and break it down for a second grader. Because I was like, what's this way? What's this composing a subtraction tape diagram, and then throwing a one in the middle?" I was like, I can't even see that. How does a second grader see that?

Janice also attributed her difficulty with reform-based mathematics teaching to the fact that it is different from the way she learned mathematics in school. As an example, Janice explained,

> Nobody showed me what volume was, nobody showed me what area was, or even perimeter. So now that's the difficult part for me . . . I think the most difficult part is putting the process into reality for me because I was taught just memorize and go, done and done. I was taught formulas and that's it, not what it meant.

Janice also had to spend a significant amount of extra time trying to teach herself the mathematics lessons before she could teach them to her students. "I had no idea how I'm going to draw this up on the whiteboard for the kids when I don't even know what I'm doing," Janice remembered. She explained,

> When I prepped the lesson plans for math, every single night I was in tears. I was up until 2 am in the morning, and I'm honestly writing lesson plans using words and using, not even models, but whatever I could to even try to make sense of it.

Lucy also had a difficult time teaching reform-based mathematics because it is different from the way she learned mathematics as a student. "When I was first reviewing it, it was tough." She explained. "I'm not going to lie, I spent nights up until 2 am just trying to figure out how to teach these kids these concepts that I've never really thought about myself." Lucy does not feel that she was adequately prepared to teach reform-based mathematics in college. She explained,

> When I was taking my method courses, I was learning all these new strategies and new ideas and all this other stuff that I can use in the classroom. But then I got put into a fifth-grade classroom and fifth-grade mathematics content was nothing I've ever experienced in my whole life. Because of Common Core, it's so much different.

She also felt alone, unsupported and like she was "thrown into that position" of teaching reform-based mathematics during her first year:

> I felt like I had no support whatsoever going in. I mean, we had mathematics meetings and whatnot, and I had conversations with teachers and specialists, but from my perspective, it was a whole brand new world for me. Fifth grade. Common Core. It was tough.

**GET 4: The Transition From Traditional to Reform-Based Mathematics Teaching Has a Negative Impact on Mathematics Teacher Identity.** This theme was selected because, for all nine participants, the transition from traditional to reform-based mathematics teaching had a negative impact on the way they perceived their identity as a mathematics teacher. Lucy recalled that during the transition period, "I was ready to call it quits because I was just so frustrated with everything, and I just felt like I was alone trying to figure it all out." She did not feel confident in herself as a reform-based mathematics teacher, and attributes this in part to her past experiences with mathematics.

Carly remembered feeling "not confident enough" in her ability to teach reform-based mathematics during the transition period. She "felt anxiety" when teaching reform-based mathematics, and was "always second-guessing" whether or not she was doing the problems correctly. Carly also remembered feeling embarrassed about doing problems wrong on the board in front of her students and then "having them call me out on it." She explained,

> That has happened and it's always like, oh gosh. Because yes, you have the answer key in front of you, but it doesn't show you how to do the problem. So I could have done the problem incorrectly, got the same answer, or vice versa, and then I'm questioning myself like, "Oh my gosh, how did that happen? How did I do that?" So, it's nerve-wracking. And there's a little bit of anxiety that comes along with it, especially when you don't feel that you're very strong.

Elle also remembered making mistakes while teaching reform-based mathematics and the embarrassment she felt when she was "called out" by her students. She recalled one such incident vividly even though it happened more than 5 years ago:

> I remember [one student], he was very smart at mathematics, and he raised his hand and he said, "Wait a minute, that's not the right answer." And we had all written it on the line and the student was right and I had written the wrong answer. And so, they even tricked me. And of course, I turned it into a learning thing, and I said, "Oh my goodness, they tricked us," and made it a silly thing. But, in reality, I felt, "Oh gosh, I'm fourth grade again. I'm embarrassed. I don't know the answer. And now I'm the teacher and I'm supposed to be responsible for knowing this."

Janice also spoke about the embarrassment she felt when she made mistakes on the board in front of her students. "I've made numerous mistakes . . . and been called on it, during math, been called on it by students . . . and I'm not purposely making these mistakes, this is happening in real life." These experiences affected the way Janice saw herself as a mathematics teacher. She remembered feeling "a lot of insecurity" about teaching reform-based mathematics. "It actually brought me down a lot on the level of the kind of teacher that I knew I could be, when it was like, 'Oh no, I have to teach mathematics today'." Janice continued,

> I felt unsuccessful. I guess I felt unsuccessful to the kids. I wasn't giving them what they needed to be successful because I wasn't given that or instructed how to do that. I don't think that I was prepared at all to teach that type of mathematics curriculum.

### *Divergent Themes*

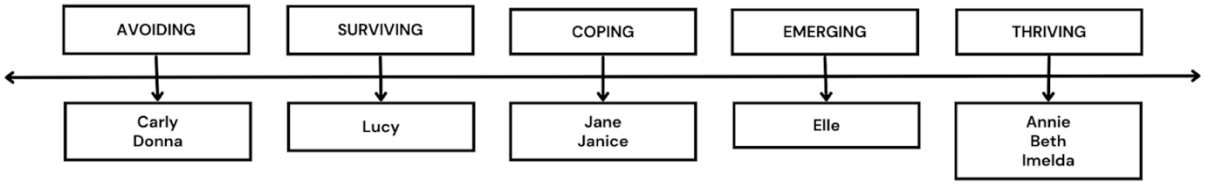
The four themes discussed in the previous section represent a path of experiences that were shared by the majority of the participants in this study. Each of the participants had negative experiences with mathematics, typically beginning in elementary school, that led them to develop

a dislike of mathematics which negatively affected their relationship with mathematics for the rest of their school careers. Then, as teachers, each of the participants recalled the transition from traditional to reform-based mathematics teaching as being a very difficult experience. For each of the participants, this experience had a negative impact on their perception of their mathematics teacher identity.

However, following the transition period, clusters of participants went on to have very different experiences with reform-based mathematics teaching. Upon close analysis of these different experiences, five distinct patterns emerged. When viewed together, these patterns represent a continuum of how self-contained elementary teachers who dislike mathematics have experienced reform-based mathematics teaching. Along this continuum, the patterns range from teachers who avoid reform-based mathematics teaching to teachers who thrive with it (see Figure 6).

**Figure 6**

*Continuum of How Self-Contained Elementary Teachers Who Dislike Mathematics Have Experienced Reform-Based Mathematics Teaching*



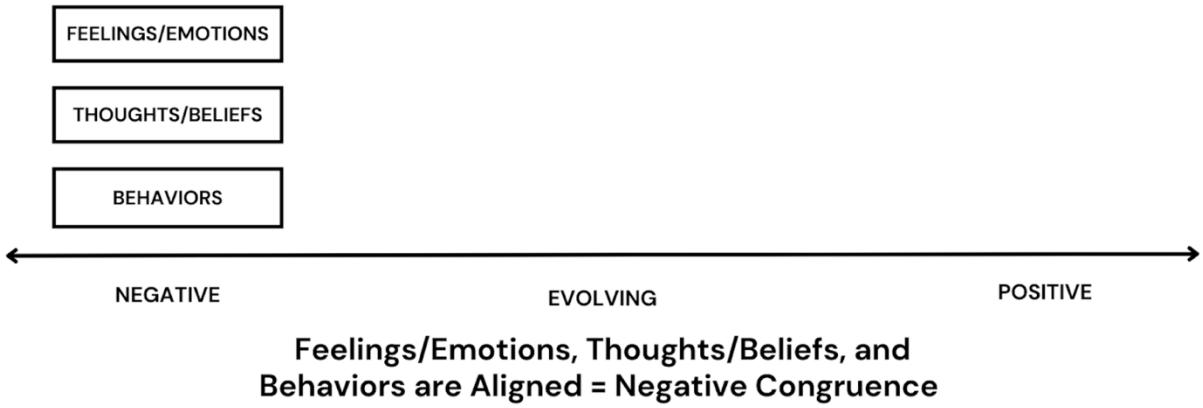

To determine how teachers in each pattern along the continuum of reform-based mathematics teaching perceive their mathematics identity, the data collected from the participants was viewed through Ladd's (2018) Holistic Identity and Personal Change Model. Ladd (2018), which provided the theoretical framework for this study, conceptualized identity as consisting of an individual's beliefs, feelings, thoughts, and behavior. As a result, information collected from

participants when asked to describe their mathematics teacher identity was categorized as either feelings and emotions, thoughts and beliefs, or behaviors. Each participant's feelings and emotions, thoughts and beliefs, and behaviors were then categorized as either negative, evolving, or positive in the context of reform-based mathematics teaching. The result was a unique mathematics teacher identity for each of the five patterns along the continuum of reform-based mathematics teaching. Each of the five patterns of reform-based mathematics teaching along this continuum, along with a description of the unique mathematics teacher identity for each pattern, will be presented separately in the following section.

**GET 5: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Avoiding Reform-Based Mathematics Teaching.** After making it through the difficult transition period, two of the participants of this study are now in a pattern of avoiding reform-based mathematics teaching. Teachers in this pattern have not embraced the philosophy of reform-based mathematics teaching, and they are moving away from reform-based mathematics teaching and reverting back to teaching mathematics in more traditional ways. For teachers in this pattern, their perception of their mathematics teacher identity remains negative. Even though they are in alignment, their feelings and emotions, their thoughts and beliefs, and their behaviors regarding reform-based mathematics teaching are all negative. As a result, these teachers have a perception of their mathematics teacher identity that is in negative congruence. A visual representation of the unique mathematics teacher identity of participants who are in a pattern of avoiding reform-based mathematics teaching is shown in Figure 7.

**Figure 7**

*Mathematics Teacher Identity of Teachers Who Are Avoiding Reform-Based Mathematics Teaching*




***Beliefs About Reform-Based Mathematics Teaching.*** Teachers who are in a pattern of avoiding have not embraced the philosophy of reform-based mathematics teaching. Donna associated reform-based mathematics teaching with teaching multiple strategies but believes that teaching mathematics this way is not beneficial for either her or her students. Donna explained,

> In the past few years, some of these things we're teaching, I didn't even get myself. One of the things, it's called the Arrow Way. And it's the way that you add. The arrow has a number on top of it, and you have to add it to make the next number. And it's like, "Why aren't we just using a plus sign? Why are we . . . ? I don't know." So, I don't personally love it.

Carly also associated reform-based mathematics teaching with teaching multiple strategies. But she believes that reform-based mathematics is confusing for students, that it is "not necessary," and says that she is "not a fan." She explained,

> Why try to fix something if it's not broken? Why put extra stuff? I mean, I totally understand the concept of teaching other ways to solve problems. I get it. There's a reason

> for it, and maybe people learn differently and all of that stuff. And I get it. But unless you're going into the mathematics field, unless you're going into something that you are specifically going to be focused on, like engineering, or if you're going to need mathematics construction-wise for angle and all that stuff, I get it. But why are we changing everything to confuse kids even more? Isn't life hard enough as it is for these kids?

Carly also dislikes reform-based mathematics teaching because of the impact it has had on parents. She stated,

> A lot of kids, they don't get the extra support at home. Their parents at home don't even know what they're covering and they're like, how can we help them because we weren't taught this way? So why change it?

***Behaviors Regarding Reform-Based Mathematics Teaching.*** Teachers who are in a pattern of avoiding have not continued to implement reform-based mathematics teaching. They have either reverted back to teaching mathematics in a more traditional way or are in the process of doing so. Carly explained,

> To be honest, we agreed as my team . . . they're like, we're just teaching them the regular way. It's not like when they get to the state test that they're telling us, "Oh, they have to answer this way." No, you have to show your work. You have to prove that you can obtain the answer. And it's not asking, "Oh, you have to do it Common Core way."

Donna has also decided to move away from reform-based mathematics teaching, and is reverting back to teaching mathematics the way that she learned it. To Donna, this means teaching adding and subtracting "in a way that they understand and then working from there, instead of throwing five different strategies at them and then expecting them to get one that sticks." She elaborated,

> My coteacher and I are breaking down what's most important for the students. Is it important to teach them four different strategies on how to do the same thing? Or does their brain mentally already do it that way? I know mine doesn't. Mine does it pretty much one way. And that's the way. Otherwise, it's hard for me to conceptualize these different ways of doing it. But we're teaching all these ways, and I feel bad that some of these students are frustrated because we're teaching them this way that they don't understand. And I get that. So that's my experience with math, just looking for a path to follow. A more concrete path.

***Feelings, Emotions, and Perception of Mathematics Teacher Identity.*** Teachers who are in a pattern of avoiding have negative feelings and emotions about reform-based mathematics teaching, and their perception of their mathematics teacher identity has remained negative. When asked to describe how she perceives her identity as a mathematics teacher, Carly replied,

> I say it all the time, you've got to fake it to make it. You literally have to put on a face regardless if you don't like it. Regardless if you don't because that's your profession, that's what you're doing, you're teaching. So even if you don't like teaching it, unfortunately you have to pretend that you do and you have to do it very well because, if they know that you don't like it, they're not going to like it either.

"I get so frustrated with some of the lessons when it comes to math," Donna said. "I'm like, here we go. We've just got to get through this lesson. We'll move on to an easier one tomorrow." She continued,

> I'm trying to, as I'm going along, I'm finding out what works. So, it gets a little frustrating, especially when I see them struggling with it. I'm like "Oh, how can I make this more understandable? What can I do to make them understand better?" So, I get a little frustrated. Sometimes I'm like, maybe I should just stop the lesson and just start

> again tomorrow. Because we're both frustrated. We're both not understanding it. So sometimes I'm like, let's move on. So, it's a little frustrating.

When asked what her identity as a mathematics teacher means to her, Donna replied,

> I think I've carried it with me since probably elementary school Around the World, and that stress. I always say it too. I'm like, I don't know. I'm not good at math. I don't know. Don't ask me to do it. I'm not good at it. I identify as not being good at math, and I don't know if I ever will be. I'll never be quick. I don't think that way. So, I don't consider myself a mathematics person at all.

She continued,

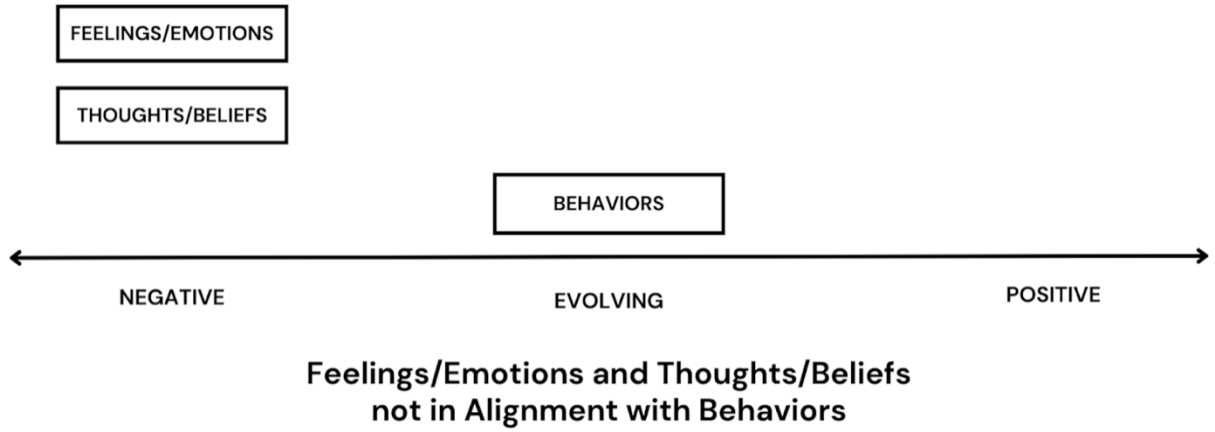
> I feel like I do the best every day, and I try to teach the core things that they're going to learn in third grade and hope that third grade can also excel their learning. I do my best to teach what core concepts that they need to know. Otherwise, some of the concepts are tough to understand.

**GET 6: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Surviving Reform-Based Mathematics Teaching.** After making it through the very difficult transition period, one of the participants of this study is now in a pattern of surviving reform-based mathematics teaching. Teachers in this pattern have not embraced the philosophy of reform-based mathematics teaching. Although they are not implementing it with full fidelity, they are continuing to implement at least some aspects of reform-based mathematics teaching because they are required to. For teachers in this pattern, their perception of their mathematics teacher identity remains negative. Their feelings and emotions and their thoughts and beliefs about reform-based mathematics teaching, which are negative, are not aligned with their behaviors, which are evolving but not yet positive. A visual representation of the unique mathematics

teacher identity of participants who are in a pattern of surviving reform-based mathematics teaching is shown in Figure 8.

**Figure 8**

*Mathematics Teacher Identity of Teachers Who Are Surviving Reform-Based Mathematics Teaching*




***Beliefs About Reform-Based Mathematics Teaching.*** Teachers in a pattern of surviving have not embraced the philosophy of reform-based mathematics teaching. When asked her beliefs about reform-based mathematics teaching, Lucy replied,

> It's tough. I've got some positives and negatives, but mostly just negatives. The way I look at it is right now I'm teaching multiplication, but with that multiplication, every single day, there's a new area model, a new strategy, a new something for the kids to learn. I feel like my kids are just so overwhelmed and so confused how to multiply because I barely have taught them the standard algorithm, which is the way I learned.

***Behaviors Regarding Reform-Based Mathematics Teaching.*** Even though teachers in a pattern of surviving have not embraced the philosophy of reform-based mathematics teaching, they have continued to implement it because they are required to do so. They are struggling to implement it effectively, however, and may not be implementing it with full fidelity. At times,

Lucy feels tempted to revert back to teaching mathematics in a more traditional way. She explained,

> It's easier for me to teach what I know compared to all these models and all [this] other stuff that Common Core is throwing at these poor kids. As a 10-year-old in fifth grade, their mind can't comprehend all that at once. So, if we spent maybe a week or maybe two weeks on just one area model, I feel like that would be a lot better. But the way Common Core is set up, it's one model every single day. So, it is confusing me which is confusing the kids because when I don't understand it, my poor students, they're obviously not going to understand it either. So, the way we look at it, I mean, on both sides struggling.

Despite this, Lucy has continued to implement reform-based mathematics teaching. She is trying to develop a positive outlook on it, and is trying to take what she knows and how she feels about mathematics and try to turn it into a positive experience for both herself and her students. Lucy explained,

> With the Common Core, I am learning all this new stuff, too. I think [that] once I become a fifth, sixth year teacher that I'll just be a breeze for me. But right now, only in my second year, I'm still learning. And I'm open to the idea of learning. Absolutely. Because again, I'm trying to find all these different ways that I can support each and every one of my children in the classroom. So, I'm taking what I know and how I feel about math, trying to turn it into a positive experience for both me and my students.

