5-2024

Exploring the mathematics identities of urban teacher residents using a trauma-informed framework.

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EXPLORING THE MATHEMATICS IDENTITIES OF URBAN TEACHER RESIDENTS USING A TRAUMA-INFORMED FRAMEWORK

By

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B.S., Georgetown College, 2014
M.Ed., University of Louisville, 2017

A Dissertation
Submitted to the Faculty of the
College of Education and Human Development of the University of Louisville
In Partial Fulfillment of the Requirements
for the Degree of

Doctor of Philosophy
In Curriculum and Instruction

Department of Elementary, Middle, and Secondary Teacher Education
University of Louisville
Louisville, Kentucky

May 2024

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A Dissertation Approved on

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ACKNOWLEDGEMENTS

I have many individuals to thank for supporting me on this educational endeavor. First, thank you to my family, without whom this work would not have been possible. Thank you to my husband for being my biggest supporter throughout my educational journey and all of my career aspirations. Thank you for believing in me and providing the right words of encouragement at just the right times. To my big kiddos, thank you for being a source of laughter, and my late-night work partners. To my little kiddos, thank you for your constant joy and helping me keep work in perspective. Thank you, also, to the best support team, my parents. Thank you to my parents for inspiring me to be the person I am today and to pursue my educational aspirations. Finally, I would like to thank my committee for their support, and guidance throughout this process. Dr. Jennifer Bay-Williams and Dr. Kate Marin, thank you for your thoughtful reflections and feedback through each step of my dissertation. Your input was invaluable. Your willingness to support this work and provide constructive criticism made this possible and encouraged me throughout this process. Thank you for being genuine sources of inspiration and encouragement throughout this work and my career. Dr. Stefanie Wooten-Burnett, thank you for always believing in me and giving me the title of Dr. Morris before I began this journey. To my first professor in graduate school, Dr. Maggie McGatha, thank you for providing a wonderful example of who I want to be as an instructor and mentor, and for numerous coaching conversations that helped guide me here.

ABSTRACT

EXPLORING THE MATHEMATICS IDENTITIES OF URBAN TEACHER RESIDENTS USING A TRAUMA-INFORMED FRAMEWORK

Samantha D. Morris

February 19th, 2024

Urban Teacher Residency (UTR) models prepare teachers to specialize in urban education. All teacher candidates, including those in UTR programs, have experiences and emotions that shape their mathematics identities. These identities can impact both the residents' mathematics instruction and the experiences of their students. This study examines how residents' mathematics identities developed as they participated in a Mathematics for Elementary Teachers (MET) course. To support this development, trauma-informed care (TIC) practices were embedded within the course. Such practices were designed to help residents process and heal from any potential mathematics trauma as they prepared to be teachers. This dissertation study uses a multiple-case study design to explore how residents with and without mathematics trauma connected these TIC practices to the development of their mathematics identity. Ultimately, this study found that TIC is an effective framework to promote the development of mathematics identities for residents with and without mathematics trauma.

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INTRODUCTION

Urban Teacher Residency (UTR) models are providing opportunities to expand and diversify the teacher workforce. All teacher candidates, including those in UTR programs, have mathematics identities that shape the way in which they engage with mathematics. Additionally, their identities and related emotions impact the experiences of their students. This study examines the development of residents' mathematics identities who are pursuing teacher certification in elementary education. Specifically, this study examines how these residents' mathematics identities develop as they participate in a Mathematics for Elementary Teachers (MET) course. To support this development, trauma-informed care (TIC) practices were embedded within the course. Such practices were designed to help residents process and heal from any potential mathematics trauma they might experience. This chapter provides context by describing UTR programs and the MET course. Additionally, this chapter discusses mathematics identity and trauma-informed care within the context of the study.

Urban Teacher Residency

The creation of Urban Teacher Residency (UTR) was catalyzed by many issues in education including teacher shortages, the need for more highly qualified teachers in urban schools, and the need for more diverse teachers (Guha et al., 2016). UTR's,

therefore, were designed to eliminate barriers and inequities in the teacher certification process for teachers who identify as Black, Indigenous, and People of Color (BIPOC) (Guha et al., 2016) and to equip these teachers with the unique set of skills, abilities, and dispositions needed in an urban school setting (Milner, 2012).

While there are many models of Teacher Residencies across the United States, the Urban Teacher Residency (UTR) model examined for this study involves a year-long program open to prospective teachers who hold a bachelor's degree in an area other than education. The program is a partnership between an urban school district and an urban university. Residents are placed in a partnership school classroom alongside a mentor teacher during normal school hours Monday through Thursday. They complete coursework within the Teacher Education Program at an urban university in the summer while the school district is not in session, as well as evenings and Fridays once the school district begins the year.

School District Experiences

At the beginning of the school year, residents observe their assigned mentor teacher and become acclimated with the classroom and school. As the semester progresses, the residents gradually take over teaching responsibilities. They begin by taking the lead on class transitions and progress to lead teaching half the school day. Residents continually collaborate and learn from their mentor teacher throughout the year. The beginning of the second semester is the start of the residents' student teaching experience. This semester allows residents more independence within the classroom. Residents continue collaborating with their mentor teacher and take the lead in lesson

planning but also teach most, or all of the day. It is in this semester that residents begin honing their own pedagogical practices more independently of the mentor teacher.

University Coursework

In the initial summer, residents take classes focused on foundational teaching skills and practice. These include classroom management, lesson planning, and culturally responsive pedagogy. Throughout the remainder of their program, they take content methods courses as well as instructional support courses aimed at helping them with lesson planning, best practices for instruction, and classroom management.

Mathematics for Elementary Teachers Course

Residents must also take courses that are state-required pre-requisites for education programs if they have not already completed them in their previous degrees. These pre-requisites vary based on the residents' undergraduate coursework and desired grade level and content area of certification. One of these pre-requisites for residents who are seeking their teacher certification for the elementary grades (K-5) is the Mathematics for Elementary Teachers course. As this is not a course required by other degrees outside of education, many residents have not taken the course previously, and thus must take it as pursue their master's degree via the UTR program. Most elementary residents take this course in the initial summer.

All residents have taken mathematics courses throughout their K-12 experiences, and many have had mathematics classes as undergraduates. Additionally, those who have a previous career have had experiences with mathematics in those careers. Having taught and mentored residents for the past three years, I have participated in countless conversations about their mathematics experiences leading up to this course. K-12 and

undergraduate experiences often entail stories of studying procedures and algorithms. Stories of residents' previous careers often reveal either the perception that they did not use mathematics, or that the mathematics used were an echo of the procedural focus of their undergraduate training. For example, a librarian coming into the program may have taken college algebra ten years ago and perceive that they did not use it in their professional work post-graduation. On the other hand, an individual with an accounting degree may identify their use of mathematics in their career using technology to compute expenses. Both examples might impact how the individual views mathematics.

This Mathematics for Elementary Teachers course is most residents' first experience with mathematics as a teacher. It is designed, therefore, to help residents understand the conceptual underpinnings of the mathematics they will be teaching. The course examines mathematics relevant to an elementary teacher and asks them to examine the "why" behind the "how" of the math. The overarching goal of the course is to grow in this conceptual understanding, developing their mathematical knowledge for teaching (MKT) (Ball et al., 2008), to ultimately prepare residents to be strong teachers of mathematics. A critical objective of this course is that they begin developing a positive relationship with mathematics.

I have been a part of the Urban Teacher Residency since its' inception. I teach this mathematics course, supervise many of the elementary education residents, and teach their math and science methods courses in the spring semester. Because we have a relationship throughout the program, it is critical for me to build a positive relationship with them through this initial course.

Mathematics Identity

Mathematics identity can be defined as how a person sees themselves as a learner and doer of mathematics. This includes a person's disposition and beliefs about their ability to participate and perform in mathematical contexts (Aguirre et al., 2013). People with positive mathematics identities are confident problem solvers, commit to solving challenging mathematics tasks, and understand that making mistakes is part of the natural process of doing mathematics (National Council of Teachers of Mathematics (NCTM), 2020a). People with negative mathematics identities, on the other hand, may resist difficult mathematics tasks, be uncomfortable tackling mathematics problems or tasks, and struggle with resilience in mathematics contexts. Martin (2006) describes a "flow" that can often happen between these two dichotomies, suggesting that mathematics identity may be a continuum rather than a distinct and strong positive or negative identity (p. 206).

Mathematics identity is a relatively new construct in the mathematics education literature and has become more prominent in the past two decades. While the overarching construct of identity has historically come from psychological perspectives, the concept of mathematics identity has shifted to a focus on the social experiences rather than solely mentally internal experiences of mathematics overtime (Graven & Heyd-Metzuyanim, 2019). Lived experiences in a mathematics context are, therefore, one of the main factors contributing to a positive or negative mathematics identity (Aguirre et al., 2013). Possible mathematics contexts are numerous and include the math experiences a student has in the classroom, in their day-to-day life (Gonzalez, et al., 2001), and in the attitudes and beliefs that peers and caregivers hold about mathematics (Aguirre et al., 2013). Since each

individual student navigates their own experiences and interpretation of those experiences (Clandinin & Connelly, 1989), each individual student forms their own mathematics identity over time based on their lived experiences.

While one might equate positive math experiences (e.g., a caregiver or peer's positive view of mathematics, a good score in mathematics, etc.) with a positive math identity, this is not always the case. Martin (2006) states, "the development of particular kinds of mathematics identities reflects how mathematics socialization experiences are interpreted and internalized to shape people's beliefs about mathematics and themselves as doers of mathematics" (p. 207). Therefore, an individual's math identity is shaped by their *interpretation and internalization* of the math experiences they have and not just shaped by the nature of the experiences themselves. For example, if a student receives a positive math score on an assessment, but has great anxiety during math assessments, the interpretation and internalization of this math experience may be negative. The student attained a positive score but the test itself was accompanied by an immense amount of anxiety, leading to a negative emotion overall. This is just one example of the many ways a student's experiences can shape the way they see themselves as a learner and doer of mathematics.

Mathematics Identities of Residents

There are many factors that can impact a residents' mathematics identity before entering the MET course. One of these factors are the other identities they may hold. Two identities that often interact with mathematics identity are race (Martin, 2006) and gender (Cvencek et al., 2021). This is largely due to the stereotyping of individuals based on race and gender in the field of mathematics (English-Clarke et al., 2012; Martin, 2006; Okeke

et al., 2009), As most residents in an UTR program identify as BIPOC and many within the elementary certification program identify as female, these residents are at greater risk for negative mathematics stereotyping throughout their mathematics experiences.

In addition to other identities, mathematics experiences pertaining to peers, caregivers, and teachers may shape the way residents see themselves as a learner and doer of mathematics (Aguirre et al., 2013). Residents have a broader and more varied array of mathematics experiences than typical undergraduate students. These experiences include: their K-12 experiences, undergraduate experiences, and potentially previous careers that included experiences in mathematics contexts. As such, residents may have had more exposure to negative mathematics experiences due to peers, caregivers, teachers, and/or employers and how their identities were valued by these groups.

Motivation is also a critical factor that might impact residents' mathematics identities. Motivation can help students engage in the mathematics context and create a cyclical effect on perceived usefulness of mathematics (Husman et al., 2004) and self-efficacy (Cribbs et al., 2015). This may ultimately influence how particular individuals see themselves. After three years of teaching residents, I have found that many of the elementary education residents in the MET course enter the program with negative mathematics identity and therefore low self-efficacy. As such, they initially struggle with motivation.

Mathematics Identities of Teachers

Teachers are a critical factor in shaping the mathematical identity of students (Gutierrez, 2013). The experiences that teachers provide and decisions they make in their math classrooms can significantly influence student math identity (Leatham and Hill,

2010). These decisions include how students participate and contribute to the mathematics, how teachers motivate students, the tasks, and activities they choose, and the classroom culture they develop (Berry, 2019; Leatham & Hill 2010; Aguirre et al., 2013).

Because teachers have such significant impact on students' mathematics identity, teachers must grapple with their own mathematics identity development. Current research suggests that when teachers do the work of negotiating the development of their own math identity, they begin to understand the power and importance of the positive mathematics identity work that they can intentionally incorporate into their classroom (Leatham and Hill, 2010). When this occurs, teachers can intentionally and substantially influence positive math identities in their students (Aguirre et al., 2013).

While there are many ways that teachers may engage in this work of negotiating the development of their own math identity, teacher education programs play a key role in shaping mathematics teacher identities (Association Mathematics Teacher Educators (AMTE), 2017). Math teacher educators have an important role in helping prospective and practicing teachers begin grappling with the development of their own math identities. This is imperative for teacher's own mathematics learning and doing and even more imperative for their future students. Recognizing that the prior mathematics experiences teachers who hold negative math identities may be somewhat powerful negative experiences, considering a perspective guided by trauma-informed care may be useful.