***Feelings, Emotions, and Perception of Mathematics Teacher Identity*.** Teachers in a pattern of surviving have negative feelings and emotions about reform-based mathematics teaching, and their perception of their mathematics teacher identity has remained negative. Lucy does not yet feel confident as a mathematics teacher. She attributed this in part to her past experiences with mathematics. She explains,

> It's my whole inner piece to it where I always struggled with math. So, I don't have that self-confidence or that self-esteem to teach it. So, when I was picked to be the fifth-grade mathematics teacher, I was overwhelmed. I mean, I literally went and cried to my dad because I was just so nervous about what am I going to do for these poor kids? What am I going to do when the state test results come back and I look like I have no idea what I'm doing because all my kids failed, which is what happened last year.

When asked what this identity means to her, Lucy replied,

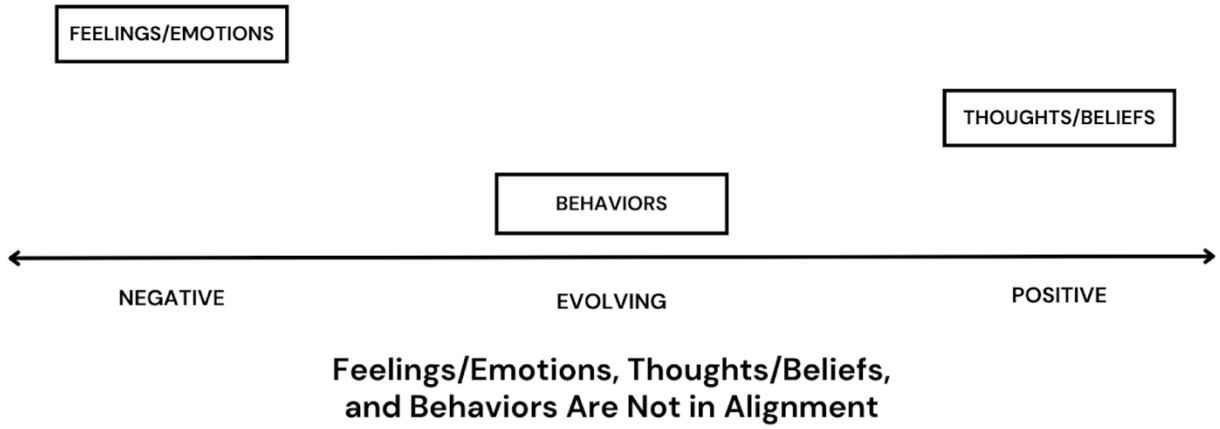
> I never really thought about it, but I mean, it means a lot because again I'm more concerned about the children and how they're doing. So, if I have a negative outlook on it, my kids are going to as well because they can see that through my teaching. So, my goal for myself is to just try to figure out what I'm doing, figure out strategies for the kids, figure out some positive ways I can go about looking at math, reaching out to other people, looking at resources. I think if I have a more positive outlook on it, then my students will start to do well too.

**GET 7: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Coping With Reform-Based Mathematics Teaching.** After making it through the very difficult transition period, two of the participants of this study are now in a pattern of coping with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching. Although they are not implementing it to the greatest extent possible, they are continuing to implement many aspects of reform-based mathematics teaching. However, for teachers in this pattern, their perception of their mathematics teacher identity remains negative. Although their thoughts and beliefs regarding reform-based mathematics teaching are positive, they are not aligned with behaviors, which are evolving but not yet positive, and their feelings and emotions, which remain negative. A visual representation of the unique

mathematics teacher identity of participants who are in a pattern of coping with reform-based mathematics teaching is shown in Figure 9.

**Figure 9**

*Mathematics Teacher Identity of Teachers Who Are Coping With Reform-Based Mathematics Teaching*




***Beliefs About Reform-Based Mathematics Teaching.*** Teachers who are in a pattern of coping have embraced the philosophy of reform-based mathematics teaching. Jane associated reform-based mathematics teaching with teaching mathematics for understanding rather than memorization. "I would describe it as more strategy-based and less memorization," Jane explained. "I think that it's teaching children to have number sense and strategies for thinking things out rather than just memorizing it." Although reform-based mathematics is very different from what Jane learned in school, she believes that it is beneficial for students. She explained,

> I do and have seen that it is very powerful and helpful for students to make the connections, and it introduces them to different patterns. And things that make sense and work for them and can work in different situations. While I was maybe only presented with, you just have to memorize your facts. That's all there is. To get to planet Pluto, you better know the nines. And I would just memorize them. And to see my students explain

> to me, "Oh, that's a doubles-plus-one. I know five plus five is ten, so five plus six is eleven." And they can verbalize that. They're talking about doubles-plus-one all the time. And it amazes me because I never, until I started teaching common core math, I never even thought about a doubles-plus-one.

Janice associated reform-based mathematics teaching with building a conceptual understanding of mathematics. This is very different from the approach to teaching mathematics that turned her away from mathematics when she was a student. Janice explained,

> I don't know if conceptual is the right word that I'm looking for, but I mean nobody gave me manipulatives. Nobody gave me drawings or models or any of this kind of stuff. So, when I was learning area, it was just what it was. You just multiplied these two numbers, and it didn't matter. So, now I understand as an educator that "Whoa, I have to actually show them the area, show them perimeter." And volume is a whole other thing, because volume to me was you just multiply these and you're done. It doesn't matter what it looks like, it doesn't matter what it feels like, any of that. No. It was multiply these three numbers and you're done. Move on to the next problem.

However, Janice admitted that she was opposed to reform-based mathematics teaching when she was first exposed to it as a parent. She explained her initial resistance to reform-based teaching and how her beliefs have evolved over time.

> When my own personal children came home with it, I was mad. I was that disgruntled parent that was like, "What is this, this is ridiculous, I have no idea. We have not learned this way. Why? Why are they making you do this?" Well, now as an educator when I can see a whole curriculum and see when it actually starts and how they introduce everything, it makes sense to me. And I think, "Oh my goodness, wow, this really isn't a bad curriculum at all. It's actually fantastic." But the way that it was brought out was

> devastating and put a bad taste in everybody's mouth. So now, when you mention Common Core, or you mention New Math, everybody just rolls their eyes and is like, well that's dumb. It's stupid. It's what's ruining this country. Honestly? No. Not if you sit back and actually look at what it is.

In fact, Janice wonders if she might have a positive relationship with mathematics today if she had experienced reform-based mathematics teaching as a student. She explained,

> I didn't learn mathematics with these little blocks and these little cubes to understand . . . Holy cow, if someone had done that for me when I was in first or second or third grade, then maybe I wouldn't have this panic with math.

She mused,

> Man, if someone had taught me like that . . . I wouldn't have had all of this and I wouldn't have freaked out or I wouldn't have been looking at the table next to me at the kid's desk who might have got a better grade than me.

***Behaviors Regarding Reform-Based Mathematics Teaching.*** Teachers who are in a pattern of coping have continued to implement reform-based mathematics teaching. However, they are not implementing it to the full extent possible or may not be implementing it with full fidelity. Although Janice agrees with the philosophy behind reform-based mathematics teaching, it has not been easy for her to teach it. She finds herself looking forward to days when she doesn't have to teach math, and admitted,

> It was like I enjoyed the days that there was a quiz or a test because I didn't have the panic of being up in front of them with all of them looking at me like this chick has no idea what she's doing.

Jane shared, "Definitely, there are times where I feel like, "All right. Take a deep breath. I can do this. It's tough." She acknowledged that teaching early primary mathematics was "much more

difficult than I even thought it was going to be," and believes that being a self-contained teacher and having to teach reform-based mathematics on top of all the other subjects makes it even more difficult. "It's only one blip on what I do in the day. To try and make it fun and hands-on, I realized that I needed more hours in the day." She explained,

> I felt like if an administrator walked in and watched my mathematics lesson that they would never be able to appreciate how much work went behind the scenes to count out 10 little unifix cubes, five yellow and five red, and they couldn't really fully appreciate what went into it. And it may look even a hot mess. Somebody's stacking them into a tower when they're supposed to be making number sentences. So, I really thought, "Wow, this is even harder than I anticipated that it would be."

Jane admitted that teaching reform-based mathematics is out of her comfort zone. Therefore, she is tempted at times to revert back to teaching mathematics in ways that are more comfortable She explained,

> Twenty years in, I definitely know that I have a comfort zone. I know that I'm going to kind of revert back to, again, like I said, keep it simple, stupid is kind of my slogan. I'm going to revert back to what's simple, what's easy.

For Jane, this means adhering to a scripted curriculum. However, she did admit that this "can be a little bit of the doldrums," and said, "I see that, but it's a lot of work to break that routine too. So, I think we kind of revert back to what's easiest for us."

***Feelings, Emotions, and Perception of Mathematics Teacher Identity*.** Teachers who are in a pattern of coping have negative feelings and emotions about reform-based mathematics teaching, and their perception of their mathematics teacher identity has remained negative. Jane is still "definitely not the most enthusiastic about math" but said, "I try to put on my game face for

the kids." When asked to describe her identity as a mathematics teacher, Jane replied, "I would say probably simplistic." She elaborated,

> I think in comparison to some of my colleagues who may have grandiose ideas, that I boiled it down. I would say that I'm definitely more of a simplistic mathematics teacher. What do we need? Yes, that is a fun game, but it looks like it could be a logistical nightmare and I want to get the most bang for my buck. If I'm going to spend time making, organizing or doling it out and it doesn't really seem to have a return on my investment, then I'm probably not going to do it again.

When asked what her identity as a mathematics teacher means to her, Jane replied,

> If the children were to ask me what my favorite subject is, I would say all of them. I never want them to think that I'm favoring reading and writing, I view all of them as being so important. So I do think it's important how we view ourselves as teachers.

She continued,

> And then the realist in me just realizes that there's no way we can all feel masters of everything as a primary teacher. I can just see in some of my colleagues the absolute joy and enthusiasm they get when they're teaching math. And I'm a little bit envious of that. I wish that it was my passion. I wish that I felt that way about it. So, I kind of waiver back and forth. Like I said, I definitely think it's important, but I also know the realism of it is that we don't all feel that we've mastered everything.

Janice lacks confidence herself as a mathematics teacher thinks that she always will. Even now, 5 years into her teaching career, she doesn't feel comfortable being observed while teaching math. When reflecting on how she perceives her identity as mathematics teacher, Janice shared, "I didn't feel confident. I lacked confidence, and I still do even after 5 years. I think I'll always lack confidence in math." She explained,

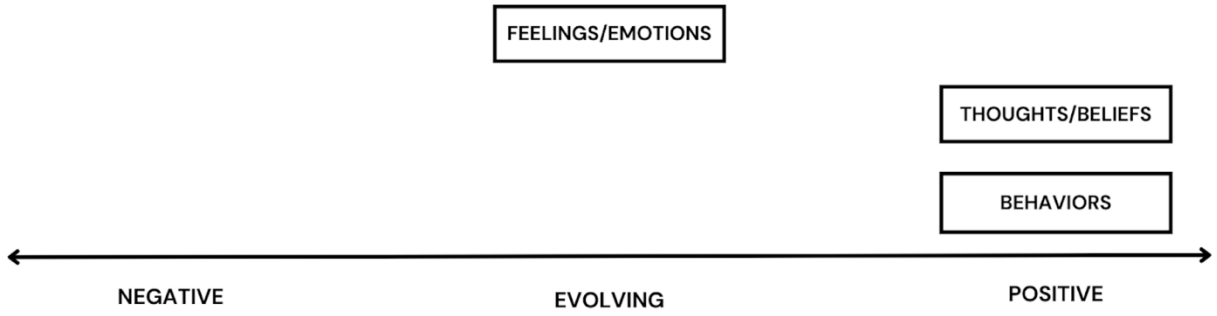
> It hasn't been easy. I've cried, I've laughed, I've been super embarrassed several times. My principal's awesome. He lets us choose when he comes in to observe us. He gives us a slot of times. In 5 years, I have never picked math, so, I think that screams my comfort level because I love when he comes into ELA, and I love when he comes into science. I had even taught social studies previously and I loved it, but I'm much more comfortable and I can go and I can just shine. And in mathematics, I don't shine, so, of course I wouldn't want him to see that.

Regarding reform-based mathematics teaching, Janice admitted. "It's hard. I'm going to keep trying. I'm going to keep doing the best I can."

**GET 8: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Emerging With Reform-Based Mathematics Teaching**. After making it through the very difficult transition period, one of the participants of this study is now in a pattern of emerging with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching and are implementing it with fidelity. However, for teachers in this pattern, their perception of their mathematics teacher identity, although evolving, is not yet positive. Although their thoughts and beliefs and their behaviors regarding reform-based mathematics teaching are positive, they are not in alignment with their feelings and emotions which are evolving but not yet positive. A visual representation of the unique mathematics teacher identity of participants who are in a pattern of emerging with reform-based mathematics teaching is shown in Figure 10.

**Figure 10**

*Mathematics Teacher Identity of Teachers Who Are Emerging With Reform-Based Mathematics Teaching*




**Feelings/Emotions Not in Alignment with Thoughts/Beliefs and Behaviors**

***Beliefs About Reform-Based Mathematics Teaching.*** Teachers in a pattern of emerging have embraced the philosophy of reform-based mathematics teaching. Elle attributed her decision to embrace reform-based mathematics teaching to the empathy she feels for her students. She explained,

> Knowing that my children need me and I can't rely on worksheets or packets because that's not what's best for them and that's not helping them, and they're going to go onto the next grade and they need the flexibility and they need to be able to think independently and worksheets don't provide them that.

Regarding her beliefs about teaching math, Elle elaborated,

> It needs to be fun; it needs to be welcoming, inviting, luring, something that kids want to do. I love manipulatives because it's tangible. And I think I love the games because they're kinesthetic and I think children are learning without necessarily knowing that they're learning. They just think they're having fun, they think they're playing a game, which is true, but they're also learning.

Elle strongly believes that reform-based mathematics teaching is beneficial for students and hopes that every teacher will implement it. She explained,

> I just hope that everybody will, at least, try the new way of doing mathematics and think about their children . . . we have to have a positive, comfortable, safe environment for children to, at least, attempt math, but also we have to find ways to get them engaged and so that they're intrigued and they want to learn about math.

Elle continued,

> I want to be that change for my students and I want to work with—obviously I'm not a mathematics coach, so I don't work with other teachers, but I do interact with other teachers. And so, I want them to make that change also and join the revolution and join and get on the bandwagon of we need to make it so it doesn't feel intense and overwhelming and make children have that negative feeling about it.

***Behaviors Regarding Reform-Based Mathematics Teaching.*** Teachers in a pattern of emerging are implementing reform-based mathematics teaching with fidelity. Elle is working hard to implement reform-based approaches designed to develop a conceptual understanding of mathematics (e.g., fluency strategies, number talks, the use of manipulatives, and a game-based approach for building addition and subtraction fluency). As a result, for the first time in her career, Elle now believes that the way she is teaching mathematics is in alignment with her overall philosophy about teaching. She explained,

> The fluency strategies have helped me tremendously because I choose to teach those, and I choose to meet students where they're at. That's just my philosophy, I'm very student-centered. I believe in kinesthetic hands-on lessons. That's always been my philosophy. So, this is just putting my money where my mouth is. I've always said I believe in that, and now I'm doing it with math.

***Feelings, Emotions, and Perception of Mathematics Teacher Identity*.** For teachers in a pattern of emerging, their perception of their mathematics teacher identity is evolving. Elle now finds teaching mathematics to be less intimidating, more fun, and she actually gets excited about teaching it. Elle believes that reform-based mathematics teaching plays to her strengths and has enabled her to find her niche as a mathematics teacher. As a result, she now feels much more confident teaching it. Elle explained,

> Sometimes people get overwhelmed by the thought of making a game, but my brain is different, so I'm the opposite. To me, a packet feels overwhelming and boring and stale and sterile and just ugh, but other people find comfort in those. I obviously do not, at all. I think they're not really effective.

She elaborated,

> So, when I'm planning and prepping, I try to make it fun and engaging and kinesthetic and hands on. So, the games, that's kind of my niche. That's kind of my area of expertise, I guess, if you will. So, I would say I don't feel dumb, stupid, I don't feel like an idiot because I have confidence in sifting through and finding good stuff and finding games that I know that my students will like.

The evolution taking place in Elle's identity as a second-grade mathematics teacher is encouraging. However, she acknowledges that her perception of her identity as a mathematics teacher is dependent on what grade level she is teaching. Elle admitted,

> To be honest with you, the only thing that's helped me overcome some of my dislike for mathematics is that I teach second grade and that I don't have to teach third-grade or fourth-grade or fifth-grade or sixth-grade math. That's helped a lot because I am quite certain I would probably fold if I had to. I don't know that I could withstand the storm if I had to teach past second-grade math.

Elle discussed her "fear factor" scale regarding teaching mathematics at different grade levels:

> So, I taught pre-K math, I felt, "Okay, I know pre-K math, shape, numbers, colors, writing numbers, I can handle that." So, I would say there was probably on a scale from zero to 10, I was zero of the fear factor when I was teaching pre-K math. Then, when I got hired and I was teaching Kindergarten math; I was probably at a Level 6, 7 being on the fear factor zero to 10. Not because I didn't know the math because, obviously, I know 5 + 5 is 10, so I might have known the answers, I guess. However, I wasn't familiar with what a number bond was, so that was a little bit like charting unknown territories, I guess. So, that was a little bit intimidating. If I was going to place a feeling on that, it would probably be intimidation or a fear of the unknown. And then, second grade, definitely the fear factor on the scale definitely went up because we're getting closer and closer to multiplication, which is where my line in the sand is.

Regardless, the evolution that has taken place in the way she perceives her identity as a mathematics teacher is exciting. When asked what this change has meant to her, Elle replied,

> It's kind of a huge deal because if I'm 34 and still could cry over being asked a multiplication or a division question, I mean that was a major impact on my life, and not helped but impacted me through elementary school, high school, college, my career as an adult. So, in all areas of my life.