Trauma-informed Care in Mathematics Teacher Education

When mathematics experiences are intensely negative over a period of time, individuals can experience what I will label "mathematics trauma" in this study. Trauma is "an umbrella term denoting the inability of an individual or community to respond in a healthy way (physically, emotionally, and/or mentally) to acute or chronic stress." (Wolpow, 2009). Thus, for the purpose of this study, I define mathematics trauma as the negative physical, emotional, and/or mental stress responses that prevent individuals from coping within mathematics contexts in a healthy way and have developed over time due to intensely negative mathematics experiences. Stress responses can have lasting neurological and psychological impacts on an individual's ability to function in the mathematics setting. A trauma-informed care (TIC) framework might be appropriate and useful tools in helping students begin to process their mathematics trauma and begin moving towards a positive mathematics identity.

While there is no one agreed-upon (TIC) framework (Thomas et al., 2019), there are three pillars that are common in all trauma-informed frameworks including (a) *safety*, (b) *managing emotions*, and (c) *connections* (Bath, 2008). While these pillars can often be thought of as "behavioral" (Ginwright, 2018), I wish to frame these three pillars around a sociocultural framework, acknowledging that the processing and healing of any trauma does not happen apart from an individual's social and cultural contexts (Alvarez, 2017). Thus, mathematics identity develops both as a psychological construct and through students' social worlds. Additionally, the three pillars of TIC provide a framework that may serve to promote the processing and healing of any potential mathematics trauma that residents may experience.

Research Questions

To help these residents prepare for a future teaching career and become effective elementary mathematics teachers, it is critical for these residents to address their mathematics identities including any potential mathematics trauma. The goal of this study, therefore, is to provide residents with opportunities to explore and strengthen their own mathematics identity development within the context of the Mathematics for Elementary Teacher course. TIC practices were embedded throughout the course to support these explorations and the continued development of residents' mathematics identity. In studying this, teacher educators can begin to understand the progression of mathematics identity in urban teacher residents. I used the following research questions to guide my research:

1. How do residents' mathematics identities change during the Mathematics for Elementary Teachers course?
2. How do residents connect trauma-informed practices embedded in the course design to the transformation of their mathematics identity?
3. How does a Mathematics for Elementary Teachers course with embedded trauma-informed practices impact mathematics identities for residents with and without mathematics trauma?

CHAPTER II

THEORETICAL FRAMEWORK AND REVIEW OF LITERATURE

The theoretical framework that guides this study draws upon several constructs from the theories that pertain to identity development and instructional practice with adult learners. In this chapter, I review the literature from these theories and the constructs that guide this study. Additionally, I review the literature on three main areas of research that inform this study: the residency teacher preparation model, mathematics identity, and trauma. I describe the theoretical framework at the beginning of the chapter and will subsequently review the literature that informs the study.

Theoretical Framework

The theories that create the theoretical framework for this study involve two distinct categories. The first category is that of mathematics identity development. Theories pertaining to identity guide the components of mathematics identity development within this study. The second category is that of instructional strategies. These theories pertain to the construction of instructional practices implemented within the Mathematics for Elementary Teachers (MET) course as part of the study. In this section, I discuss the theories guiding this study within each category. At the end of this section on theoretical framework, I discuss the implications for the MET course.

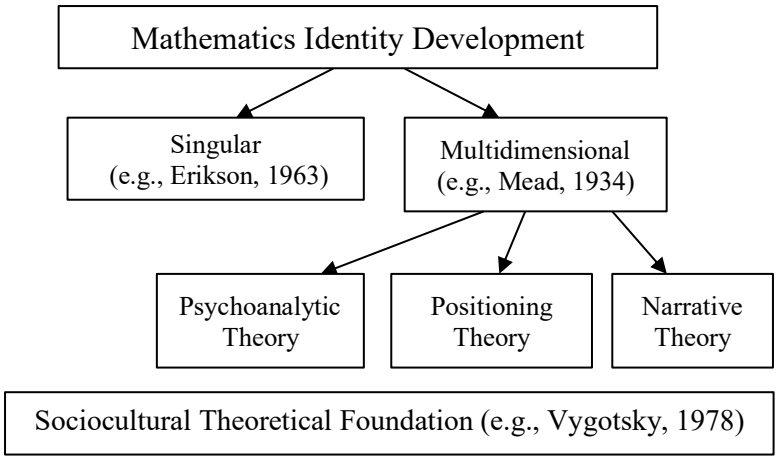
Theories on Identity

Theories on identity development help guide this research pertaining to mathematics identity development. The two main identity development theories that undermine mathematics identity research include two main branches. The first describes identity that is singular and progresses through stages which are guided by an individual's sociocultural and historical context (Erikson, 1963). The second branch of identity within this research is multidimensional in nature and continually changing due to ongoing interactions negotiated by social context (Mead, 1934). Both branches of identity theory informed Vygotsky's Sociocultural Theory (1978) as they pertained to the individual in context of their overall social, cultural, and historical context. Sociocultural Theory is, therefore, the foundational theoretical underpinning for this study.

In addition to these theories, there are also several other theoretical frameworks that appear in mathematics identity literature. The three that guided this study include Psychoanalytic Theory (Freud, 1923), Positioning Theory (Harre & Van Langenhove, 1999), and Narrative Theory (Fisher, 1984). These theories align with Mead's (1934) multidimensional view of identity as they pertain to shifts in identity as ongoing interactions with the individual and their sociocultural contexts. Figure 1 below shows the relationship of these theories on identity development as they pertain to mathematics identity development. This section describes each of these theories.

Figure 1

Theoretical Framework: Identity Development



Identity in Stages of Psychosocial Development

The construct of identity has roots in the work of two theorists, Mead (1934) and Erikson (1963). These theorists described identity in differing ways. Erikson's theory on identity held that an individual's identity was singular and developmental in nature. He argued that identity develops through processing of social interactions of groups as an individual strives for "continuity of experience" (p. 208). Mead's theory defines identity as multi-dimensional and developed through continual interactions overtime.

In his work, Erikson (1963) outlined stages of psychosocial development that are critical in identity development throughout an individual's life. These stages indicate a "crisis" that an individual must negotiate within their social groups to reach a critical understanding for their identity. If individuals "successfully complete" a stage, there is a "virtue" or identity that the individual develops. The first stage in Erikson's theory (1963) is that of trust vs. mistrust in infancy. If an infant is cared for by the adults and community around them, they develop trust However, if the infant does not experience

consistent caregiving, they develop mistrust as a foundation of their identity. If the infant completes this stage successfully, they have hope that the adults and others around them will provide for their needs. If not, the child develops fear (Erikson, 1963). The next stage that happens in a toddler's life (ages 18 months to 3 years) is autonomy vs. shame and doubt. Erikson (1963) explains that in this phase, children experience the independent development of skills apart from the adults in their lives. If successfully completed, children learn the virtue of "will". This will increase their independence and confidence over time. In ages 3-5, children experience the crisis of initiative vs. guilt. In this phase, children discover how to exert their independence through play and social interaction. If successfully completed, children will gain the identity of "purpose" as opposed to guilt.