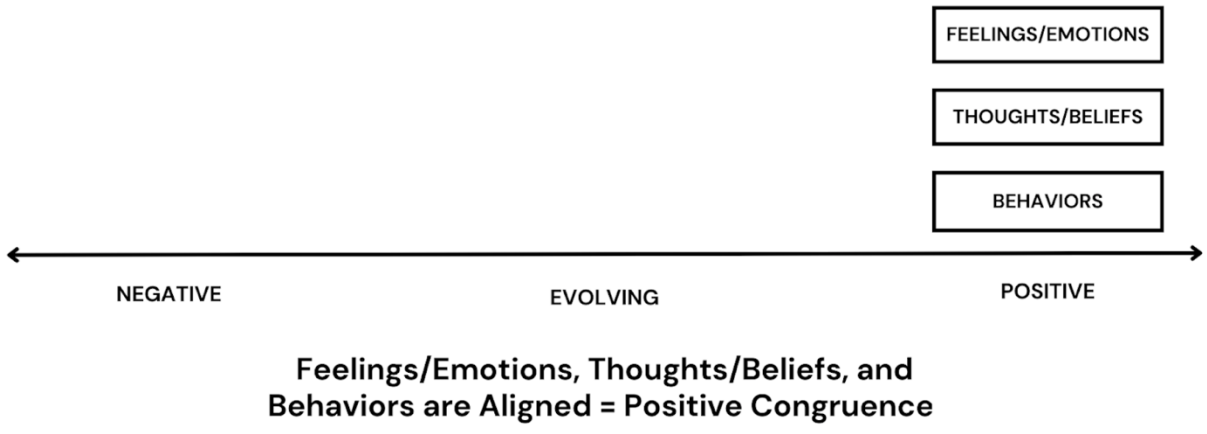
She continued,

> I guess I just want to make sure that all new teachers, or even teachers that are veteran teachers that are willing to make that change and make that shift. I just want to make sure that we can help the students that are coming through and the next generation, and have them not have that wall up or have that guard up, so they can feel confident and comfortable and safe, not feel dumb, stupid, and like they're idiots.

**GET 9: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Thriving With Reform-Based Mathematics Teaching**. After making it through the very difficult transition period, three of the participants of this study are now in a pattern of thriving with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching and are continuing to implement it with fidelity. For teachers in this pattern, their perception of their mathematics teacher identity has undergone a transformation and is now positive. Their feelings and emotions, their thoughts and beliefs, and their behaviors regarding reform-based mathematics teaching are in alignment. These teachers have a mathematics teacher identity that is in positive congruence. A visual representation of the unique mathematics teacher identity of participants who are in a pattern of thriving with reform-based mathematics teaching is shown in Figure 11.

**Figure 11**

*Mathematics Teacher Identity of Teachers Who Are Thriving With Reform-Based Mathematics Teaching*




***Beliefs About Reform-Based Mathematics Teaching.*** Teachers who are in a pattern of thriving have embraced the philosophy of reform-based mathematics teaching. Beth associates reform-based mathematics teaching with teaching students multiple strategies for solving

problems and believes that common core mathematics is founded on the idea that there is more than one way to learn mathematics . She explained,

> Common Core I feel like does give you different strategies. So, we're working on addition right now. One of the strategies is you pull it apart in the expanded form and then you add 30 and 40, and then you add the 7 and the 2 and then put them together. Whereas growing up, I don't feel . . . maybe we did do it, but I don't remember doing it that way."

She continued,

> It's definitely opened my mind and made me realize, "Oh, there's more than one way to learn this. There's multiple ways that you can learn this." And really, it's just what works best for each person.

Annie associates reform-based mathematics teaching with building a conceptual understanding of mathematics and with teaching students multiple strategies for solving problems. She believes that this approach to teaching mathematics has benefitted both her students and herself. Annie explained,

> I find that it's teaching more of the conceptual ideas behind mathematics and giving students the opportunity to find a way that works for them, which made mathematics seem easier for me. Getting to see the pictorial representations, drawing out the arrays when we were talking about multiplication, that, for me, learning it made it easier. So, I find that reformed mathematics or Common Core really is just looking at the concept and breaking it down in a way that a student can understand it.

Imelda associates reform-based mathematics teaching with "trying to explain the why, not just how." She believes that this approach to teaching mathematics is beneficial not only for students, but for teachers as well. Imelda explained,

> From a child's perspective, and from a teacher's perspective, I really kind of like it because it does so much to explain why. So, we don't just say, "When you are doing 2 by 2 multiplication for the second partial product, you need to put a zero in the ones place." That wasn't explained to me. And honestly, it wasn't until I started teaching Common Core or reform mathematics that I realized why we put a zero in the ones place. So, I'd gone all those decades not understanding the why of math.

***Behaviors Regarding Reform-Based Mathematics Teaching.*** Teachers in a pattern of thriving have continued to implement reform-based mathematics teaching and are implementing it with fidelity. Since implementing reform-based mathematics teaching, Annie believes that more of her students are understanding and making connections with mathematics. In illustration, Annie said,

> For example, addition. I have some students who can do it mentally. They know how to do it mentally. They can figure it out. I have others who need that physical representation in front of them, whether it's counter blocks, or cubes, or something that they can manipulate. I've found there are others who can do it with a picture, all the different ways. What I like about it is that I am teaching them different strategies that they can then take and internalize to make it easier for them. And if I can give them the tools, I feel like I'm handing them the toolbox. And I say, you pick what you need and what's going to work for you. And that makes it easier for them.

Annie approaches teaching mathematics now "with that lens of it can cause anxiety not knowing something. How can I make it a little less anxiety-inducing and a little less scary?" She believes that having this mindset has made it easier for her to teach mathematics and is currently working to adjust even more in her classroom to make mathematics more exciting and fun. She said,

> I'm going to find different ways for my students to learn, whether that's incorporating games, whether it's trying to be more hands-on with mathematics instead of what I was used to with worksheet, worksheet, worksheet, workbook, formulas, things like that.

Beth also finds reform-based mathematics teaching to be very different from what she experienced as a student. Her memories of mathematics as a student include "drill and kill" worksheets, a focus on memorization, sitting at your desk working alone, only being taught one way so either you get it or you don't, and not having manipulatives. She recalled, "When I went to school we just sat there and 'Here's your lesson; here's your worksheet; let's see what you can do'." But now, as a mathematics teacher, Beth is implementing reform-based mathematics teaching. She uses mathematics manipulatives. Her students play fluency games instead of doing "drill and kill" worksheets. She does number talks to build their number sense instead of focusing on memorization. Her students work in groups instead of sitting at their desks and working alone. They have conversations about mathematics, they talk about "the why" of mathematics, and she exposes her students to multiple strategies for solving problems instead of just teaching them one. She explained,

> I think the main thing is the dislike of just sitting there and you either know it or you don't. The drill and kill, changing to the strategy games, letting those kids have those little rewards and accomplishments and knowing they can be successful. And there's more than one way to do this. So, from the kill and drill to the games and the strategies, that's the biggest thing I feel like I noticed. From not liking it, to being able to expand your math.

Imelda has fully implemented reform-based mathematics teaching and is working hard to "eliminate the emotional response to math" in her students. She described herself as "a mindful mathematics teacher" and said, "I really think that sort of calming down that emotional edge to mathematics learning is a big part of what we as educators need to do." Imelda described her

"mindful approach" to mathematics teaching as having three components, the first of which is doing "mindfulness work" with her students. She explained,

> So, before math, we do a lot of calming, we do a lot of centering. My nickname in school is the T-Rex and I have a big picture of a T-Rex on the board, but when we start math, I say, "That T-Rex is the only scary thing about what we're going to do now. Nothing else is scary, everything else is learnable. There are a few things that you need to do, and there are a few things that I need to do. And if we all do the things that we're supposed to do, we're going to be fine."

The second component of Imelda's "mindful approach" to mathematics teaching is not allowing her students to use the word "easy." According to Imelda,

> I don't allow any kid to use the word easy because I say all that means is that it's easy to you. It's not easy to other people. And we never want to make someone else feel unintelligent or unable to do this because of the easy word that we've used. And there will come a time when something is not easy to you, that's inevitable, and you don't want someone else to make you feel badly about that.

The third component of Imelda's mindful approach to mathematics teaching is emphasizing bravery. She elaborated,

> I use the word bravery a lot. So we'll be working out a problem and I'll say, "Do I have a brave mathematician who'd like to try this?" And some of them won't raise their hand. And I'll say, "Look, let's be brave. Let's give this a try. I'm going to help you through this."

***Feelings, Emotions, and Perception of Mathematics Teacher Identity.*** Teachers in a pattern of thriving have positive feelings and emotions about reform-based mathematics teaching. The way they perceive their identity as a mathematics teacher has undergone a transformation and

is now positive. Annie believes that the experience of teaching reform-based mathematics has changed her mindset about math. She enjoys mathematics so much more now and finds teaching mathematics this way to be more fun not only for her students, but for her as well. Annie explained,

> It's actually changed my mindset with math. I would regularly say that I hated mathematics growing up. I would tell my mom, "I hate math. I don't want to go to mathematics class. It's the worst. I'm awful at it." It's completely changed my mindset. I've found, with the things that we're doing, I can make it much more fun. I actually get excited for mathematics time.

Annie described her identity as a mathematics teacher as "something that's evolving." She added,

> I would say I'm definitely enthusiastic. I'm very excited about it. And I'm very hopeful, hopeful for my students that the way that I'm trying to teach them and the things that I'm trying to teach them and engage them in will make them like or hopefully love math.

When asked what her identity as a mathematics teacher means to her, Annie replied,

> I'm grateful. It sounds odd to say I'm grateful to have the experiences I had because they've made me a better teacher. And again, a different time. Those teachers that I had were all wonderful, but they caused me a lot of anxiety, which, in turn, really did help me. In a weird way, it helped me to become a better teacher and to actually grow to like math.

Since she began teaching Common Core mathematics, Beth's identity as a mathematics teacher has changed in a positive way. She actually enjoys teaching mathematics now, and says that last year was her favorite year of teaching mathematics ever. Beth feels as though she is becoming a stronger mathematics teacher every year, and said "The more I learn, the more I grow, the more I love it." Beth credits expanding her knowledge about mathematics and learning new ways to

teach it with helping her to overcome her dislike of mathematics and become more comfortable teaching it. When talking about reform-based mathematics teaching and her growth as a mathematics teacher, Beth frequently mentioned professional development experiences that she has chosen to undertake and research about teaching mathematics that she had been exposed to. “I feel like this summer, when I did the strategy workshop, it definitely expanded my knowledge to make it easier for students,” Beth said. She added, “I feel like each year the more I learn, the more workshops I go to, I feel like I become stronger every year.”

When asked what her identity as a mathematics teacher means to her, Beth replied, “It makes me excited to teach math. Because now that I love it and I understand it more, I feel like I can bring that out in my classroom to let the students do the same and be able to have fun with it.” She added, “I do enjoy it now, a lot more than I ever have. Especially with my small class last year, we were able to explore it and fall in love with mathematics as a class.”

During the years that Imelda has been teaching reform-based mathematics, her relationship with mathematics has undergone a complete transformation. Imelda credits reform-based mathematics with changing both her relationship with mathematics and her identity as a mathematics teacher. “I really don’t think I started getting over my aversion to mathematics until I started teaching it,” Imelda explained. “As a learner, no. But as a teacher, I learned to love it” she added. Imelda looks forward to teaching mathematics with “pleasure” and “excitement” now, and said, “I just think it’s so cool. I wish I had known as a kid how numbers work and the neat things that you can do with numbers.” She elaborated,

> I really enjoy mathematics now. I love to teach mathematics now. And I think if I can talk to the kids about how cool some of this stuff is in mathematics and about how there’s more than one way to solve a problem and I’m going to teach you—and that’s another thing I like about the Common Core is I’m going to teach you four or sometimes even five

> ways to solve a problem so that if you can't figure out how to do it using standard algorithm, you have other possibilities. And so, I really like that part of being a mathematics teacher.

She continued,

> I like talking about the elegance of even something like using the distributive property to figure out a multiplication problem or building an area model to figure out a multiplication problem or a division problem, and how neat that is, that we can play with numbers in so many ways and come up with an answer, not just one way, but a whole bunch of ways. I just like to talk about the elegance of math.

## Summary

The purpose of this qualitative, interpretive phenomenological study was to explore, investigate, and interpret the lived experiences and perceptions of elementary mathematics teachers. Specifically, this study was designed to explore the experiences and perceptions of elementary mathematics teachers (a) who are trained to be generalists; (b) who teach all core academic subjects, including mathematics in a self-contained classroom setting; and (c) who would describe themselves as either disliking or having disliked mathematics. Individual semistructured interviews with nine participants who met all of the inclusion criteria and were willing to talk about their experiences. The participants came from seven different public school districts located in one rural county located in Northern New York State.

Following data analysis, which was done manually, nine themes emerged. The nine themes were then mapped together to provide a visual representation of the lived experiences and perceptions of elementary teachers who dislike mathematics in the context of mathematics education reform. The first four themes are considered convergent themes because they represent shared experiences that were common to all participants. The convergent themes, presented

chronologically, are as follows: (a) dislike of mathematics began in elementary school, (b) dislike of mathematics negatively affected their relationship with mathematics throughout their time as mathematics students, (c) the transition from traditional to reform-based mathematics teaching is very difficult, and (d) the transition to reform-based mathematics teaching has a negative impact on mathematics teacher identity.

The remaining five themes are considered divergent themes because, after making it through the difficult transition period, clusters of participants went on to have very different experiences. The five divergent themes represent five distinct patterns of how elementary teachers that dislike mathematics have experienced reform-based mathematics teaching. When mapped together, these patterns comprise a continuum that ranges from avoiding reform-based mathematics teaching to thriving with it.

Theme 5 describes how some of the participants are now in a pattern of avoiding reform-based mathematics teaching. Teachers in this pattern have not embraced the philosophy of reform-based mathematics teaching, and they are moving away from reform-based mathematics teaching and reverting back to teaching mathematics in more traditional ways. For teachers in this pattern, their perception of their mathematics teacher identity remains negative. Even though they are in alignment, their feelings and emotions, their thoughts and beliefs, and their behaviors regarding reform-based mathematics teaching are all negative. As a result, these teachers are caught in a pattern of negative congruence.

Theme 6 describes how some of the participants are now in a pattern of surviving reform-based mathematics teaching. Teachers in this pattern have not embraced the philosophy of reform-based mathematics teaching. Although they are not implementing it with full fidelity, they are continuing to implement at least some aspects of reform-based mathematics teaching because they are required to. For teachers in this pattern, their perception of their mathematics teacher

identity remains negative. Their feelings and emotions and their thoughts and beliefs about reform-based mathematics teaching, which are negative, are not aligned with their behaviors, which are evolving but not yet positive.

Theme 7 describes how some of the participants of this study are now in a pattern of coping with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching. Although they are not implementing it to the greatest extent possible, they are continuing to implement many aspects of reform-based mathematics teaching. However, for teachers in this pattern, their perception of their mathematics teacher identity remains negative. Although their thoughts and beliefs regarding reform-based mathematics teaching are positive, they are not aligned with behaviors, which are evolving but not yet positive, and their feelings and emotions remain negative.

Theme 8 describes how some of the participants of this study are now in a pattern of emerging with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching and are implementing it with fidelity. However, for teachers in this pattern, their perception of their mathematics teacher identity, though evolving, is not yet positive. Although their thoughts and beliefs and their behaviors regarding reform-based mathematics teaching are positive, they are not in alignment with their feelings and emotions which are evolving but not yet positive.

Theme 9 describes how some of the participants of this study are now in a pattern of thriving with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching and are continuing to implement it with fidelity. For teachers in this pattern, their perception of their mathematics teacher identity has undergone a transformation and is now positive. Their feelings and emotions, their thoughts and

beliefs, and their behaviors regarding reform-based mathematics teaching are in alignment. They have reached positive congruence.

The following chapter, Chapter 5, concludes this research study. This chapter includes an interpretation of the findings of this study and a discussion of their importance. Implications, recommendations for action, and recommendations for further study will also be discussed.

# CHAPTER 5: CONCLUSION

The predominant model of elementary instruction in the United States is the self-contained classroom (Markworth et al., 2016). In a self-contained classroom, one teacher is responsible for delivering core academic instruction in all subject areas (Markworth et al., 2016). As a result, most elementary teachers in the United States are trained to be generalists (NCTM, 2010). A generalist is a teacher trained to teach all core academic subjects rather than specializing in any particular one (Murphy & Glanfield, 2010).

Due to the increased expectations for rigorous mathematics instruction demanded by the CCSS-M, it has become increasingly difficult for elementary teachers who are trained to be generalists to deliver expert instruction in mathematics (Markworth et al., 2016). As a result, many elementary teachers have struggled to teach the CCSS-M effectively (Ostashevsky, 2016). This problem is compounded by the reality that many elementary teachers dislike mathematics (Johnson, 2018), as elementary teachers who have a negative relationship with mathematics are less likely to implement reform-based approaches for teaching it (Wilkins, 2008). It is now more than a decade since the release of the CCSS-M, but traditional mathematics instruction is still prevalent in elementary schools and reform-based mathematics instruction has not been widely embraced (Boaler, 2019; Huinker, 2020; Spillane et al., 2018).

The purpose of this qualitative, interpretive phenomenological study was to explore, investigate, and interpret the lived experiences and perceptions of elementary mathematics teachers. Specifically, this study was designed to explore the experiences and perceptions of elementary mathematics teachers (a) who are trained to be generalists; (b) who teach all core academic subjects, including mathematics, in a self-contained classroom setting; and (c) who would describe themselves as either disliking or having disliked mathematics. The central

research question is: What are the lived experiences and perceptions of self-contained elementary teachers who dislike mathematics? The following subquestions were also addressed:

4. How have self-contained elementary teachers who dislike mathematics experienced mathematics?
5. How have self-contained elementary teachers who dislike mathematics experienced reform-based approaches for teaching mathematics?
6. How do self-contained elementary teachers who dislike mathematics perceive their own identity as a mathematics teacher?

The lived experiences and perceptions of these teachers were viewed through the lens of mathematics teacher identity in the context of mathematics education reform. A more thorough understanding of the lived experiences and perceptions of elementary teachers who dislike mathematics will enable mathematics educators to develop professional learning experiences designed to help both preservice and inservice elementary teachers (a) improve their relationship with mathematics and (b) increase both their willingness and their ability to implement reform-based mathematics teaching.