While the aforementioned phases are critical for foundational identity development, the next set of phases is focused on ages of school-aged children. Erikson (1963) explains that children ages 5-12 experience the crisis of industry vs. inferiority. In this stage, children develop a better understanding of themselves in a peer context (Erikson, 1963). In addition, teachers become an important adult in their social sphere. When these social interactions help children become more industrious, their confidence and therefore industry increases, developing the identity of competence. If not, the child may develop inferiority. From 12-18 years, a child experiences identity vs. role confusion. In this phase, a child begins to experiment to discover if they will accept their current identity and to discover what their role might be into adulthood, producing the virtue of fidelity.

The remaining three stages are those that take place into adulthood. Intimacy vs. isolation occurs in adults ages 18-40 in which adults explore relationships and commitments to the community around them (Erikson, 1963). Generativity vs. stagnation takes place in ages 40-65 years in which adults determine whether they will innovate and continue to make an impact or become stagnant and lack productivity and influence. Finally, Ego Integrity vs. despair is the state in adults ages 65 and older in which they must decide if they will fall into despair or continue to maintain their derived identity (Erikson, 1963).

Erikson (1963) believes that the results of these crises in each stage of psychosocial development were shaped by the social interactions an individual experiences and resulted in embodiment of various identities.

Identity as Multi-Dimensional

Rather than singular stages proposed by Erikson, Mead's (1934) theory on identity held that an individual's identity was multi-dimensional and developed through continual interactions overtime. Mead believes that identity was formed through everyday interactions with an individual's culture and with others around them. Similar to Vygotsky, he believes that language was a primary mediator of identity, orienting an individual's identity around linguistic patterns and social communication of a group (Mead, 1934). In his review of identity frameworks, Park (2015) explains, "Mead's concept of identity focuses on the means by which individuals form in their relation to roles, statuses, and cultural persona, and how these identities organize affect, motivation, action, and agency" (p. 6). Thus, how an individual orients themselves through and within the world around them impacts their identities. Consequently, an individual's

affect, motivation, action, and agency come out of the individual's understanding of these identities.

Sociocultural Theory

Sociocultural Theory, developed by Lev Vygotsky (1978), builds on these theories from both Erikson (1963) and Mead (1934). Sociocultural Theory argues that individuals learn from interaction with others, their culture, and the world around them. Vygotsky(year) believes that "learning is a necessary and universal aspect of the process of developing culturally organized, specifically human psychological function" (p. 90). In other words, the learning in social and cultural contexts is the predecessor of development. Vygotsky (1978) used mediation of tools and signs, language, and Zones of Proximal Development (ZPD) as key components of this sociocultural view of development.

Vygotsky (1978) discusses that "tools" and signs" mediate human learning (p. 54). Tools, in Vygotsky's (1978) explanation are externally oriented, a "means by which human external activity masters nature" (p. 55) and a sign is internally oriented, a "means of mastering oneself" (p. 5). When negotiation between the external and internal takes place, "higher psychological function, or higher behavior" occurs (Vygotsky, 1978, p. 55) Thus, external tools provided culturally and through social interactions and the signs an individual uses internally mediate that individual's learning. Cultural and social interactions, therefore, are critical to an individual's internal understanding, interpretation, and subsequent behaviors.

According to Vygotsky (1978), language is the most important of these tools in the learning process. His theory explains that language is developed first to assign

meaning and create basic communication between individuals who share the language. As language continues to develop, it becomes a tool to construct understanding that is mediated through social and cultural experiences (Vygotsky, 1978). As language is the tool to access the shared meaning system, language as Vygotsky (1978) uses it, is the root of culture.

ZPD, another key component to Vygotsky's theory,is the "distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86). In this view, learning happens when students are challenged slightly above their current level of understanding and can only happen through a collaborative, social process between the student, teachers, and peers. Thus, learning happens through social interactions, not individual processes (Vygotsky, 1978).

These components of Sociocultural Theory form the foundational understanding that social and cultural interaction are fundamental for learning and that learning, and development cannot happen apart from this social and cultural context.

Connecting Identity to Sociocultural Theory

While they differ in their understanding of how identity forms developmentally, both Erikson's and Mead's theories on identities are sociocultural in nature. Vygotsky (1978) uses the foundations from these theorists to explain identity from a sociocultural perspective. He understood identity as a "higher-order psychological function" that was mediated through the "tools" external to the individual and "signs" internal to the individual with language as a primary tool for identity formation (Vygotsky, 1978). Like

Sociocultural Theory on learning, Vygotsky (1978) believes that identity development is not independent and ahistorical. Rather, identity develops based on the social and cultural context in respect to interactions overtime.

Mathematics Identity

Mathematics identity is a relatively new construct, shaped in large part by existing theories on identity including the sociocultural view of identity from Mead (1934), Erikson (1963), and Vygotsky (1978) (Graven & Heyd-Metzuyamin, 2019). In a meta-analysis of two decades of Mathematics Identity research, Graven & Heyd-Metzuyamin (2019) found that the majority of mathematics identity research most heavily reflected "Meadian" identity theories. These articles consider Mead's (1934) understanding of sociocultural constructs which shape one's mathematics understanding as they move through their schooling experiences. Mathematics identity research within this framework allows for multiple dimensions of an individual's identity to both influence and be influenced by other identities they hold. Moreover, mathematics identity impacts a students' emotion, motivation, behavior, and agency in the mathematics classroom. This aligns with Mead's perspective which explains that negotiated identities impact affect, motivation, action, and agency (Mead, 1934).

With the sociocultural view of identity as the theoretical underpinnings for identity, there are several other theoretical frameworks that appear in mathematics identity literature (e.g., Darragh, 2018; Lutovac & Kaasila, 2018) including Psychoanalytic Theory (Freud, 1923), Positioning Theory (Harre & Van Langenhove, 1999), and Narrative Theory (Fisher, 1984).

Psychoanalytic Theory. Psychoanalytic theory is rooted in Freud's work around the psyche (Freud, 1923) which suggests that behavior is influenced by memories and experiences that are operated by both in the conscious and subconscious (Freud, 1923). Psychoanalytic theories are broad in range and utilized in many areas of study including psychology, medicine, and education, among many others. In an educational context, psychoanalytic theory can explain a child's resistance to learning due to unfavorable conditions. In a review of literature on psychoanalytic views of teaching and learning, Mayes (2009) explains that there are elements of one's psyche that are impacted beyond cognition in an educational environment. These impacts come from social interactions with peers, teachers, the curriculum, alongside a student's social and emotional development. The psyche and "learning ego", therefore, can be damaged by negative experiences in the educational realm and mental health and the "learning ego" can be improved through positive experiences in the educational realm (Mayes, 2009, p. 554-555). An understanding of psychoanalytic theory, therefore, can help teachers discover elements of the educational environment that can guide students in these positive experiences and therefore more positive "learning ego's". This theoretical lens helps students, teachers, and pre-service teachers think about mathematics identity as a complex interworking of the conscious and unconscious and positions them as change agents that can injure or positively develop the psyche and therefore mathematics identity in the classroom.

Positioning Theory. Additionally, the theory of positioning (Harre & Van Langenhove, 1999) plays a primary role in considering how students adopt a mathematics identity. Positioning is concerned with roles and power. Harre (2012) states, "Positioning

Theory is based on the principle that not everyone involved in a social episode has equal access to rights and duties to perform particular kinds of meaningful actions at that moment and with those people" (p. 193). Thus, in any given circumstance there are power differentials that impact the way that an individual sees themselves and the way that others see them. This theory uses *storylines* (Harre & Van Langenhove, 1999) as a way of describing these specific positionings, similar to the idea of *figured worlds* described by Holland et al. (1998). Thus, an individual participating in any given discourse is positioned based on the social structures. In any given circumstance, there is a discourse of power by which actions and speech and are arranged (Harre & van Langenhove, 1999). In the mathematics identity literature, positioning theory is utilized to understand the positioning of students, teachers, and pre-service teachers within mathematics discourses, but also within larger societal discourses in which they are a part (Darragh, 2018; Graven & Heyd-Metzuyamin, 2019). If individuals are positioned negatively within mathematics contexts, this may negatively shape their "learning ego". On the contrary, if individuals are positioned positively within contexts, this may positively shape their "learning ego" (Freud, 1923). Memories and experiences tied to these positionalities can have long term impacts on this "learning ego" and therefore their identity as mathematics learners and doers (Mead, 1934).

Narrative Theory. Another theory commonly used in mathematics identity research is that of Narrative Theory (Fisher, 1984). Narrative Theory furthers both Sociocultural (Vygosky, 1978) and Positioning Theory (Harre & van Langenhove, 1999) with the belief that stories are a basic human strategy for understanding our experience and that stories are built on basic narrative ideas of structures, elements, uses and effect

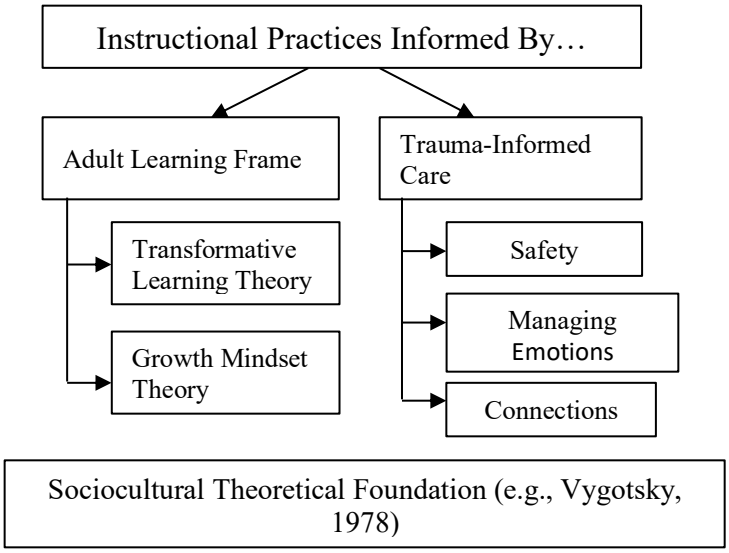
(Fisher, 1984). Thus, narratives, or stories, are the mechanism through which individuals come to their own understanding of their experiences within social and cultural experiences over time. Mathematics Identity researchers utilize this framework as a lens through which students, teachers, and pre-service teachers can tell the *story* of their own mathematics identity (Darragh, 2016; Lutovac, 2020; Lutovac and Kaasila, 2011; Hodges and Hodge, 2017).

Theories Guiding Instructional Practices

Theories on adult learning and trauma guide the instructional practices implemented within this study. Transformative Learning Theory (Mezirow, 1997) works in tandem with Growth Mindset Theory (Dweck, 1999) to inform instructional strategies as they pertain to adult learners. Additionally, Trauma Theory (Freud, 1920) underpins the trauma-informed care practices embedded within the Mathematics for Elementary Teachers (MET). Figure 2 below shows these theories on adult learning and trauma-informed care as they pertain to instructional strategies within thee MET course. This section describes each of these theories.

Figure 2

Theoretical Framework: Instructional Practices



Adult Learning

Adult learners who enter educational environments come with a variety of life experiences and skills (Kenner & Weinerman, 2011). Mezirow theorized that adults struggle to apply their old understanding to new situations, instead they reflect on how new understandings connect and relate to their previous experiences. This is how they form new understandings and perspectives (1997). The theory explains phases of transformative learning that move adult learners from "a disorienting dilemma" through "critical assessment of assumptions", to "acquisition of knowledge to carry out a new plan" and end in "exploring and trying new roles" and "building self-efficacy in new roles and relationships" and therefore new learning (Meizrow, 1997). Thus, through a transformative learning lens, adult learners gain "new perspectives" on themselves and

their learning, adding, and transforming their previous understandings into new learning and understandings.

Transformative learning theory is complemented by the Theory of Growth Mindset (Dweck, 1999). Simply stated, this theory is based on a "belief that intellectual ability can be developed" and contrasts the belief in a fixed mindset which is the belief that "these characteristics are fixed and unchangeable" (Yeager & Dweck, 2020). Thus, contrary to historical beliefs, this theory explains that learning and brain development continues throughout adulthood (Dweck, 1999). At its root, this theory is both motivational and neurological. The idea of neuroplasticity explains the brain's ability to continue to adapt and learn throughout adulthood (Ng, 2018). Motivation can be described as the "volition to engage in a task for inherent satisfaction" (Ng, 2018) Thus, when an individual holds the belief that their brain has the capacity to learn and grow, they may be more motivated to pursue this growth away from old patterns and understanding. This motivation and neurological response seem to be cyclical in nature, meaning as individuals are more motivated, they enter into more learning and growth opportunities, continuing to build their brain's malleability (Ng, 2018). This mindset is critical for adult learners. If adult learners enter a learning environment with a fixed mindset and do not believe they can learn new knowledge and patterns of thinking, they will be less motivated in the learning environment and can consequently decrease their brain's malleability.