The pool of potential participants for this research study was self-contained K–5 teachers currently teaching in a public school district located within one county in northern New York State. Criteria for inclusion included: (a) currently teaching in any Grade K–5; (b) trained to be a generalist, not a mathematics specialist; (c) teach all core academic subjects, including mathematics, in a self-contained classroom setting; and (d) self-identify as either disliking or having disliked mathematics. Following recruitment efforts, nine of the 10 teachers who responded with interest were selected for participation. One potential participant was eliminated because she met all of the inclusion criteria with the exception of one. She did not identify as disliking mathematics, and the researcher decided that this criteria was nonnegotiable. The nine

participants represented seven different public school districts, and included one Kindergarten teacher, one first-grade teacher, three second-grade teachers, one fourth-grade teacher, and three fifth-grade teachers. The years of teaching experience for the participants ranged from a minimum of 2 years to a maximum of 20 years.

A semistructured research interview was conducted over Zoom with each of the nine participants. The use of a semistructured format enabled the researcher to ask a combination of specific questions designed to collect demographic information and open-ended questions that encouraged the participants to talk freely about their experiences and perceptions. This format also enabled the researcher to ask follow-up or probing questions as necessary according to the individual responses of each participant. Prior to the interview, the participants were asked to select a pseudonym to be used in place of their real name. Some of the participants elected to choose their own pseudonym, and others asked the researcher to select one for them. To protect the confidentiality of the participants, the pseudonyms were used throughout the duration of the study. The interviews were recorded in Zoom and sent to Rev Transcription, a professional transcription service, to be transcribed into written text. Once the written transcripts were received, member checking began. All nine transcripts were accepted during the member-checking process, and no requests for changes were made.

Data analysis was conducted manually using the procedure for IPA data analysis set forth by Smith et al. (2022). This is a seven-phase process that entails (a) conducting an initial reading of the first case, (b) taking exploratory notes, (c) constructing experiential statements, (d) searching for connections across experiential statements, (e) clustering the experiential statements into PETs, (f) repeating the process for all other cases, and (g) developing GETs that represent patterns of shared experience across all cases. (Smith et al., 2022). Nine GETs emerged from the data analysis process. The nine themes were then mapped together to provide a visual

representation of the lived experiences and perceptions of elementary teachers who dislike mathematics in the context of mathematics education reform.

The first four GETs are considered convergent themes because they represent shared experiences that were common to all of the participants. They include:

1. Dislike of mathematics began in elementary school;
2. Dislike of mathematics negatively affected their relationship with mathematics throughout their time as mathematics students;
3. The transition from traditional to reform-based mathematics teaching is very difficult; and
4. The transition from traditional to reform-based mathematics teaching has a negative impact on mathematics teacher identity.

GETs 5–9 are considered divergent themes because after Theme 4, clusters of participants went on to have very different experiences. The five divergent themes represent five distinct patterns of how elementary teachers that dislike mathematics have experienced reform-based mathematics teaching. When mapped together, these patterns comprise a continuum that ranges from avoiding reform-based mathematics teaching to thriving with it. They include:

5. Some self-contained elementary teachers who dislike mathematics are avoiding reform-based mathematics teaching;
6. Some self-contained elementary teachers who dislike mathematics are surviving reform-based mathematics teaching;
7. Some self-contained elementary teachers who dislike mathematics are coping with reform-based mathematics teaching;
8. Some self-contained elementary teachers who dislike mathematics are emerging with reform-based mathematics teaching; and

9. Some self-contained elementary teachers who dislike mathematics are thriving with reform-based mathematics teaching.

This chapter includes four sections. The first section presents an interpretation of the findings of this study in the context of the central research question and subquestions. The three sections that follow discuss implications, recommendations for action, and recommendations for further study. This chapter concludes this research study.

## Interpretation and Importance of Findings

The central research question answered through this study was: What are the lived experiences and perceptions of self-contained elementary teachers who dislike mathematics? In this section, the researcher presents an interpretation of findings related to the three research subquestions of this study.

### Research Subquestion 1: How Have Self-Contained Elementary Teachers Who Dislike Mathematics Experienced Mathematics?

Results in this section answer research Subquestion Number 1 regarding how self-contained elementary teachers who dislike mathematics have experienced reform-based mathematics. Each of the nine participants in this study developed a dislike of mathematics during the time that they were students. For seven of these participants, their dislike of mathematics began when they were in elementary school. Three participants cited fourth grade as the year that their dislike of mathematics began, one participant cited fifth grade, and three participants spoke of their dislike of mathematics as beginning in elementary school but did not cite a specific grade. The remaining two participants only spoke about disliking mathematics during their high school years. The words that participants used to describe their time as mathematics students included stupid, dumb, idiot, not smart, stressed out, anxious, embarrassed, and shamed. These results are consistent with the findings of previous research which indicates

that past experiences with mathematics as a student (e.g., those that occurred during K–12 schooling) influences the development of a teacher's identity as both a learner and a teacher of mathematics (Bennison, 2015; Norman, 2021).

Four participants attributed their dislike of mathematics to instructional practices used during the time that they were students. Examples provided include mad minutes, sprints, mathematics facts Around the World, mathematics fact kickball, having to memorize multiplication facts to earn rewards, and being forced to do problems on the board in front of the class. These and other such practices caused the participants to believe that they were not good at mathematics because they were not as fast as their peers. Instructional practices such as these are not consistent with reform-based mathematics instruction (Schoen & LaVenia, 2019). According to Schoen and LaVenia (2019), teachers who have a "facts-before-word-problems" view believe that a fast recall of basic facts is a prerequisite for procedural fluency. They believe that it is necessary for students to master computational procedures, but that an understanding of why these procedures work is not important. This is in opposition to a "word-problems-before-facts" view in which teachers believe that students develop number sense and gain a deeper conceptual understanding of mathematics through the process of solving problems. "Facts-before-word-problems" beliefs are consistent with traditional mathematics instruction, and "word-problems-before-facts" beliefs are consistent with reform-based mathematics instruction (Schoen & LaVenia, 2019). These results also support previous research indicating that instructional practices which have traditionally been used to teach mathematics in elementary schools (e.g., those that focus on memorization and timed testing) cause many students to develop mathematics anxiety and disengage with mathematics at a young age (Boaler et al., 2015).

Three participants attributed their dislike of mathematics to approaches used to teach mathematics that were prevalent during the time that they were students. Examples provided

include (a) being taught that there is only one way to do math, (b) full emphasis placed on getting the correct answer rather than the process used to obtain it, and (c) being expected to memorize and use formulas to do mathematics instead of being taught to understand it. Approaches such as these are not consistent with reform-based mathematics instruction (Schoen & LaVenia, 2019). According to Schoen and LaVenia (2019), teachers with a "direct transmissionist" view of mathematics teaching believe that students must be taught specific procedures to solve problems. This is opposition to a "cognitive constructivist" view in which it is believed that it is important for students to discover how to solve problems and to invent strategies on their own. Direct transmissionist beliefs are consistent with traditional mathematics instruction, and cognitive constructivist beliefs are consistent with reform-based mathematics instruction (Schoen & LaVenia, 2019). These results support research indicating that what a teacher believes about the teaching of mathematics influences their instructional practices (Ernest, 1989; Fives & Buehl, 2016).

Two participants attributed their dislike of mathematics to limiting ability beliefs and stereotypes that were prevalent during the time that they were students. Examples provided include the belief that only some people are smart enough to be good at mathematics, and the stereotype that girls are not as good at mathematics as boys. Beliefs such as these are not consistent with reform-based mathematics instruction (Fives & Buehl, 2016). In a transmissionist view of student learning, it is believed that some students have the ability to become mathematically proficient and others do not (Askew et al., 1997). Reform-based mathematics teaching requires teachers to adhere to the belief that ability is malleable and that all students have the ability to learn and understand mathematics, which might either be supported or hindered by a teacher's existing beliefs (Fives & Buehl, 2016). These results support research

indicating that what a teacher believes about the learning of mathematics influences their instructional practices (Ernest, 1989; Fives & Buehl, 2016).

For eight of the nine participants, their dislike of mathematics negatively affected their relationship with mathematics for the rest of their time as mathematics students. One participant recalled telling her parents repeatedly that she hated mathematics and did not want to go to mathematics class. Two participants spoke of being in remedial mathematics classes throughout high school, and one remembered hiding in the bathroom to avoid having to go to mathematics class. One participant chose to attend a career technical center in high school to avoid having to take higher level mathematics classes. One participant remembers struggling with mathematics in high school and feeling that her teachers were not understanding or supportive. She took one mathematics class in college, but only because she was required to, and believes that she never would have passed this class without help. Two other participants specifically mentioned that they chose not to take calculus in high school. One went on to take calculus in college, but remembers being disinterested and not seeing the point of it. One participant did take calculus in high school, but after that knew that she did not want to take any mathematics classes in college. These results are consistent with the findings of NRC (2001), which indicate that students who lack a productive disposition in mathematics have a tendency to believe that their mathematical ability is fixed and that no amount of hard work and effort will change it. Students with this mindset quickly lose confidence in their ability to solve problems; therefore, they avoid challenging situations and are easily frustrated by mistakes. They develop a negative relationship with mathematics and often avoid taking higher level mathematics classes when they reach high school, which precludes them from careers in STEM and other fields that require mathematical proficiency (NRC, 2001). These results are also consistent with research indicating that many

students experience difficulties with mathematics at a young age that negatively affects their entire mathematics career (Mathematics & Movement, 2020).

**Research Subquestion 2: How Have Self-Contained Elementary Teachers Who Dislike Mathematics Experienced Reform-Based Approaches for Teaching Mathematics?**

The results in this section answer research Subquestion Number 2 regarding how self-contained elementary teachers who dislike mathematics have experienced teaching reform-based mathematics. During their time as preservice teachers, all nine of the participants in this study were trained to be generalists, not mathematics specialists. As a result, the majority of these participants believe that the preparation they received during their time in college did not adequately prepare them to teach reform-based mathematics. This is consistent with research indicating that many elementary teachers, who are trained to be generalists and are not mathematics specialists, lack the depth of mathematical knowledge required to teach mathematics conceptually (Ostashevsky, 2016).

Eight of the nine participants in this study spoke of the transition from traditional to reform-based mathematics teaching as being a very difficult experience. This was compounded by the fact that, as self-contained teachers, they were also planning and preparing to teach all of the other core academic subjects at the same time. This is consistent with the findings of Neumayer-Depiper (2013) which indicate that novice elementary teachers face many difficulties and challenges when they transition from a teacher-preparation program that emphasized a reform-based approach for teaching mathematics into an actual elementary classroom.

When discussing their difficulty with the transition from traditional to reform-based mathematics teaching, seven of the nine participants spoke of having to re-learn mathematics a different way before they could teach it to their students. Three of the participants spoke of struggling to do this at home each night, and two specifically stated that they were up until 2 am

each night just trying to understand the next mathematics lesson so that they could teach it to their students the following day. This is consistent with research indicating that many elementary teachers have struggled to teach the CCSS-M effectively because it represents a model of mathematics instruction that differs greatly from what most elementary teachers experienced as mathematics students (Huinker & Bill, 2017; Ostashevsky, 2016).

Three participants mentioned the resistance that they received from parents regarding reform-based mathematics teaching, which added to the difficulty they had in teaching it. This is consistent with research that has indicated that major reform initiatives can be seen as a challenge to the existing body of collective expertise and history of practice, which is often deeply entrenched within mathematics teachers and even within society as a whole. This makes it difficult for teachers who are attempting to change their practice (Van Zoest & Bohl, 2005). It is also consistent with research that has indicated that novice teachers who enter the profession and who have been trained to use reform-based mathematics instruction are often met with resistance from parents and community members; as a result, many revert back to teaching mathematics in traditional ways (Neumayer-Depiper, 2013).

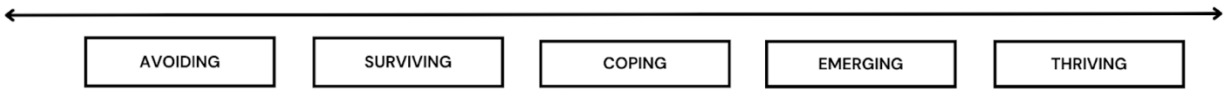
For eight of the nine participants in this study, the transition from traditional to reform-based mathematics teaching negatively affected their mathematics teacher identity. Many of the participants recalled being concerned about how other people viewed them as mathematics teachers. Several vividly remembered doing mathematics problems incorrectly in front of the class and being "called out" on these mistakes by their students. Others remembered not wanting their administrator to observe them while teaching mathematics. The words that these eight participants used to describe their feelings and emotions during this time included intimidated, confused, scared, afraid, frustrated, overwhelmed, insecure, embarrassed, stressed, nervous, anxious, and unsuccessful. These results are consistent with Hodgen and Askew (2006), who

found that significant professional change is emotionally difficult for teachers and can be perceived as "deeply emotionally threatening" to a teacher's identity. Although it is difficult to achieve teacher change in any subject, it is even more difficult to achieve teacher change in mathematics because mathematics generates more emotions for teachers than any other subject (Hodgen & Askew, 2007). The results of this study also support the findings of other researchers who recognized the impact of relationships with students, other teachers, and administrators on mathematics teacher identity (Bennison, 2015; Sun, 2017).

Following this transition period, clusters of participants went on to have different experiences with reform-based mathematics teaching. Upon close analysis of these different experiences, five distinct patterns emerged. When viewed together, these patterns represent a continuum of how self-contained elementary teachers who dislike mathematics have experienced reform-based mathematics teaching. Along this continuum, the patterns range from teachers who avoid reform-based mathematics teaching to teachers who thrive with it (see Figure 12).

**Figure 12**

*Continuum of How Self-Contained Elementary Teachers Who Dislike Mathematics Have Experienced Reform-Based Mathematics Teaching*




Two of the participants of this study are in a pattern of avoiding reform-based mathematics teaching. Teachers who are avoiding reform-based mathematics teaching have not embraced the philosophy of reform-based mathematics teaching, and are reverting back to teaching mathematics in more traditional ways. One of the participants of this study is now in a pattern of surviving reform-based mathematics teaching. Teachers who are surviving reform-based mathematics teaching have not embraced the philosophy of reform-based mathematics

teaching. They are continuing to implement at least some aspects of reform-based mathematics teaching because they are required to, but they are not implementing it with full fidelity. Two of the participants of this study are now in a pattern of coping with reform-based mathematics teaching. Although teachers who are coping with reform-based mathematics teaching have embraced the philosophy of reform-based mathematics teaching and are continuing to implement many aspects of it, they are not implementing it with complete fidelity. One of the participants of this study is now in a pattern of emerging with reform-based mathematics teaching. Teachers who are emerging with reform-based mathematics teaching have embraced the philosophy of reform-based mathematics teaching and are continuing to implement it. Three of the participants of this study are now in a pattern of thriving with reform-based mathematics teaching. Teachers who are thriving with reform-based mathematics teaching have embraced the philosophy of reform-based mathematics teaching and are implementing it with fidelity. These results are consistent with research indicating that a mathematics teacher's beliefs affect their instructional practices (Askew et al., 1997; Ernest, 1989; Polly et al., 2013) and can either support or undermine their willingness to implement reform-based mathematics teaching (Fives & Buehl, 2016; Schoen & LaVenia, 2019). They are also consistent with research indicating that teachers who have the same mathematical knowledge might decide to act in different ways because they have very different beliefs about how it should be taught (Van Zoest & Bohl, 2005).

**Research Subquestion 3: How Do Self-Contained Elementary Teachers Who Dislike Mathematics Perceive Their Own Identity as a Mathematics Teacher?**

The results in this section answer research Subquestion Number 3 regarding how self-contained elementary teachers perceive their identity as mathematics teachers. Ladd's (2018) Holistic Identity and Personal Change Model provided the theoretical framework for this study. According to Ladd (2018), the lowest level of personal change is behavior, and the highest level

of personal change is identity. Identity affects beliefs, beliefs affect feelings, feelings affect thoughts, and thoughts affect behavior. As a result, identity controls the entire structure of personal change (Ladd, 2018).

The information shared by the participants when asked to describe their mathematics teacher identity was categorized as either feelings and emotions, thoughts and beliefs, or behaviors. Each participant's feelings and emotions, thoughts and beliefs, and behaviors were then categorized as either negative, evolving, or positive in the context of reform-based mathematics teaching. The result was a unique mathematics teacher identity for each of the five patterns, or stages, along the continuum of reform-based mathematics teaching: Avoiding, surviving, coping, emerging, and thriving. These results are consistent with research by Sun (2017), which revealed a variety of different mathematics teacher identities for service elementary teachers, spread out along a continuum from "passive ambitious mathematics teacher identity" to "active ambitious mathematics teacher identity" (Sun, 2017, p. 51).

The pattern of avoiding reform-based mathematics teaching is farthest to the left on the continuum of reform-based mathematics teaching for self-contained elementary teachers who dislike mathematics. Teachers who are avoiding reform-based teaching perceive their mathematics teacher identity to be negative. Although their feelings and emotions, thoughts and beliefs, and their behaviors in the context of reform-based mathematics teaching are in alignment, they remain negative. As a result, these teachers are in negative congruence. This result is consistent with the findings of Sun (2017) who indicated that some teachers have a passive mathematics teacher identity in the context of reform-based mathematics teaching. According to Sun (2017), teachers with a passive mathematics teacher identity are less receptive to reform-based mathematics teaching because it does not align with their beliefs about the teaching and learning of mathematics. They are not on board with the changes they are being asked to make,

they do not see the value in professional learning experiences that are required of them, and they are not committed to their growth and development as reform-based mathematics teachers.

After the pattern of avoiding, the next step to the right on the continuum of reform-based mathematics teaching for self-contained elementary teachers who dislike mathematics is the pattern of surviving reform-based mathematics teaching. Teachers who are surviving reform-based teaching perceive their mathematics teacher identity to be negative. Although their behaviors in the context of reform-based mathematics teaching are evolving, they are not aligned with their feelings and emotions and their thoughts and beliefs about reform-based mathematics teaching, which remain negative. This result supports the findings of Sun (2017) who indicated that some teachers remain reluctant and hesitant about certain aspects of reform-based mathematics teaching—often because they lack the pedagogical skills necessary to do so. Although they might be attempting to implement some aspects of reform-based mathematics teaching, they are not doing so consistently or with full fidelity.

After the pattern of surviving, at the midpoint of the continuum of reform-based mathematics teaching for self-contained elementary teachers who dislike mathematics is the pattern of coping with reform-based mathematics teaching. Teachers who are coping with reform-based teaching perceive their mathematics teacher identity to be negative. Although their thoughts and beliefs in the context of reform-based mathematics teaching are positive, they are not aligned with either their behaviors, which are evolving, or their feelings and emotions, which remain negative. This result is consistent with research indicating that a teacher's professed beliefs are not always consistent with their instructional practices (Swan, 2006), and that there are often consistencies between a teacher's professed identity as a reform-based mathematics teacher and the reality of what they are able to implement in their classroom (Hodges & Cady, 2012). This result also supports research indicating that contextual factors (e.g., test-driven school cultures

and taken-for-granted ideas and ways of practice regarding the teaching and learning of mathematics) act as barriers to the implementation of reform-based mathematics teaching because they complicate the relationship between an individual's identity as a mathematics teacher and their enacted practice (Bennison, 2015; Neumayer-Depiper, 2013).

After the pattern of coping, the next step to the right on the continuum of reform-based mathematics teaching for self-contained elementary teachers who dislike mathematics is the pattern of emerging with reform-based mathematics teaching. Teachers who are emerging with reform-based teaching perceive their mathematics teacher identity to be evolving. Their thoughts and beliefs and their behaviors in the context of reform-based mathematics teaching are positive; however, they are not in alignment with their feelings and emotions which are evolving but not yet positive. This result supports the findings of Sun (2017) who indicated that some teachers, even though their beliefs align with reform-based mathematics teaching, might still find it challenging to implement it consistently or with fidelity. However, despite these challenges, these teachers continue to believe that reform-based mathematics teaching is beneficial for their students which motivates them to continue to grow and improve and reform-based mathematics teachers.

After the pattern of emerging, on the far right side of the continuum of reform-based mathematics teaching for self-contained elementary teachers who dislike mathematics is the pattern of thriving with reform-based mathematics teaching. Teachers who are thriving with reform-based teaching perceive their mathematics teacher identity to be positive. Their feelings and emotions, thoughts and beliefs, and behaviors in the context of reform-based mathematics teaching are all in alignment. They have reached positive congruence. This position is consistent with the findings of Sun (2017) who indicated that some teachers have an active mathematics teacher identity in the context of reform-based mathematics teaching. According to Sun (2017),

teachers with an active mathematics teacher identity have beliefs that align with reform-based mathematics teaching. They have a strong growth mindset, and are committed to their growth and development as reform-based mathematics teachers.

## Implications

### Implication 1: Efforts to Reform Elementary Mathematics Instruction Must Account for Mathematics Teacher Identity

Past and present reform efforts such as the New Math Reform Movement of the 1970s, the Standards-Based Movement of the 1980s, and the CCSSI of the current era have attempted to change the instructional behaviors of elementary teachers through the release of policy initiatives, curriculum directives, and content and process standards that mandate a shift from traditional to reform-based approaches for teaching elementary mathematics. The New Math Reform Movement and Standards-Based Reform Movement both ended in failure, largely because of resistance from elementary teachers (Epstein & Miller, 2011). And in the current era, many elementary teachers have struggled to teach the Common Core Standards effectively (Ostashevsky, 2016).

The Ladd (2018) Holistic Identity and Personal Change Model provided the theoretical framework for this study. This model provides a conceptualization of the concept of identity and a holistic perspective on personal change that helps to explain why the desired change in the instructional behavior of elementary mathematics teachers (implementing reform-based mathematics teaching with fidelity) has been so elusive. When viewed through the lens of Ladd's (2018) Holistic Identity and Personal Change Model, it can be seen that past reform efforts have attempted to achieve this desired change by targeting the lowest level of the holistic identity and personal model, which is behavior. In doing so, the reform efforts have failed to take into account the higher levels of Ladd's (2018) Holistic Identity and Personal Change Model—the thoughts,

feelings, and beliefs that elementary teachers have about mathematics, as well as their identities as both mathematics learners and mathematics teachers. This approach is considered a bottom-up approach to personal change. When a bottom-up approach to personal change is employed, the outcome is likely to be resentment and noncompliance with the desired behavioral change (Ladd, 2018).

Efforts to achieve the desired change in instructional behaviors of elementary mathematics teachers (i.e., implementing reform-based mathematics teaching with fidelity) will likely not succeed unless a top-down approach to personal change is employed. According to Ladd (2018), a top-down approach to personal change targets the highest level of the Holistic Identity and Personal Change Model first, which is identity. When identity is changed first, the desired changes in beliefs, feelings, thoughts, and behaviors will naturally follow (Ladd, 2018). The use of a top-down approach to personal change significantly increases the likelihood that the desired behavioral change will be achieved, which, in this case, is the successful implementation of reform-based mathematics teaching by elementary teachers. This implication is consistent with findings of Hodgen and Askew (2007) who indicated that professional development that attempts to improve mathematics instruction by focusing only on teacher knowledge is doomed to fail, and that professional development must address the emotional development necessary for change by giving teachers the opportunity to explore their identities as mathematics learners and mathematics teachers.

**Implication 2: Mathematics Teacher Identity Can Be Positively Impacted by Cognitive, Affective, and Social Factors**

The results of this study indicate that the mathematics teacher identity of self-contained elementary teachers who dislike mathematics is negatively affected by cognitive, affective, and social factors. This is consistent with models of mathematics teacher identity developed by Van

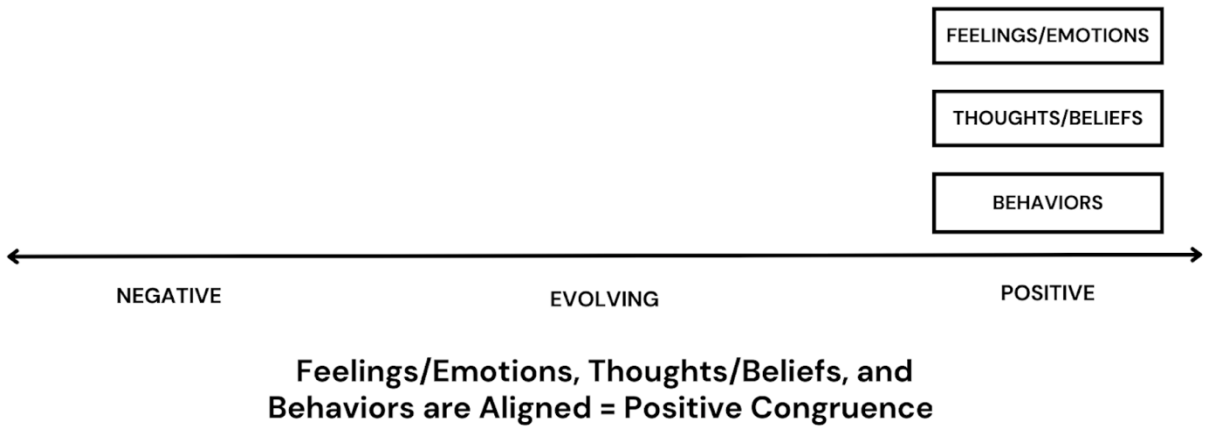
Zoest and Bohl (2005) and Bennison (2015). Six of the nine teachers who participated in this study spoke of lacking either the content knowledge needed to understand reform-based mathematics or the pedagogical knowledge needed to teach it effectively. These are considered cognitive factors (Bennison 2015; Van Zoest & Bohl, 2005). Eight of the nine teachers spoke of experiencing negative feelings and emotions while teaching reform-based mathematics. These are considered affective factors (Bennison, 2015; Van Zoest & Bohl, 2005). Five of the nine teachers spoke about their perceptions of how other people perceive them as mathematics teachers (e.g., their students, their colleagues, and their administrators). These are considered social factors (Van Zoest & Bohl, 2005; Bennison, 2015). These results show that, if mathematics teacher identity can be negatively affected by cognitive, affective, and social factors, it can be positively affected by them, too.

**Implication 3: All Three Components of Mathematics Teacher Identity Must Be in Positive Congruence**

From current research, policy, and standards in the field of mathematics education, the desired behavior for self-contained elementary teachers who dislike mathematics is to implement reform-based mathematics teaching with fidelity (Huinker, 2020; Huinker & Bill, 2017). The results of this study indicate that teachers who are thriving with reform-based mathematics teaching perceive their mathematics teacher identity to be positive, and that the feelings and emotions, thoughts and beliefs, and behaviors of these teachers in the context of reform-based mathematics teaching are all in positive congruence (see Figure 13).

**Figure 13**

*Mathematics Teacher Identity of Participants Who Are in a Pattern of Thriving With Reform-Based Mathematics Teaching*




These results show that, if a teacher's thoughts and beliefs or their feelings and emotions about reform-based mathematics teaching are not in alignment with this desired behavior, it is likely that the teacher might have some level of resistance to reform-based mathematics teaching. The further the teacher's mathematics teacher identity is away from positive congruence, the stronger the resistance is likely to be. Teachers who are closer to positive congruence might continue to implement reform-based mathematics teaching, but it is likely that they will not implement it consistently or with full fidelity. Teachers who are further away from positive congruence might continue to implement reform-based mathematics teaching, but only because they are being required to, which might cause resentment and eventually lead to noncompliance. Teachers who are in negative congruence might abandon reform-based mathematics instruction altogether and revert back to teaching mathematics in more traditional ways. This implication is consistent with research indicating that successful implementation of reform-based mathematics teaching has been hampered by the existence of dominant cultural beliefs about the teaching and learning of mathematics (NCTM, 2014). Many teachers believe that students should be taught as

they were, with the use of instructional practices that emphasize the rote memorization of facts and procedures through repetitive practice (NCTM, 2014). Such beliefs have perpetuated the use of traditional models of mathematics instruction which are still pervasive in many elementary classrooms (Huinker & Bill, 2017).

**Implication 4: It Is Possible for Teachers to Change Their Mathematics Teacher Identity**

Prior to and during the transition from traditional to reform-based mathematics teaching, all nine of the teachers who participated in this study had a negative perception of their mathematics teacher identity. Following the transition, six of the teachers still have a negative mathematics teacher identity. However, one teacher has a mathematics teacher identity that is evolving, and three teachers now have a mathematics teacher identity that is positive. This result indicates that it is possible for self-contained elementary teachers who dislike mathematics to change their mathematics teacher identity. This result is supported by research indicating that teacher identity "is not fixed nor is it imposed; rather it is negotiated through experience and the sense that is made of that experience" (Sachs, 2005, as cited in Norman, 2021, p. 11).

**Implication 5: Changing Your Mathematics Teacher Identity Is an Active Process**

The results of this study indicate that for four of the nine self-contained elementary teachers who dislike mathematics and who participated in this study, their mathematics teacher identity has undergone a positive change. All four of these teachers were motivated to improve their relationship with mathematics, and discussed steps that they chose to undertake to develop and grow as reform-based mathematics teachers. Examples provided included (a) attending professional learning opportunities (e.g., workshops and summer camps for mathematics teachers), (b) participating in book studies and reading other professional literature about the teaching of math, and (c) seeking help and support from mathematics coaches. These results show that, for self-contained elementary teachers who dislike math, improving their mathematics

teacher identity is an active process, not a passive one. This implication is supported by Sun (2017), who found that some elementary teachers have an active mathematics teacher identity in the context of reform-based mathematics teaching. According to Sun (2017), teachers with an active mathematics teacher identity had a strong growth mindset and were actively committed to their own learning. These teachers not only were more receptive to professional development that was required of them, they also actively sought out additional learning opportunities, resources, and professional learning communities that supported their growth as reform-based mathematics teachers.

**Implication 6: Character Traits and Well-Being Matter**

The results of this study indicate that four of the nine self-contained elementary teachers who dislike mathematics that participated in this study were able to overcome both their negative past experiences with mathematics and the difficult transition from traditional to reform-based mathematics teaching. Three of these teachers are now in a pattern of thriving with reform-based mathematics teaching, and the fourth is in a pattern of emerging with it. As they spoke about how they experienced this change, the responses of all four of these teachers demonstrated positive character traits (e.g., resilience, perseverance, positive outlook, curiosity, generosity, and empathy). This shows that self-contained elementary teachers who dislike mathematics that can strengthen and develop these traits have a higher likelihood of being able to successfully change their mathematics teacher identity. This implication is supported by Davidson (2016) who found that the four keys to well-being are resilience, positive outlook, attention, and generosity. Davidson (2016) also found that these four traits are actually skills that can be improved with training and practice, and that the development of these skills promotes personal growth and lasting change.

### Implication 7: Preservice Elementary Teachers Must Have Opportunities to Engage in Mathematics Identity Work

The results of this study indicate that for all nine of the self-contained elementary teachers who dislike mathematics and who participated in this study, their dislike of mathematics had already developed by the time they entered their college-level teacher preparation program. This is consistent with the findings of other researchers who have indicated that many preservice elementary teachers identify as having negative experiences with mathematics as students and as having low confidence in their ability to teach it (Lutovac & Kaasila, 2014; Norman, 2021). These results show that (a) it is likely that many preservice elementary teachers currently enrolled in college-level teacher preparation programs have components of their mathematics teacher identity that are not in alignment with reform-based mathematics teaching, and (b) that it is likely that they have some level of resistance to reform-based mathematics teaching. As a result, unless these preservice teachers are given opportunities to change their mathematics teacher identity and break out of this pattern as part of their coursework, it is unlikely that they will implement reform-based mathematics teaching with fidelity in their future classrooms. This implication is supported by Lutovac and Kaasila (2014) who advocated for the necessity of providing preservice teachers the opportunity to engage in mathematics identity work. Lutovac and Kaasila (2014) defined mathematics identity work as "a process of deep reflection and self-evaluation where past, present and future mathematical identities enter into a dialog that leads to one's awareness of a tension or gap between the actual and the ideal state of mathematical identity" (p. 131).

### Implication 8: Inservice Elementary Teachers Must Have Opportunities to Engage in Mathematics Identity Work

The results of this study indicate that during their time as in-service teachers, all nine of the self-contained elementary teachers who dislike mathematics and who participated in this

study had components of their mathematics teacher identity that were not aligned with reform-based mathematics teaching. The majority of these teachers continue to be resistant to reform-based mathematics teaching at some level, and are not implementing it consistently or with fidelity. These results indicate that, unless inservice teachers are given opportunities to do identity work, this pattern of resistance to reform-based mathematics teaching is unlikely to change. This implication is supported by Hodges and Cady (2012) who described an individual's identity as a mathematics teacher as a trajectory that will continue to change and be refined over time. As a result, it is important to consider where individual teachers are on this trajectory, what next steps are necessary, and to provide the professional learning experiences necessary for them to develop an identity as a reform-based mathematics teacher (Hodges & Cady, 2012).

**Implication 9: "The After is the Before for the Next During"**

This implication was inspired by Goleman and Davison (2017), who coined the phrase, "the after is the before for the next during" (p. 45). Although Goleman and Davidson (2017) applied this phrase to their study of altered traits, it can be broadly applied when planning interventions designed to promote personal change in any area. The results of this study indicate that following the transition from traditional mathematics teaching, five distinct patterns emerged on a continuum from teachers who avoid reform-based teaching to teachers who thrive with it. Two of the self-contained elementary teachers who dislike mathematics are now in a pattern of avoiding reform-based mathematics teaching, one is in a pattern of surviving it, two are in a pattern of coping with it, one is in a pattern of emerging with it, and three are in a pattern of thriving with it.

These results show that the achievement of the ultimate goal, which is a pattern of thriving with reform-based mathematics teaching, should not be undertaken all at once. Instead, self-contained elementary teachers who dislike mathematics, along with their mathematics coaches,

curriculum coordinators, principals, or others who are helping them to implement reform-based mathematics teaching, should have a goal of moving from pattern to pattern toward the far right end of the continuum, one step at a time.

In the case of self-contained elementary teachers who dislike mathematics in the context of mathematics education reform, "before" refers to the pattern where the teacher is in at baseline. For example, a teacher might be in a pattern of avoiding reform-based mathematics teaching. "During" refers to the temporary changes that happen while the teacher undertakes mathematics identity work that will end when the experience has been completed. "After" refers to enduring changes to mathematics teacher identity that last beyond the experience and become permanent, meaning that the teacher has moved one step to the right on the continuum and is now in a pattern of surviving reform-based mathematics teaching. The "after," which in this case is the pattern of surviving, then forms the baseline of the next "before," and the next level of "during," or mathematics identity work, begins. And so, it repeats, from pattern to pattern along the continuum, with the ultimate goal being a pattern of thriving with reform-based mathematics teaching.

## Recommendations for Action

### Recommendation for Action 1: Use Process and Identity Maps to Create Hope and Possibility

The results of this study indicate that following the transition from traditional mathematics teaching, five distinct patterns emerged on a continuum from teachers who are avoiding reform-based teaching to teachers who are thriving with it. To provide a visual representation of how the self-contained elementary teachers who participated in this study have experienced reform-based mathematics teaching, two different types of concept maps were created for each pattern. The process maps provide a visual representation of the lived experiences of teachers in each pattern,

and the identity maps provide a visual representation of how the teachers in each pattern perceive their mathematics teacher identity. The process and identity concept maps can be found in Appendix G.

These concept maps will be of great value to self-contained elementary teachers who dislike mathematics, along with their mathematics coaches, curriculum coordinators, principals, or others who are helping them to implement reform-based mathematics teaching. The myriad of creative ways that these maps can be used is beyond the scope of this dissertation. However, in a general sense, the maps can be used to create hope and possibility for self-contained elementary teachers who dislike mathematics and have a negative perception of their mathematics teacher identity. When these teachers become aware that they are not alone in feeling that way, and that it is possible to change their relationship with mathematics and improve their mathematics teacher identity, it is likely that they will experience feelings of hope. When they realize that they are simply stuck in a negative pattern, identify this pattern, and learn that other teachers like them have successfully broken this pattern, they are likely to believe that positive change is a possibility. These teachers, along with colleagues who are supporting them, can then leverage this hope and possibility and use it as motivation to start taking active steps to improve their mathematics teacher identity. This recommendation is supported with the findings of Hodges and Cady (2012) who indicated that, because identity is in part a trajectory, an individual's identity as a mathematics teacher will continue to change and be refined over time. As a result, it is important to consider where individual teachers are on this trajectory, what next steps are necessary, and to provide the professional development experiences necessary for them to develop an identity as a reform-based mathematics teacher Hodges and Cady (2012).