Trauma Theories that Influence Trauma-Informed Care

Studies on trauma began to emerge in the 1990's (Mambrol, 2018; Thomas et al., 2019) and relied heavily on Freud's theories on traumatic experience and memory. Freud

was the first to create theories around trauma (Mambrol, 2018). His theories focused on the remembrance of a traumatic event and the "psychological pain" the memory causes. Freud (1920) argued that a psychological pain, creates a period of repression of these memories to the unconscious a type of "protective shield" (p. 35) against the traumatic memory. However, this "protective shield" can be breached when an experience triggers the resurfacing of a memory (Freud, 1920). Freud's Trauma Theory discussed this occurrence as "Traumatic neurosis", an "extensive breach in the protective shield and describes the behavior resulting from this breach as neurotic and psychotic (Freud, 1920, p. 35). This original trauma theory contended that trauma resulted from "weakness and deficiencies in moral character" (Goodman, 2017) alongside their inability to effectively manage their emotions and behavior (Van der Kolk, 2015). Such symptoms described in the original Trauma Theory (Freud, 1920) is now known as Post Traumatic Stress Disorder in which individuals who have traumatic memories are left with psychosomatic symptoms that can trigger anxiety, depression, flashbacks, and dissociation (Van der Kolk, 2015). With this better understanding of the brain and behavior, recent literature has shifted from the use of Trauma Theory to a trauma theory that considers the impact of traumatic experiences on the brain and development.

This shift has now been termed Contemporary Trauma Theory (CTT) and explains that traumatic experiences lead to intense changes in neurobiology, creating a survival response in the body and results in an altered state of being (Herman, 1992). In his summary of Herman's theory, Geary (2007) explains,

> Trauma occurs when an event is so frightening it causes a prolonged alarm reaction, where the body is primed and pumped with chemicals and enzymes and

> does not calm down for a long time. In any person, this creates an altered neurological state (Geary, 2007, p. 3).

Thus, when traumatic events occur in childhood, this "altered neurological state" can have lasting devastating effects including impacts on sensory, emotional, and cognitive formation (Cole et al., 2009; Geary 2007; Wolpow et al., 2011). With this understanding, CTT positions survivors of trauma as physically or psychologically impaired and in need of help and healing (Herman, 1992). In education, CTT can help educators embody a lens of understanding when considering the "nature and impact of trauma" (Thomas et al., 2019). The research utilizing this theory outlines a "perspective shift" (Thomas et al., 2019) for teachers in the efforts of "help and healing" for their trauma-exposed students rather than punishments for misbehavior or "misguided morals" that Trauma Theory may have posed (Freud, 1920).

Attachment theory is an underpinning of Contemporary Trauma Theory (Bowlby, 1951). This theory defines attachment as a lasting psychological connectedness between human beings. Cherry (2020), in her analysis of Contemporary Trauma Theory, states that the theory "suggests that infants have an innate need to form an attachment bond with a caregiver. This an evolved response that increases a child's chances of survival" (p. 5). This attachment, in part, provides an innate sense of safety to the infant (Bowlby, 1982) and has its roots in Erikson's trust vs. mistrust crisis of life in his stages psychosocial development (Erikson, 1968). This theory is furthered by psychologists Ainsworth (1970) and Harlow (1958) who found that attachment has profound impacts on behavior. Young and colleagues (2019) have more recently described that when the attachment cycle is not completed early in life, there is a negative impact on behavior

over time and throughout their life. In education, this theory informs a trauma-exposed student's need for safe and positive connections with teachers and other students. Moreover, if the attachment cycle is not completed early in life, these connections may need to be intentionally fostered through social and emotional skills in the educational setting (Durlak & Mahoney, 2019).

Trauma-Informed Care Framework

Trauma-informed Care (TIC) is a framework of support, born out Contemporary Trauma Theory, for individuals who have experienced trauma (Bath, 2008). This term is used across many disciplines including the fields of child welfare, mental health, and education (e.g. Gerber et al., 2019 Rivard et al., 2003; Wolpow et al., 2009). While there is no consensus on any one outline of practices behind this framework (Thomas et al., 2019), there "appears to be remarkable consensus about key prerequisites for healing-those critical factors or therapeutic pillars that need to be in place if healing is to take place" (Bath, 2008, p. 18). These pillars are safety, connections, and managing emotions (Bath, 2008), and each are discussed in the next three paragraphs

Safety in TIC work is more complex than *protection from danger*. Rather safety is "multi-faceted" and includes physical and emotional needs such as "consistency, reliability, predictability, availability, honesty, and transparency" (Bath, 2008). As much of the acting out cycle in trauma-exposed children is due to a lack of control (Hinton et al., 2018), safety in terms of TIC also must have emphasis on having a balance of control and power that is appropriate for an individual's developmental needs (Bath, 2008; Cole et al., 2009; Perry, 2006; Wolpow et al., 2011).

The connections pillar refers to healthy connections between a trauma-exposed child and their care givers and mentors (Bath, 2008). Positive relationships are critical for healthy development, but trauma-exposed children often associate adults with negative emotions (Bath, 2008; Cole et al., 2009; Wolpow et al., 2011). This negative association can lead to a lack of connection and behaviors that can be categorized as avoidant or even aggressive (Bath, 2008; Hinton, Keels, & Williams, 2018).

The third pillar, emotional management, has received significant attention in the literature. In short, these researchers explain that complex trauma often results in emotional dysregulation and issues of impulse control (Bath, 2008; Geary, 2007; Cole et al., 2009; Wolpow et al., 2011). Regulation and impulse control is critical to child development to help children manage emotions and self-regulate and to learn these skills in order to function in social environments (Alvord & Grados; Bath, 2008).