**Recommendation for Action 2: Provide Opportunities for Preservice Teachers to Engage in Mathematics Identity Work**

Six of the nine elementary teachers who participated in this study felt that they were not adequately prepared as preservice elementary teachers to understand or to teach reform-based mathematics. From the results of this study, the researcher recommends that teacher preparation programs provide mathematics methods coursework that address both the cognitive knowledge and the pedagogical knowledge necessary for teachers to successfully implement reform-based mathematics teaching. They should also help to prepare them for social influences that they will encounter, including students, teachers, administrators, and parents who might be resistant to reform-based mathematics instruction. And perhaps most importantly, this coursework should provide preservice elementary teachers with opportunities to engage in mathematics identity work as it relates to reform-based mathematics teaching. This should include providing experiences that will enable preservice elementary teachers to become aware of and address their feelings and emotions, thoughts and beliefs, and behaviors about mathematics and reform-based mathematics teaching. Ideally, these courses would start in the freshman year and then be evenly spaced throughout the duration of the teacher preparation program.

This recommendation is supported by the findings of Norman (2021). According to Norman (2021), teacher preparation programs should provide opportunities for preservice elementary teachers to reflect on their past experiences as mathematics students and to understand how those experiences have shaped their mathematics identity and their emerging mathematics teacher identity. This recommendation is also supported by Lutovac and Kaasila (2014) who studied preservice elementary teachers who dislike mathematics that were given the opportunity to engage in identity work related to the teaching of mathematics. As a result of this identity work, some of the preservice teachers in the study chose to distance themselves from their

negative pasts, rise above their fears about their future as mathematics teachers, and were motivated to learn and grow as mathematics teachers.

**Recommendation for Action 3: Provide Opportunities for Inservice Teachers to Engage in Mathematics Identity Work**

The results of this study indicate that during their time as inservice teachers, all nine of the self-contained elementary teachers who dislike mathematics and who participated in this study had components of their mathematics teacher identity that were not aligned with reform-based mathematics teaching. The majority of these teachers still continue to be resistant to reform-based mathematics teaching at some level, and are not implementing it consistently or with fidelity. These results show that, unless inservice teachers are given opportunities to do identity work, this pattern of resistance to reform-based mathematics teaching is unlikely to change. This is consistent with the findings of Hodgen and Askew (2007) who indicated that (a) professional development which attempts to improve mathematics instruction by focusing only on teacher knowledge is doomed to fail, and (b) professional development must address the emotional development necessary for change by giving teachers the opportunity to explore their identities as both mathematics learners and mathematics teachers (Hodgen & Askew, 2007). It is also consistent with the recommendations of Sun (2017) to (a) identify the mathematics teacher identity of teachers prior to delivering professional development, and then (b) use the experiences and personal narratives that informed the development of their mathematics teacher identity as tools when designing and delivering the professional development experiences.

From the results of this study, the researcher recommends that professional learning opportunities be provided for in-service elementary teachers that address both the cognitive knowledge and the pedagogical knowledge necessary for teachers to successfully implement reform-based mathematics teaching. These professional learning opportunities should also help

inservice elementary teachers to understand and navigate social factors such as students, teachers, administrators, and parents who may be resistant to reform-based mathematics teaching. And perhaps most importantly, in service elementary teachers should also be provided professional learning opportunities that will enable them to engage in mathematics identity work as it relates to reform-based mathematics teaching. This should include providing experiences that enable in-service elementary teachers to become aware of and address their feelings and emotions, thoughts and beliefs, and behaviors about mathematics and reform-based mathematics teaching. This recommendation is consistent with findings of Schoen and LaVenia (2019), who indicated that successful implementation of reform-based mathematics teaching requires a shift in the existing beliefs that many teachers hold about the teaching of math.

**Recommendation for Action 4: Develop Onboarding Programs for Novice Elementary Teachers**

For self-contained elementary teachers who dislike math, the transition from traditional to reform-based mathematics teaching is very difficult. Preparing teachers for this transition ahead of time and then supporting them while they are going through it will increase the likelihood that they will continue to implement reform-based mathematics with fidelity after the transition. This should involve exposing teachers to cognitive, affective, and social factors that have a positive impact on their mathematics teacher identity in the context of reform-based mathematics teaching and continuing to support them as they navigate this transition.

Ideally, this program would meet for several sessions spread out at intervals throughout the course of a school year. The purpose of the program would be to provide both the content knowledge and the pedagogical knowledge that these novice teachers would need to successfully implement reform-based mathematics teaching at their specific grade level. It would also provide opportunities to do mathematics identity work, which would enable them to become aware of and

address their feelings and emotions, thoughts and beliefs, and behaviors regarding reform-based mathematics and reform-based mathematics teaching. In addition, this program would act as a professional learning community, which is a community of learners either within one school or across several schools or districts that would meet regularly to discuss their experiences teaching reform-based mathematics at that grade level. This community would help novice teachers to feel supported as they navigate the transition from traditional to reform-based mathematics teaching. This recommendation is supported by the findings of Sun (2017) who shed light on the importance of accounting for mathematics teacher identity when designing and delivering professional development to support teachers transitioning to reform-based mathematics teaching.

## Recommendations for Further Study

This study of self-contained elementary teachers who dislike mathematics supplements existing literature on mathematics teacher identity in the context of mathematics education reform. The results of this study are of value to teachers, administrators, instructional coaches, members of P–12 school communities, institutions of higher education, mathematics educators, and designers of educational programming. However, additional research could also help to deepen our understanding of how self-contained elementary teachers have experienced reform-based mathematics teaching.

### Recommendation for Further Study 1: Replicate This Study in Other Locations

The participants of this study represent a small sample size from one county located in northern New York State. As a result, the results of this study might not be representative of how all self-contained elementary teachers who dislike mathematics have experienced reform-based mathematics teaching. Teachers from other regions in New York State, or in different states, might have had different experiences with mathematics and with reform-based mathematics teaching. They might also have different perceptions of their mathematics teacher identities. As a

result, it is recommended that this study be replicated for other self-contained elementary teachers who dislike mathematics in different locations.

**Recommendation for Further Study 2: Create Action Plans and Templates**

The purpose of this interpretive phenomenological study was to explore, investigate, and interpret the lived experiences and perceptions of self-contained elementary mathematics teachers who dislike mathematics in the context of mathematics education reform. Consistent with the premise of phenomenological research, the purpose of this study was to develop a deeper understanding of the nature of this phenomenon, not to determine a solution for it. The results of this study show that for self-contained elementary teachers who dislike mathematics, the transition from traditional to reform-based mathematics teaching is a very difficult experience. However, following the transition, five different patterns emerged ranging from teachers who are avoiding reform-based mathematics teaching to those who are thriving with it. This information will be of use to mathematics educators, mathematics coaches, school administrators, and others interested in working with self-contained elementary teachers who dislike mathematics to increase both their willingness and their ability to successfully implement reform-based mathematics teaching. The results of this study show that self-contained elementary teachers who dislike mathematics would benefit from opportunities to engage in mathematics identity work. The results also show that this identity work should focus on helping teachers move from pattern to pattern, one step at a time, with each step moving farther to the right on the continuum. However, it is beyond the scope of this study to suggest how this should be done. As a result, it is recommended that future research be undertaken to design creative action plans and templates to be shared with teachers who are in each of the five patterns of reform-based mathematics teaching.

### Recommendation for Further Study 3: Longitudinal Studies of Teachers Who Engage in Identity Work

The results of this study indicate that self-contained elementary teachers who dislike mathematics would benefit from opportunities to engage in mathematics identity work. This is true for both preservice and in-service elementary teachers. As a result, it is recommended that future research include longitudinal studies of both preservice and in-service teachers who are provided experiences that would enable them to engage in mathematics identity work to determine the long-term implications of the mathematics identity work and the effectiveness of the experiences over time.

### Recommendation for Further Study 4: Replicate Study for Self-Contained Elementary Teachers Who Like Mathematics

The purpose of study was to explore, investigate, and interpret the lived experiences and perceptions of self-contained elementary mathematics teachers who dislike mathematics to develop a deeper understanding of how these teachers have experienced reform-based mathematics teaching. As a result, the researcher did not include teachers who are trained to be mathematics specialists, who teach mathematics in a departmentalized classroom setting, or who identify as liking mathematics. As a result, it is recommended that future research replicate this study for these teachers to develop a deeper understanding of how they have experienced mathematics and reform-based mathematics teaching, and how they perceive their identity as mathematics teachers.

## Conclusion

This study is significant because it addresses a gap in the existing literature in the field of mathematics education by exploring the phenomenon of self-contained elementary teachers who dislike mathematics to determine how they have experienced mathematics, how they have

experienced reform-based mathematics teaching, and how they perceive their identity as mathematics teachers. The results of this study indicate that each of the nine teachers who participated in this study developed a dislike of mathematics during the time that they were students. For the majority of the teachers, this dislike began in elementary school. Four participants attributed their dislike of mathematics to instructional practices used during their time as students, three participants attributed their dislike of mathematics to approaches used to teach mathematics, and two participants attributed their dislike of mathematics to limiting stereotypes and ability beliefs. For eight of the nine participants, their dislike of mathematics negatively affected their relationship with mathematics for the rest of their school careers.

Eight of the nine participants in this study spoke of the transition from traditional to reform-based mathematics teaching as being a very difficult experience. This was compounded by the fact that, as self-contained teachers, they were also planning and preparing to teach all of the other core academic subjects at the same time. When discussing their difficulty with the transition from traditional to reform-based mathematics teaching, seven of the nine participants spoke of having to re-learn mathematics a different way before they could teach it to their students. Three participants mentioned the resistance that they received from parents regarding reform-based mathematics teaching, which added to the difficulty that they had teaching it. For eight of the nine participants in this study, the transition from traditional to reform-based mathematics teaching negatively affected their perception of their mathematics teacher identity. Many of the participants recalled being concerned about how other people viewed them as mathematics teachers. Several vividly remembered doing mathematics problems incorrectly in front of the class and being “called out” on these mistakes by their students. Others remembered not wanting their administrator to observe them while teaching math.

Following this transition period, clusters of participants went on to have different experiences with reform-based mathematics teaching. Upon close analysis of these different experiences, five distinct patterns emerged. When viewed together, these patterns represent a continuum of how self-contained elementary teachers who dislike mathematics have experienced reform-based mathematics teaching. Along this continuum, the patterns range from teachers who avoid reform-based mathematics teaching to teachers who thrive with it. Two of the participants of this study are now in a pattern of avoiding reform-based mathematics teaching. Teachers in this pattern have not embraced the philosophy of reform-based mathematics teaching, and they are moving away from reform-based mathematics teaching and reverting back to teaching mathematics in more traditional ways. One of the participants of this study is now in a pattern of surviving reform-based mathematics teaching. Teachers in this pattern have not embraced the philosophy of reform-based mathematics teaching. They are continuing to implement at least some aspects of reform-based mathematics teaching because they are required to, but they are not implementing it with full fidelity. Two of the participants of this study are now in a pattern of coping with reform-based mathematics teaching. Although teachers in this pattern have embraced the philosophy of reform-based mathematics teaching and are continuing to implement many aspects of reform-based mathematics teaching, they are not implementing it with complete fidelity. One of the participants of this study is now in a pattern of emerging with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching and are continuing to implement it. Three of the participants of this study are now in a pattern of thriving with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching, and are implementing it with fidelity.

This information gained from this study is vitally important to elementary teachers, mathematics coaches, curriculum coordinators, principals and school administrators, and other members of K–12 school communities. It is also of great value to mathematics education researchers, mathematics education reformers, those who design educational programming for preservice and inservice teachers, professors of mathematics education and other mathematics teacher educators, and members of higher education communities. By helping to illuminate the experiences of self-contained elementary teachers who dislike mathematics in the context of mathematics education reform, the findings of this study will enable more elementary teachers to overcome their dislike of mathematics and embrace reform-based mathematics teaching.

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# APPENDIX A

# INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

UNE UNIVERSITY OF NEW ENGLAND

INNOVATION FOR A HEALTHIER PLANET

**Institutional Review Board**
**Julie Longua Peterson, Chair**

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**DATE OF LETTER**: September 15, 2022

**PRINCIPAL INVESTIGATOR**: Melinda Bixby
**FACULTY ADVISOR**: Lori Sanchez, EdD

**PROJECT NUMBER**: 0822-16
**RECORD NUMBER**: 0822-16-01
**PROJECT TITLE**: Elementary Mathematics Teacher Identity in the Context of Mathematics Education Reform: A Phenomenological Approach
**SUBMISSION TYPE**: Exempt Project
**SUBMISSION DATE**: 8/21/2022

**ACTION**: Determination of Exempt Status
**DECISION DATE**: 9/15/2022

**REVIEW CATEGORY**: Exemption Category # 2(ii)

The UNE Institutional Review Board (IRB) for the Protection of Human Subjects has reviewed the materials submitted in connection with the above referenced project and has determined that the proposed work is exempt from IRB review and oversight as defined by 45 CFR 46.104.

Additional IRB review is not required for this project as submitted. However, if any changes to the design of the study are contemplated (e.g., revision to the protocol, data collection instruments, interview/survey questions, recruitment materials, participant information sheet, and/or other IRB-reviewed documents), the Principal Investigator must submit an amendment to the IRB to ensure the requested change(s) will not alter the exempt status of the project.

Please feel free to contact me at (207) 602-2244 or irb@une.edu with any questions.

Best Regards,

Bob Kennedy, MS
Director, Research Integrity

# APPENDIX B

## RECRUITMENT MATERIALS

**Teacher Recruitment Letter (to be sent via email and used to recruit participants via snowballing)**

Dear Fellow Educator,

My name is Mindy Bixby, and I live in Canton, New York. I was an elementary teacher for 23 years, and am now a doctoral student at the University of New England. For my dissertation I am conducting a research project with the goal of developing a deeper understanding of the experience of being an elementary mathematics teacher, and I am seeking teachers from St. Lawrence County to collaborate with me on this project.

My goal is to recruit about 10 participants who are currently teaching in any grade K–5 at a public school district located in St. Lawrence County. Specifically, I am seeking elementary teachers (a) who are trained to be generalists; (b) who teach all core academic subjects, including mathematics in a self-contained classroom setting; and (c) who would describe themselves as either disliking or having disliked mathematics. If all of this applies to you, then I am very interested in hearing about your experience.

Participation in this study will involve meeting with me for one interview which will be conducted online and recorded in Zoom. During the interview I will ask you to describe your experiences with mathematics and how these experiences have impacted your identity as a mathematics teacher. The interview will take no more than one hour of your time.

Participation in this study is voluntary and will be completely confidential. A pseudonym will be used instead of your real name, and both your identity and that of your school would be kept confidential at all times. The results of this research project may be shown at meetings or published in journals to inform other professionals. If any papers or talks are given about this

research, your name will not be used. For more detailed information on what participation in this project would entail, you may refer to the Participant Information Sheet attached to this letter.

If you are interested in helping me with this project, I would love to hear from you! You may email your name and preferred contact information (such as email address or phone number) to me at mbixby@une.edu, or you may either call or text your preferred contact information to me at 315-854-4461 if you prefer.

Thank you for your consideration.

Sincerely,

Mindy Bixby
mbixby@une.edu
315-854-4461

**Teacher Recruitment Letter (to be used for social media posts)**

Dear Fellow Educator,

My name is Mindy Bixby, and I live in Canton, New York. I was an elementary teacher for 23 years, and am now a doctoral student at the University of New England. For my dissertation I am conducting a research project with the goal of developing a deeper understanding of the experience of being an elementary mathematics teacher, and I am seeking teachers from St. Lawrence County to collaborate with me on this project.

My goal is to recruit about 10 participants who are currently teaching in any grade K–5 at a public school district located in St. Lawrence County. Specifically, I am seeking elementary teachers (a) who are trained to be generalists; (b) who teach all core academic subjects, including mathematics in a self-contained classroom setting; and (c) who would describe themselves as either disliking or having disliked math. If all of this applies to you, then I am very interested in hearing about your experience.

Participation in this study will involve meeting with me for one interview which will be conducted online and recorded in Zoom. During the interview I will ask you to describe your experiences with mathematics and how these experiences have impacted your identity as a mathematics teacher. The interview will take no more than one hour of your time.

Participation in this study is voluntary and will be completely confidential. A pseudonym will be used instead of your real name, and both your identity and that of your school would be kept confidential at all times. The results of this research project may be shown at meetings or published in journals to inform other professionals. If any papers or talks are given about this research, your name will not be used.

If you are interested in helping me with this project, I would love to hear from you! You may email your name and preferred contact information (such as email address or phone number) to me at mbixby@une.edu, or you may either call or text your preferred contact information to me at 315-854-4461 if you prefer. A Participant Information Sheet providing more detailed information on what participation in this project would entail will be emailed to you at that time.

Thank you for your consideration.

Sincerely,

Mindy Bixby
mbixby@une.edu
315-854-4461

# APPENDIX C

## INTERVIEW PROTOCOL

Thank you for volunteering to participate in this research project. The goal of this project is to develop a deeper understanding of the experiences and perceptions of elementary mathematics teachers. Specifically, this study will explore the experiences and perceptions of elementary mathematics teachers (a) who are trained to be generalists; (b) who teach all core academic subjects including mathematics in a self-contained classroom setting; and (c) who would describe themselves as either disliking or having disliked mathematics.

Your participation in this study will be kept strictly confidential. The information collected from you during this project will be stored on a password-protected laptop computer. This computer, along with any hard copies of the materials, will be stored in a locked desk at my home. I am the only person that will have access to this information. This information will be kept for three years following completion of this study then will be destroyed.

This interview will take no more than one hour of your time. You will be asked to choose a pseudonym of your choice that we will use instead of your real name, and you have the option of turning your camera off during the interview to provide for an additional layer of privacy if you choose. The interview will be recorded in Zoom and then transcribed into written form.

When the transcription process has been completed I will email you the transcript of your interview. You will then have seven days to review it for accuracy and make any changes you would like to make. After seven days, if I have not heard back from you, I will assume that you feel the transcript is accurate and that you do not wish to make any changes. After this has taken place, the recording of your interview will be deleted.

I would also like to remind you that you have the ability to withdraw from this study at any time. If you chose to do so, any information collected from you would be destroyed and would not be used in this study.

I will now go over the Participant Information Sheet for the study with you.

Do you have any questions or concerns?

Do you have a pseudonym you would like to use? _____

Are you ready to proceed with the recorded interview?