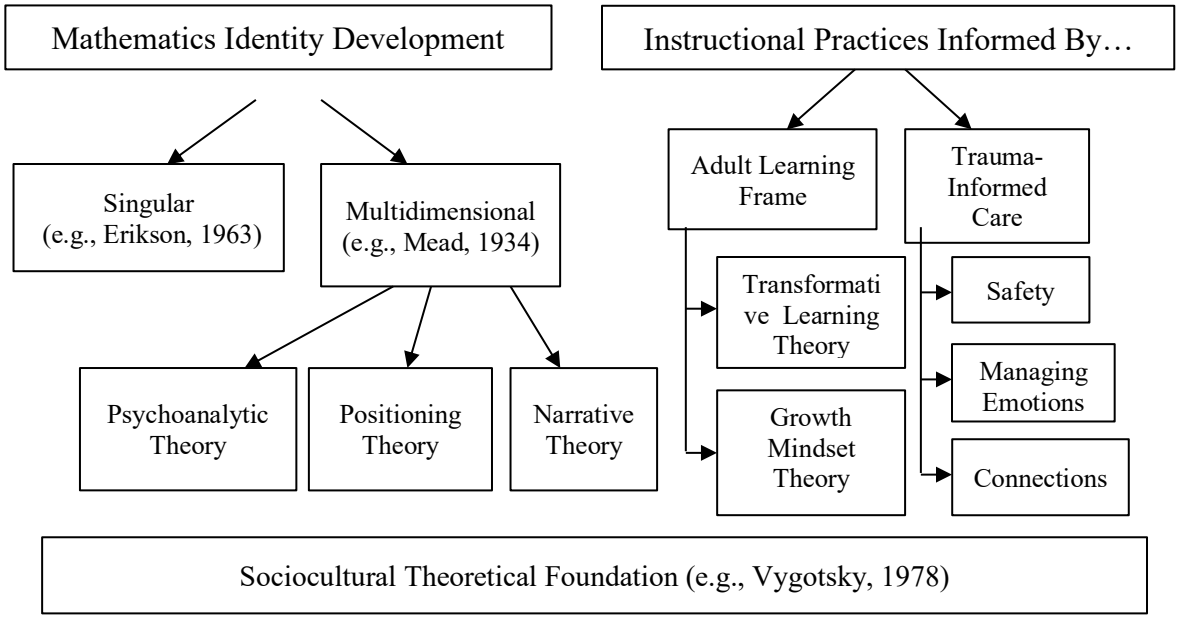
Application of Theoretical Framework for the Current Study

The individuals who participated in this study were adult learners in an urban teacher residency, many of whom identify as Black, Indigenous, or People of Color (BIPOC). These residents explored their mathematics identity throughout the Mathematics for Elementary Teachers (MET) course. These residents have many lived experiences, both in their personal life experiences and in their experiences within the mathematics contexts. Using a sociocultural lens allowed myself as the researcher and instructor (R-I) to view the development of the residents' mathematics identity as one aspect of their multi-faceted identity mediated through social and cultural interactions and developed over time. Moreover, the theories guiding this study provided a construct for the exploration of mathematics identity within these residents using instructional

practices focused on adult learning and trauma-informed care (TIC). The interaction of these theories is demonstrated in Figure 3 below. I then discuss how the constructs from each of these theories are utilized in the design of the study and applied within the MET course.

Figure 3

Theoretical Framework



Identity Theories' Constructs

Sociocultural theory (Vygotsky, 1978) explains that the interactions that we have in the many *figured worlds* around us dictate how our identity is shaped (Holland et al., 1998). Thus, the residents in this study have formed their mathematics identity as one part of their multi-faceted identity (Mead, 1934). Psychoanalytic Theory (Freud, 1923) explains that this identity may have been positively or negatively formed due to the experiences, memories, and "learning ego" that an individual forms based on these experiences and memories. Therefore, if residents within this study have been positioned negatively within mathematics contexts, this may negatively shape their "learning ego".

On the contrary, if residents have been positioned positively within mathematics contexts, this may positively shape their "learning ego". Memories and experiences tied to these positionalities can have long term impacts on this "learning ego" and therefore their identity as mathematics learners and doers (Mead, 1934).

Positioning theory, therefore, provides a framing for residents' exploration of mathematics identity as they examine how they position themselves within the mathematics context and how others position them within the mathematics context (Harre & van Langenhove, 1999) and how this has impacted their mathematics identity. Narrative theory can also help support the exploration as residents recognize and make meaning of their positionality through the narrative, or stories, that they share (Fisher, 1984). For this study, I facilitated experiences in the Mathematics for Elementary Teachers course aimed at helping residents examine their own narratives around mathematics. This helped residents explore how they have positioned themselves and how they have been positioned by others in the mathematics context and how this has influenced their mathematics identity.

Trauma Theories' Constructs

Contemporary Trauma Theory informed how I facilitated experiences with residents to process their mathematics identity and its formation. Contemporary Trauma Theory explains that intensely negative mathematics experiences may have lasting neurological and psychological impacts that may negatively influence identity (Geary, 2007). This theory informs my work with residents in helping residents understand that intensely negative experiences in mathematics contexts may have lasting neurological and psychological impacts that may have negatively influenced their mathematics

identity. As such, this theory informed activities and discussions within the class to help with the processing of these experiences.

This work is also be underpinned by Attachment Theory (Bowlby, 1951) which explains that intensely negative experiences in childhood may impact the ability to attach and form relationships (Bowlby, 1951). Research has suggested that attending to relationship in the form of social and emotional learning in the classroom can promote positive relationships in the classroom, even if a student's ability to form relationships has been impacted by previous traumatic experiences (Durlak & Mahoney, 2019). Attachment Theory, therefore, informed how I interacted with residents and how I promoted interactions among residents. I designed collaborative exploration activities and promoted positive relationships with and amongst the residents as they process their mathematics experiences.

The three pillars of TIC frameworks (safety, managing emotions, and connections) were built largely from these theories (Bath, 2008). These were the foundational pillars that I used to facilitate experiences as residents explore their mathematics identity. These three pillars will be discussed in depth in the Procedures section of Chapter 3.

Connecting Trauma-Informed Care and Sociocultural Theory

Trauma-informed care has been criticized in some research (e.g., Alvarez, 2017; Ginwright, 2018; Golden, 2020) as individualistic, focused on cognitive processes and innate abilities rather than accounting for the social and cultural contexts of individuals. I argue, however, that trauma-informed care can include aspects of cognitive processes while acknowledging that these cognitive processes of an individual are shaped by

societal and cultural influences. The critiques of TIC are discussed below, leading to a discussion on TIC from a sociocultural perspective.

One critique in the use of a TIC framework that lends itself to a stance counter to Sociocultural Theory (Vygotsky, 1978) is the development of a deficit perspective. If there is an assumption that students could "just work harder" on coping skills and see an increase in their ability to cope in an environment, the teacher is focusing on innate abilities that a student has rather than the context of their trauma responses (Golden, 2020). Additionally, some teachers operate under the assumption that all students enter the classroom with trauma-exposure (Thomas et al., 2019). Both of these perspectives can lead to a deficit perspective of students.