It is now time to begin the interview. Please let me know if you would like to have any question explained, repeated, or rephrased. You also have the option to skip any questions that you do not wish to answer.

I will now begin recording this interview.

**Interview Questions:**

1. Tell me about your teaching career. How many years have you been teaching, what grades and subjects have you taught, etc.?
2. What experiences have led you to develop a dislike of math?
3. How would you define reform-based mathematics instruction? (Other terms commonly used by teachers include Common Core math, the "new" math, teaching mathematics conceptually, etc.)
4. Tell me about your experience teaching reform-based math?
5. How have the experiences you have shared with me today impacted your identity as a mathematics teacher? This can include beliefs, emotions, thoughts, and behaviors you have that are related to teaching math.
6. What does this identity mean to you?

7. Do you have any other information to share with me that would help me to understand how your dislike of mathematics has impacted your experience as a mathematics teacher?

# APPENDIX D

## LIVED EXPERIENCES AND PERCEPTIONS OF SELF-CONTAINED ELEMENTARY MATHEMATICS TEACHERS WHO DISLIKE MATHEMATICS: PERSONAL EXPERIENTIAL THEMES (PETs)

| Personal Experiential Themes | Experiential Statements |
|---|---|
| **Annie** | |
| PET 1: Dislike of mathematics stems from teaching practices used in elementary school. | • 5th grade was the turning point when she decided that she hated math.<br>• Credits dislike of mathematics to teaching practices used in 5th grade such as Mad Minutes, mathematics fact kickball, and being forced to do problems on the board in front of everyone. |
| PET 2: Experiences with mathematics had a negative impact on her identity during childhood. | • Mathematics caused her to feel anxiety and embarrassment.<br>• Mathematics caused her to feel stupid and dumb.<br>• Felt like she was not as good at mathematics as her peers because they were faster.<br>• Felt like her brain didn't understand math. |
| PET 3: Associates reform-based mathematics with teaching multiple strategies and teaching for understanding. | • Associates reform-based mathematics with teaching more of the conceptual ideas behind math.<br>• Associates reform-based mathematics with teaching multiple strategies and then allowing students to choose which way works best for them. |
| PET 4: She has embraced reform-based mathematics teaching | • Easier to understand for both her and for her students.<br>• More fun both for her and for her students<br>• Teaching mathematics this way has changed her mind set about math. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 5: Reform-based mathematics teaching has had a positive impact on her mathematics teacher identity. | • Feels enthusiastic and excited about teaching mathematics now.<br>• Feels hopeful that her students will love mathematics because of the way she is teaching it.<br>• Views the evolution in her mathematics teacher identity as a huge personal change. |
| PET 6: Has used negative experiences with mathematics in childhood as motivation to overcome her dislike of mathematics and her fear of teaching it. | • Feels grateful that she had these experiences because they have helped her to grow as an educator.<br>• They have taught her what not to do.<br>• They have made her think about what she can do so it doesn't happen to someone else. |
| PET 7: Has used empathy for her students as motivation to overcome her dislike of mathematics and her fear of teaching it. | • Wants to teach mathematics differently than the way she was taught.<br>• Is working to make mathematics more hands-on and more fun.<br>• Wants her students to love math. |
| **Beth** | |
| PET 1: Dislike of mathematics began in elementary school and stems from the "one-way-fits-all" approach to teaching it. | • Mathematics was only taught one way, and either you got it or you didn't.<br>• There wasn't a why, just the how.<br>• We didn't have conversations about math.<br>• Mathematics was boring. |
| PET 2: Associates reform-based mathematics with teaching multiple strategies. | • Common core gives you different strategies.<br>• There is more than one way to learn math, and it is about what works best for each person.<br>• Has opened her mind to a new way of thinking about math. |
| PET 3: Teaching reform-based mathematics was very difficult at first. | • Had to teach herself the mathematics before she could teach it.<br>• Took extra planning time.<br>• Had to take it home each night.<br>• It was difficult to understand.<br>• Was not confident teaching it. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 4: Has embraced reform-based mathematics teaching. | • Group work (instead of sitting in seat working by yourself).<br>• Manipulatives.<br>• Number talks to build number sense (instead of memorization).<br>• Teaching different strategies (instead of one-way-fits-all).<br>• Hands-on games (instead of worksheets). |
| PET 5: Since implementing reform-based mathematics teaching, her mathematics teacher identity has undergone a positive change. | • Believes she is becoming a stronger mathematics teacher each year.<br>• Has fun teaching math.<br>• Is excited to teach math.<br>• Enjoys teaching math. |
| PET 6: Expanding her knowledge about mathematics and how to teach it has helped her to overcome her dislike of mathematics and become more comfortable teaching it. | • Attending workshops.<br>• Doing book studies.<br>• Learning about current research in the field. |
| **Carly** | |
| PET 1: Was a strong mathematics student but lost interest in it and didn't see the point. | • Was strong in mathematics but lost interest in it.<br>• Was strong in mathematics from elementary school until early high school.<br>• Lost interest with mathematics in high school.<br>• Had a teacher she didn't jive with.<br>• Felt embarrassed when called out in front of peers for doing a problem wrong.<br>• Did not take calculus in high school.<br>• Took calculus in college but was not interested in it and didn't see the point. |
| PET 2: Has not embraced the philosophy of reform-based mathematics teaching. | • It is not necessary – Why fix something if it isn't broken?<br>• It does not make sense – Why are we changing things to confuse things even more?<br>• Parents can't help their kids because they weren't taught mathematics this way. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 3: Teaching reform-based mathematics was not a good experience. | • Felt unprepared to teach it.<br>• Felt overwhelmed.<br>• Did not feel confident enough in her ability to do the math, which led her to dislike teaching it.<br>• Felt embarrassed when she would do a problem wrong in front of her students.<br>• Felt anxiety because was not sure she was teaching the mathematics correctly. |
| PET 4: Has not embraced reform-based mathematics teaching, and her mathematics teacher identity has remained negative. | • Describes mathematics teacher identity as "fake it to make it."<br>• Eventually her team agreed to keep teaching mathematics "the regular way."<br>• When they departmentalized this year, she chose to stop teaching math. |
| PET 5: Believes that departmentalizing or using mathematics specialists to teach mathematics at every grade level would be beneficial for students. | • Teaching mathematics is not for everybody.<br>• Not every elementary teacher should be teaching math.<br>• If students have a teacher that doesn't like math, they won't like it either.<br>• Connections with teachers are very important.<br>• Each grade level should have a specialized mathematics teacher that is fully focused on it.<br>• Is better for students to have a mathematics teacher who likes teaching mathematics and is good at it.<br>• Is very thankful that they decided to departmentalize this year, so she no longer has to teach math. |
| **Donna** | |
| PET 1: Dislike of mathematics stems from teaching practices used in elementary school. | • 4th grade was the turning point when she decided that she hated math.<br>• Credits dislike of mathematics to teaching practices used in 4th grade such as mathematics facts Around the World, sprints, and being forced to memorize multiplication facts. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 2: Experiences with mathematics had a negative impact on her identity during childhood. | • Felt like she was not as good at mathematics as her peers because they were faster.<br>• Felt like her brain didn't understand math.<br>• Mathematics caused her to feel embarrassed.<br>• Mathematics caused her to feel stressed out.<br>• Struggled with required mathematics classes in both high school and college. |
| PET 3: Teaching reform-based mathematics has been a difficult experience. | • Has to try to teach herself the mathematics before she can teach it to students.<br>• She doesn't understand it and believes that the students don't understand it.<br>• She is frustrated and believes that the students are frustrated. |
| PET 4: She has not embraced reform-based mathematics teaching. | • Feels reform-based mathematics is confusing and hard to understand.<br>• Feels teaching multiple strategies is confusing and overwhelming for both her and her students.<br>• Is reverting back to teaching mathematics in traditional ways. |
| PET 5: Her mathematics teacher identity has remained negative. | • Does not see herself as a mathematics person.<br>• Does not look forward to teaching math.<br>• Does not feel confident teaching reform-based math.<br>• Does not want to be observed teaching math. |
| **Elle** | |
| PET 1: Dislike of mathematics stems from teaching practices used in elementary school. | • 4th grade was the turning point when she decided that she hated math.<br>• Credits dislike of mathematics to teaching practices used in 4th grade such as mathematics facts Around the World and being forced to do problems on the board in front of the class. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 2: Experiences with mathematics had a negative impact on her identity during childhood. | • Felt like she was not as good at mathematics as her peers because they were faster.<br>• Mathematics caused her to feel stupid, dumb, not smart embarrassed.<br>• Mathematics caused her to feel anxiety and panic.<br>• Mathematics was not comfortable and not safe.<br>• Chose to avoid higher level mathematics classes in high school. |
| PET 2: Experiences with mathematics during childhood still have a negative impact on her identity as an adult. | • Just mention of the word "math" triggers a strong emotional reaction.<br>• Feels her brain acts in ways to protect her from math. |
| PET 3: At first, teaching reform-based mathematics was a difficult experience. | • It is scary and intimidating.<br>• Did not feel confident teaching it.<br>• Felt embarrassed by making mistakes in front of class.<br>• Asked to departmentalize during pandemic so didn't have to teach mathematics in front of parents. |
| PET 4: She has embraced reform-based mathematics teaching. | • Associates reform-based mathematics teaching with getting students to think critically.<br>• Is using reform-based teaching practices such as number talks, fluency strategies, and fluency games.<br>• Hopes that every teacher will try this new way of doing math. |
| PET 5: Since implementing reform-based mathematics teaching, her mathematics teacher identity has become more positive. | • Feels less intimidated and more confident.<br>• Gets excited about teaching math.<br>• Has fun teaching math.<br>• Is embracing her philosophy about teaching while teaching mathematics now for the first time.<br>• Feels she is playing to her strengths as a teacher while teaching math.<br>• She had been departmentalized but chose to take back math. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 6: Empathy for students has helped her to overcome her dislike of mathematics and fear of teaching it. | • Uses negative experiences with mathematics as motivation to give her students a positive experience with math.<br>• Negative experiences have taught her what not to do.<br>• Is working to create a safe and supportive environment for her students to learn math.<br>• Wants her students to feel confident, comfortable, and happy while learning math.<br>• Wants to be the change for her students and for other teachers |
| PET 7: Support of colleagues who love mathematics and enjoy teaching it have helped her to become more comfortable teaching reform-based math. | • Mathematics coach who loves mathematics and is excited about teaching it.<br>• Mathematics interventionist that pushes in during mathematics class and is good at mathematics – is like a safety net. |
| PET 8: Although her mathematics teacher identity has become more positive, she still is not completely comfortable teaching reform-based math. | • Feels she is a good teacher in all other areas but never outgrew it with math.<br>• Students ask questions and she doesn't know the answers.<br>• Would not feel comfortable without support of mathematics interventionist who pushes in during mathematics class.<br>• Fear of teaching mathematics gets stronger as the grade levels get higher.<br>• Doesn't believe she can teach past second grade math.<br>• Wants to protect her students from math. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| **Imelda** | |
| PET 1: Dislike of mathematics began in elementary school and stems from the stereotype that only some people are smart enough to be good at math. | • Message she heard from both teachers and parents – You're either good at mathematics or you're not good at mathematics and there is nothing in between.<br>• Believes mathematics instruction was weaponized – Designed to sort out the kids who were smart enough to do well in mathematics from those that were not.<br>• Felt teaching strategies used only benefited the top tier kids.<br>• Felt teachers weren't comfortable with the mathematics themselves and were not trained well enough to help students who were not comfortable with math. |
| PET .2: Experiences with mathematics had a negative impact on her identity during childhood. | • Mathematics has an "emotional hit" for her.<br>• As soon as she could stop taking mathematics in high school, she stopped taking math. |
| PET 3: Teaching reform-based mathematics was very difficult at first. | • Teachers didn't have the prior knowledge needed.<br>• Students didn't have the prior knowledge needed.<br>• Parents were frustrated and resistant. |
| PET 4: Has embraced reform-based mathematics teaching | • Associates reform-based mathematics teaching with teaching multiple strategies and explaining the "why" of mathematics not just the "how."<br>• Believes she never understood the "why" of mathematics until she implemented reform-based mathematics teaching.<br>• Wishes she had been taught mathematics this way. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 5: Since implementing reform-based mathematics teaching, her mathematics teacher identity has undergone a positive change. | • Credits reform-based mathematics teaching with changing her relationship with math.<br>• Loves teaching mathematics now.<br>• Looks forward to teaching mathematics with excitement and pleasure.<br>• Thinks mathematics is cool.<br>• Enjoys teaching multiple strategies and talking about the elegance of math. |
| PET 6: Expanding her knowledge about mathematics and how to teach it has helped her to overcome her dislike of mathematics and become more comfortable teaching it. | • Stresses the importance of being a continuous learner.<br>• Took initiative to undertake professional development about mathematics teaching.<br>• Reads books and other professional literature to stay abreast of current research in the field.<br>• Believes the more she learned about mathematics and how to teach it, the more excited she got about teaching it. |
| PET 7: She is working to "eliminate the emotional response to math" in her students. | • Practices mindfulness with students before mathematics class.<br>• Does not allow students to use the word "easy" in mathematics class.<br>• Emphasizes bravery in mathematics class – Be brave and give it a try then I will help you.<br>• Wants students to be aware of their feelings about math. |
| **Jane** | |
| PET 1: Dislike of mathematics stems from teaching practices used in elementary school. | • Dislike began in 4th grade.<br>• Credits dislike to teaching practices such as mathematics facts Around the World and being forced to memorize multiplication facts.<br>• Credits dislike to the stereotype that girls are not as good at mathematics as boys. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 2: Experiences with mathematics had a negative impact on her identity during childhood. | • Felt like she was not as good at mathematics as her peers because they were faster.<br>• Did not see herself as a mathematics person.<br>• Did not want to take mathematics classes in college. |
| PET 3: Agrees with the philosophy of reform-based mathematics teaching. | • Associates reform-based mathematics teaching with emphasizing learning strategies rather than memorization, teaching multiple strategies for figuring things out, and building number sense.<br>• Believes reform-based mathematics teaching is beneficial for students. |
| PET 4: Has not fully embraced reform-based mathematics teaching. | • It is more difficult than she expected it to be.<br>• Is a big learning curve.<br>• Takes more prep time, which is difficult when also prepping to teach every other subject.<br>• Having students use manipulative and play games can be chaotic.<br>• It is difficult to move away from your routine. |
| PET 5: Her mathematics teacher identity has remained negative. | • Is not enthusiastic about teaching reform-based math.<br>• Teaching reform-based mathematics is out of her comfort zone.<br>• Tends to keep it simple and revert back to what is easiest.<br>• Has to “put on my game face” when teaching math. |
| PET 6: Support of colleagues has helped her to become more comfortable teaching reform-based math. | • Administration that understands and is supportive of reform-based mathematics teaching.<br>• Mathematics coaches who love math, are enthusiastic about teaching it, and understand what it is like to be an elementary teacher. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 7: Believes that departmentalizing or using mathematics specialists to teach mathematics at every grade level would be beneficial for students. | • Believes the reality is that there is no way an elementary teacher can master everything.<br>• Teaching mathematics is overwhelming and frustrating for some elementary teachers.<br>• Wants all students to have a mathematics teacher who has absolute joy and enthusiasm about teaching math. |
| **Janice** | |
| PET 1: Dislike of mathematics began in elementary school and stems from the approaches used to teach it. | • Dislike stems from emphasis on getting the correct answer – You're either right or wrong and there's nothing in between.<br>• Dislike stems from being made to memorize mathematics and use formulas without being taught to understand it. |
| PET 2: Experiences with mathematics had a negative impact on her identity during childhood. | • By 5th grade she hated math.<br>• She avoided going to mathematics class.<br>• Did what she needed to do to get by for the rest of her school career.<br>• Thought I'm never going to need this I'm never going to use this. |
| PET 3: She has embraced the philosophy of reform-based mathematics teaching. | • Associates reform-based mathematics teaching with building a conceptual understanding of mathematics instead of emphasizing memorization.<br>• Wishes she had been taught mathematics this way. |
| PET 3: Teaching reform-based mathematics has been a difficult experience. | • She was not taught mathematics this way as a student.<br>• Feels she was not prepared to teach reform-based mathematics in college.<br>• Had to spend hours trying to teach herself the mathematics each night before she could teach it to students.<br>• Was overwhelming on top of having to plan to teach every other subject. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| PET 5: Her mathematics teacher identity has remained negative. | • Lacks confidence teaching mathematics and thinks she always will.<br>• Feels insecure.<br>• Feels embarrassed when she makes mistakes in front of students.<br>• Looks forward to days she doesn't have to teach math.<br>• Does not want to be observed teaching math. |
| PET 6: Support of colleagues has helped her to become more comfortable teaching reform-based math | • Took the initiative to ask administration for help.<br>• Now has a retired mathematics teacher coming in for her mathematics class twice each week. |
| PET 7: Is working to create an environment that is supportive for students. | • Wants students to believe it is okay to make mistakes, okay to get a problem wrong, okay to be vulnerable.<br>• Shares her feelings about mathematics with her students. |
| **Lucy** | |
| PET 1: Dislike of mathematics developed during her time as a mathematics student. | • Dislike of mathematics was influenced by parents.<br>• Dislike of mathematics stems from the way she perceived her ability in mathematics as compared to her peers.<br>• Dislike of mathematics stems from the way she thought that other people perceived her ability. |
| PET 2: Experiences with mathematics had a negative impact on her identity during childhood. | • Mathematics caused her to feel embarrassment.<br>• Felt like she was not as good at mathematics as her peers because they were faster.<br>• Felt like her brain didn't understand math. |
| PET 3: Teaching reform-based mathematics has been a difficult experience | • Did not feel adequately prepared to teach it/supported while teaching it.<br>• Had to spend hours trying to learn how to do mathematics this way before I can teach it. |

| Personal Experiential Themes | Experiential Statements |
|---|---|
| | • Having to teach all other subjects on top reform-based mathematics makes it even more difficult.<br>• She almost quit teaching because of having to teach reform-based math. |
| PET 4: She has not embraced the philosophy behind reform-based mathematics teaching. | • Feels reform-based mathematics is confusing and hard to understand.<br>• Feels teaching multiple strategies is confusing and overwhelming for both her and her students.<br>• Feels it would be easier to teach mathematics the way she learned. |
| PET 5: Reform-based mathematics teaching has had a negative impact on her mathematics teacher identity. | • Feels like she doesn't have the self-confidence or the self-esteem to teach reform-based math.<br>• Feels overwhelmed.<br>• Feels frustrated.<br>• Feels like she doesn't know what she is doing.<br>• Feels nervous.<br>• Feels unsuccessful.<br>• There are many parallels between how she feels as a mathematics teacher and how she felt as a mathematics student. |
| PET 6: She is trying to develop a positive mindset about math. | • Is open to learning.<br>• Is trying to change her mind set about math.<br>• Wants to figure out how to make positive experience for both her and her students.<br>• Feels hopeful that things will be better in the future. |
| PET 7: Departmentalization has helped her to overcome her dislike of mathematics and become more comfortable teaching it. | • Has more time to focus on mathematics content.<br>• Has made teaching reform-based mathematics much easier. |

# APPENDIX E

## LIVED EXPERIENCES AND PERCEPTIONS OF SELF-CONTAINED ELEMENTARY MATHEMATICS TEACHERS WHO DISLIKE MATHEMATICS: GROUP EXPERIENTIAL THEMES (GETs)

| Group Experiential Themes (GETs) | SubThemes |
|---|---|
| GET 1: Dislike of mathematics began as a student in elementary school. | • Teaching practices used.<br>• Philosophy of how mathematics should be taught.<br>• Limiting stereotypes and ability beliefs. |
| GET 2: Dislike of mathematics negatively impacted their relationship with mathematics throughout their time as mathematics students. | |
| GET 3: The transition to reform-based mathematics teaching is very difficult. | |
| GET 4: The transition to reform-based mathematics teaching has a negative impact on mathematics teacher identity. | |
| GET 5: Some teachers are avoiding reform-based mathematics teaching. | • Have not embraced the philosophy.<br>• Have not continued to implement.<br>• Perception of their mathematics teacher identity remains negative. |
| GET 6: Some teachers are surviving reform-based mathematics teaching. | • Have not embraced the philosophy.<br>• Have continued to implement because they are required to.<br>• Perception of their mathematics teacher identity remains negative. |
| GET 7: Some teachers are coping with reform-based mathematics teaching. | • Have embraced the philosophy.<br>• Have continued to implement.<br>• Perception of their mathematics teacher identity remains negative. |
| GET 8: Some teachers are emerging with reform-based mathematics teaching. | • Have embraced the philosophy.<br>• Have continued to implement.<br>• Perception of mathematics teacher identity is evolving. |

| | |
|---|---|
| GET 9: Some teachers are thriving with reform-based mathematics teaching. | • Have embraced the philosophy.<br>• Have continued to implement.<br>• Perception of their mathematics teacher identity has changed and is now positive. |

# APPENDIX F

## LIVED EXPERIENCES AND PERCEPTIONS OF SELF-CONTAINED ELEMENTARY MATHEMATICS TEACHERS WHO DISLIKE MATHEMATICS IN THE CONTEXT OF MATHEMATICS EDUCATION REFORM

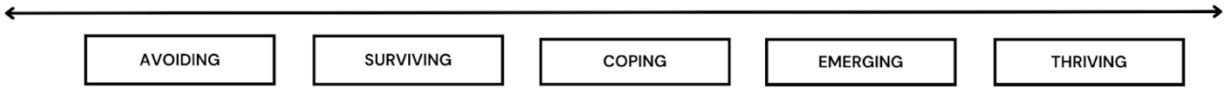

**Continuum of Math Teacher Identity in the Context of Reform-Based Math Teaching**

# APPENDIX G

# LIVED EXPERIENCES AND PERCEPTIONS OF SELF-CONTAINED ELEMENTARY MATHEMATICS TEACHERS WHO DISLIKE MATHEMATICS: PROCESS AND IDENTITY MAPS FOR EACH OF THE FIVE INDIVIDUAL PATTERNS ALONG THE CONTINUUM OF REFORM-BASED MATHEMATICS TEACHING

**Figure 1**

*Continuum of How Self-Contained Elementary Teachers Who Dislike Mathematics Have Experienced Reform-Based Mathematics Teaching*

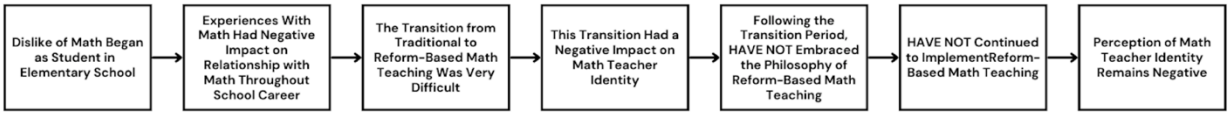



## Pattern 1: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Avoiding Reform-Based Mathematics Teaching

The pattern of avoiding reform-based mathematics teaching is shown in Figure 2.

**Figure 2**

*Pattern of Avoiding Reform-Based Mathematics Teaching*

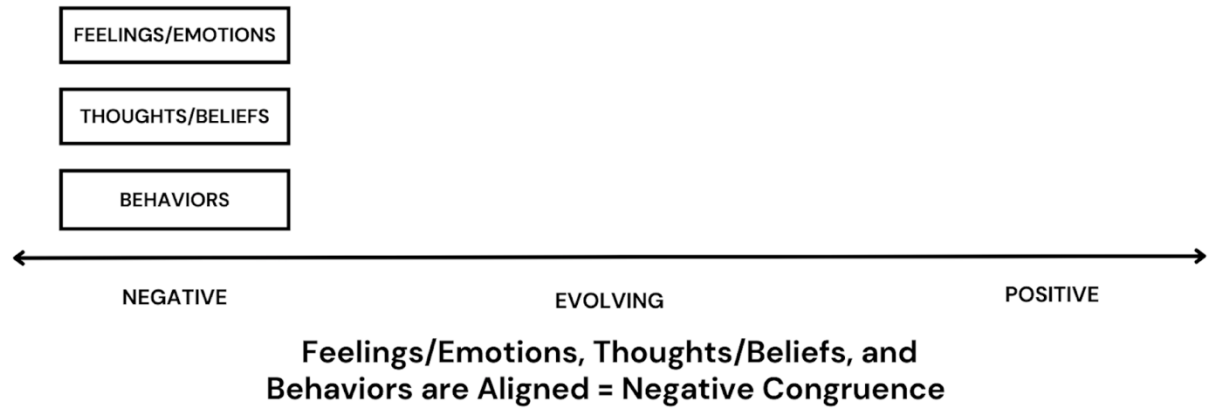



After making it through the difficult transition period, two of the participants of this study are now in a pattern of avoiding reform-based mathematics teaching. Teachers in this pattern have not embraced the philosophy of reform-based mathematics teaching, and they are moving away from reform-based mathematics teaching and reverting back to teaching mathematics in more traditional ways. For teachers in this pattern, their perception of their mathematics teacher identity remains negative. Even though they are in alignment, their feelings/emotions, their thoughts/beliefs, and their behaviors regarding reform-based mathematics teaching are all

negative. As a result, these teachers have a perception of their mathematics teacher identity that is in negative congruence. A visual representation of the unique mathematics teacher identity of participants who are in a pattern of avoiding reform-based mathematics teaching is shown in Figure 3.

**Figure 3**

*Mathematics Teacher Identity of Participants Who Are in a Pattern of Avoiding Reform-Based Mathematics Teaching*

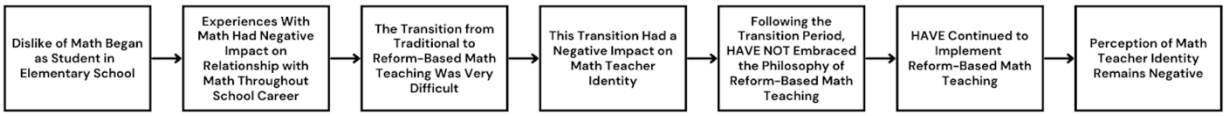



**Pattern 2: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Surviving Reform-Based Mathematics Teaching**

The pattern of surviving reform-based mathematics teaching is shown in Figure 4 below.

**Figure 4**

*Pattern of Surviving Reform-Based Mathematics Teaching*

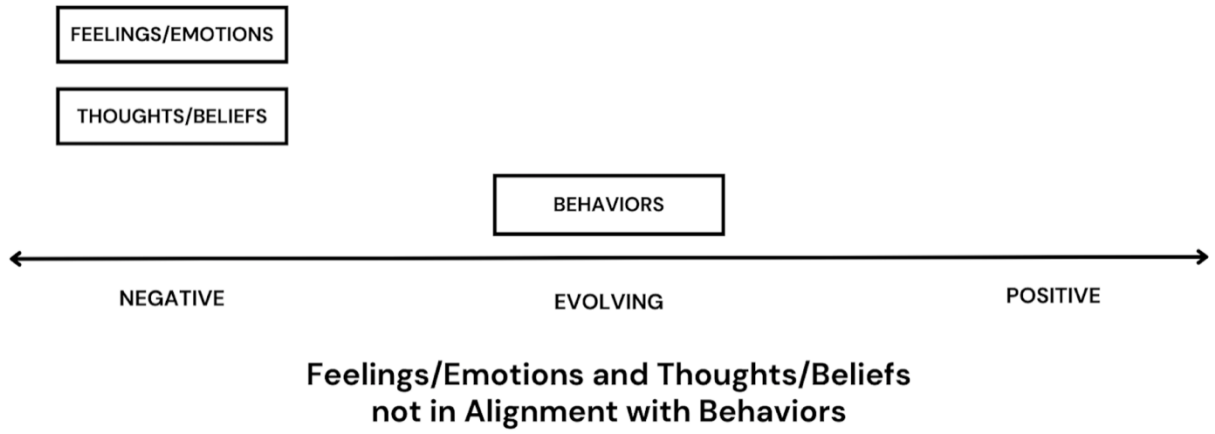



After making it through the very difficult transition period, one of the participants of this study is now in a pattern of surviving reform-based mathematics teaching. Teachers in this pattern have not embraced the philosophy of reform-based mathematics teaching. Although they are not

implementing it with full fidelity, they are continuing to implement at least some aspects of reform-based mathematics teaching because they are required to. For teachers in this pattern, their perception of their mathematics teacher identity remains negative. Their feelings/emotions and their thoughts/beliefs about reform-based mathematics teaching, which are negative, are not aligned with their behaviors, which are evolving but not yet positive. A visual representation of the unique mathematics teacher identity of participants who are in a pattern of surviving reform-based mathematics teaching is shown in Figure 5.

**Figure 5**

*Mathematics Teacher Identity of Participants Who Are in a Pattern of Surviving Reform-Based Mathematics Teaching*

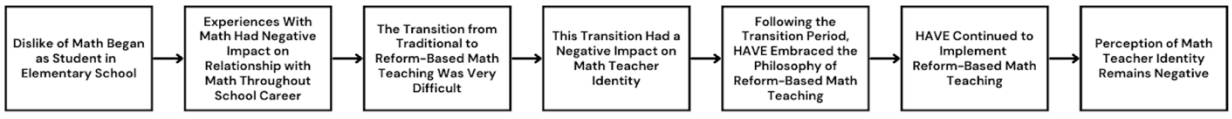



**Pattern 3: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Coping With Reform-Based Mathematics Teaching**

The pattern of coping with reform-based mathematics teaching is shown in Figure 6 below.

**Figure 6**

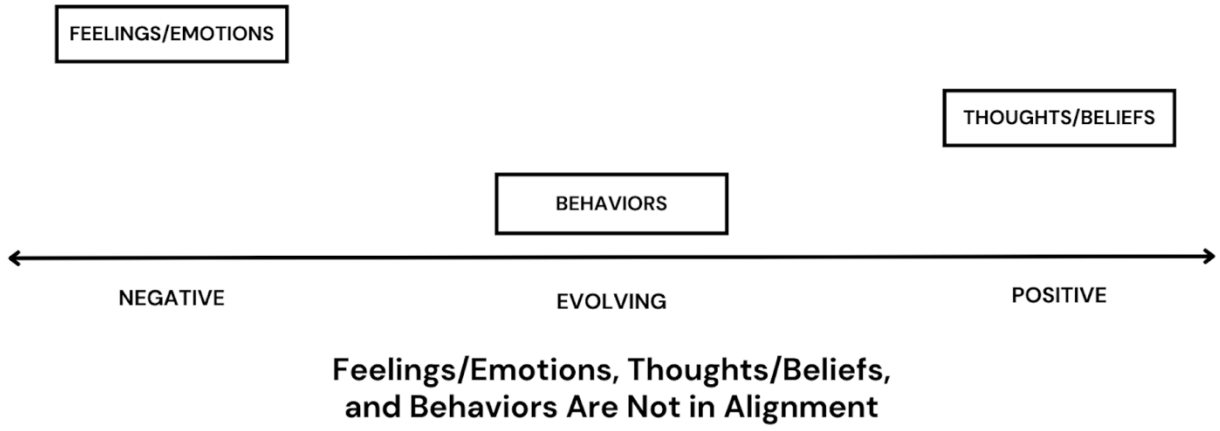
*Pattern of Coping With Reform-Based Mathematics Teaching*



After making it through the very difficult transition period, two of the participants of this study are now in a pattern of coping with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching. Although they are not implementing it to the greatest extent possible, they are continuing to implement many aspects of reform-based mathematics teaching. For teachers in this pattern, however, their perception of their mathematics teacher identity remains negative. Although their thoughts/beliefs regarding reform-based mathematics teaching are positive, they are not aligned with behaviors, which are evolving but not yet positive, and their feelings/emotions, which remain negative. A visual representation of the unique mathematics teacher identity of participants who are in a pattern of coping with reform-based mathematics teaching is shown in Figure 7.

**Figure 7**

*Mathematics Teacher Identity of Participants Who Are in a Pattern of Coping With Reform-Based Mathematics Teaching*

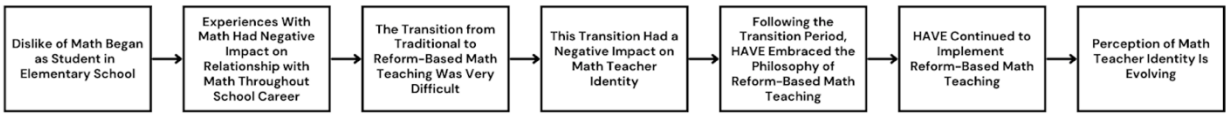



**Pattern 4: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Emerging With Reform-Based Mathematics Teaching**

The pattern of emerging with reform-based mathematics teaching is shown in Figure 8 below.

**Figure 8**

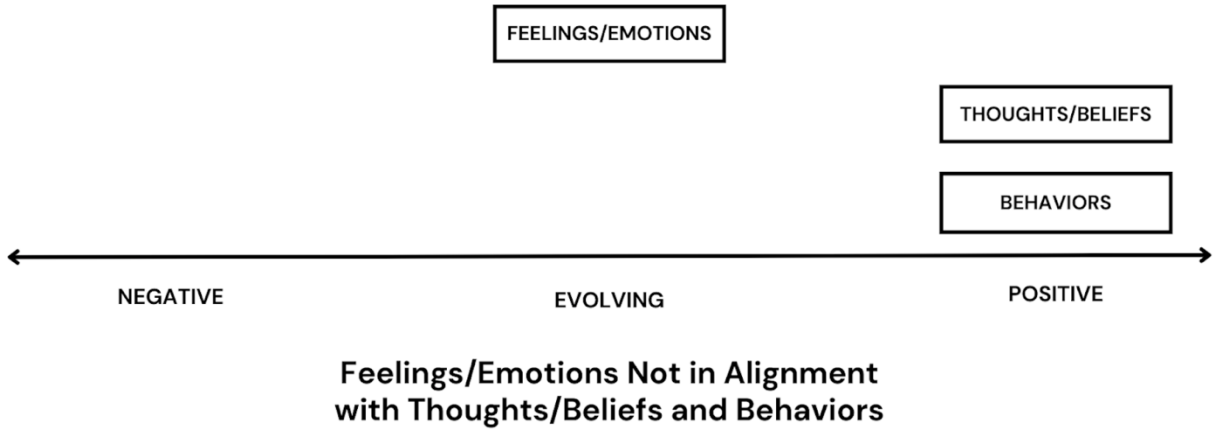
*Pattern of Emerging With Reform-Based Mathematics Teaching*




After making it through the very difficult transition period, one of the participants of this study is now in a pattern of emerging with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching and are implementing it with fidelity. For teachers in this pattern, however, their perception of their mathematics teacher identity, though evolving, is not yet positive. Although their thoughts/beliefs and their behaviors regarding reform-based mathematics teaching are positive, they are not in alignment with their feelings/emotions which are evolving but not yet positive. A visual representation of the unique mathematics teacher identity of participants who are in a pattern of emerging with reform-based mathematics teaching is shown in Figure 9.

**Figure 9**

*Mathematics Teacher Identity of Participants Who Are in a Pattern of Emerging With Reform-Based Mathematics Teaching*

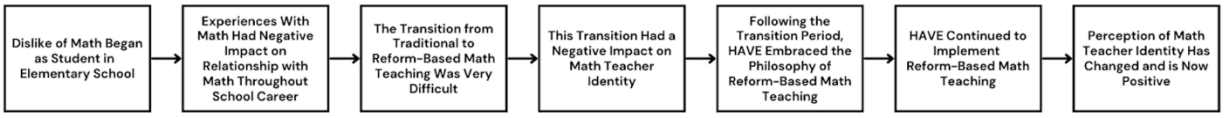


**Pattern 5: Some Self-Contained Elementary Teachers Who Dislike Mathematics Are Thriving With Reform-Based Mathematics Teaching**

The pattern of thriving with reform-based mathematics teaching is shown in Figure 10 below.

**Figure 10**

*Pattern of Thriving With Reform-Based Mathematics Teaching*




After making it through the very difficult transition period, three of the participants of this study are now in a pattern of thriving with reform-based mathematics teaching. Teachers in this pattern have embraced the philosophy of reform-based mathematics teaching, and are continuing to implement it with fidelity. For teachers in this pattern, their perception of their mathematics teacher identity has undergone a transformation and is now positive. Their feelings/emotions, their thoughts/beliefs, and their behaviors regarding reform-based mathematics teaching are in alignment. These teachers have a mathematics teacher identity that is in positive congruence. A visual representation of the unique mathematics teacher identity of participants who are in a pattern of thriving with reform-based mathematics teaching is shown in Figure 11.

**Figure 11**

*Mathematics Teacher Identity of Participants Who Are in a Pattern of Thriving With Reform-Based Mathematics Teaching*