One in four individuals have experienced Adverse Childhood Experiences (outlined in the Trauma section of the literature review) (SAMSHA, 2015). However, the lens of trauma-informed care is important for the expanded Adverse Childhood Experiences which extend to include racism (Cronholm et al., 2015). As most of the residents in this study identify as BIPOC, these residents may be particularly positioned to have experienced racial and community trauma (Golden, 2020). Moreover, as students of color have been historically marginalized in the educational setting (Lynn & Parker, 2006), these pre-service teachers may have academic trauma that has produced "an altered neurological state" from "prolonged alarm reaction" (Geary, 2007, p. 37) in an academic setting. There is also a body of research that points to students of color being marginalized specifically in the mathematics classroom (Ladson-Billing, Tate, 1995; Dixon & Anderson, 2017; Durant, 2013) and therefore may hold a greater concentration of mathematics trauma as well. As such, it is critical to use trauma-informed care for all

residents and acknowledge the possibility of trauma in its' multiple forms, influenced by societal and cultural influences.

Another critique of trauma-informed care is that its use does not encompass the totality of an individual, but is "focused only on his harm, injury, and trauma" and is therefore a deficit perspective of hurt rather than an asset-based lens of healing (Ginwright, 2018, p. 6). Golden (2020) furthers this by explaining that trauma-informed care under current TIC frameworks support the solution to "problem behavior" rather than the holistic student. He states, "this approach assumes a static, culture free, and ahistorical understanding of normative behavior" (2017). Thus, when TIC frameworks are employed, they are addressing behavior rather than the narrative the student tells about their trauma and the hope and joy that the student experiences apart from their trauma (Ginwright, 2018).

To mitigate this perspective, recent literature has reconsidered approaching trauma-informed practices from a sociocultural perspective. This is particularly relevant with a view of multi-faceted trauma. The theories of trauma through a sociocultural lens reveal that an individual may experience complex trauma in childhood alongside other forms of trauma (racial trauma, community trauma, academic trauma etc.), and trauma from feelings of hopelessness, abandonment, etc. due to these trauma-exposures (Ginwright 2018) simultaneously. Moreover, the pillars of TIC discussed in the literature (safety, connection, and emotion management) should be discussed as social and cultural constructs. Golden (2020) explains that a TIC approach "overwhelmingly locates the problem in the students and pathologizes them, especially when the label of "appropriate behaviors" may be "racial, gendered, or class biased, among others" (p. 72). Because the

residents in this study have been largely marginalized and may be exposed to a greater amount of mathematics trauma, it is particularly important for this sociocultural view of trauma-informed care to be utilized for this study. This may help mitigate additional deficit perspectives of them as individuals and their mathematics experiences.

This sociocultural view of trauma-informed care is uniquely designed to help promote healing and growth within trauma-exposed individuals (Bath, 2008; Ginwright 2018; Golden 2020). It is therefore well equipped to promote growth and healing for students who have experienced trauma in the mathematics classroom. Figure 1 above, therefore, shows that sociocultural theory underpinned my use of trauma theories and the resulting TIC framework. When I discuss TIC, I will be referring to this sociocultural perspective of trauma-informed care that looks at the holistic individual. This view of trauma-informed care aims to promote healing and growth for residents in the mathematics setting rather than mitigate behaviors that have been deemed "problematic" in a white dominated narrative.

Adult Learning Theories Constructs

While theories on identity and trauma pertain to individuals of all ages, the residents in the Mathematics for Elementary Teachers course were adult learners. As such, it is important to consider this course through Adult Learning Theories. The two learning theories that informed the work in the Mathematics for Elementary Teachers course were Transformative Learning Theory (Meizrow, 1997) and Growth Mindset Theory (Dweck, 1999). Exploration of mathematics identity with the lens Transformative Learning Theory helped residents build on their previous experiences and perspectives to gain new insight and understanding of their mathematics identity. Growth Mindset

Theory (Dweck, 1999), then, explains that it is possible for the brain to grow and develop throughout an individual's lifetime (Dweck, 1999). As the researcher and instructor (R-I) for this MET course, I used this theory to help residents understand that their mathematics identity is not stagnant, but fluid and flexible.

In conclusion, the collection of theories outlined in Figure 3 and explained above were used to shape a collaborative learning experience in which there were no set power structures between instructor and residents. This environment aimed to provide residents a safe space to process any mathematics trauma they had incurred, and reconsider deficit identities they may hold as mathematics learners. My goal was to provide a community and experience for residents to transform their mathematics identity as students and as teachers. For the remainder of this chapter, I outline research literature around the areas of the residency teacher preparation model, mathematics identity, and trauma, using the theoretical framework above as the underpinnings.

Review of the Literature

In this section, I review the literature on three main areas of research that inform this study. These include the residency teacher preparation model, mathematics identity, and trauma.

Residency Teacher Preparation Model

This discussion includes a brief overview of teacher education and the development of alternative routes to teacher certification programs. I then outline literature that discusses the effectiveness of these programs which largely resulted from national concerns over teacher shortages and a lack of qualified teachers in the field. While alternative route programs were effective in many ways, there are still significant

issues in the teacher workforce including a lack of teachers who identify as BIPOC and difficulties recruiting and retaining teachers in urban schools and districts. I discuss literature that aims to explain why these issues are prevalent. I then address literature regarding Teacher Residency Programs and later, Urban Teacher residency programs which were created to help address these issues. I then turn to a discussion on the effectiveness of these Urban Teacher Residency Programs.

Brief Overview of Teacher Education and the Creation of Alternative Routes to Certification

The education of teachers within the United States has grown and developed significantly over time. The first teaching requirements came about in the 1800's in which individuals were required to take a test that focused on reading, writing, and arithmetic to earn a teaching certificate (Ravitch, 2003). This was required in most states by the year 1867 (Ravitch, 2003). Training for these tests were not standardized or regulated and were not shifted to institutions of higher education until the 1900's. At this time, the teacher certification became standardized and began to include pedagogical courses. These were aimed to help individuals become, not just knowledgeable about the content they were teaching, but also develop skills in the art of teaching (Larabee, 2008).

There have been many significant shifts in teacher preparation since this move to institutions of higher education. One of these shifts was prompted by The Nation At Risk Report (National Commission on Excellence in Education, 1983). This report sparked concern that teachers were in short supply and schools were failing. This report initiated many reform efforts such as the National Board for Professional Teaching Standards which created standards aimed at strengthening teacher education and certification

(Darling-Hammond, 1996). Additionally, the nation began to prepare for an "unprecedented teacher shortage" that was predicted by the year 2000 (Hussar, 1999). In response to these concerns, many states began creating alternative routes to teacher certification. While programs varied from state to state, all alternative certification programs allowed individuals with a bachelor's degree to earn their teaching certification through a shortened program and "on-the-job training" in effort to recruit and retain more teachers (Roach & Cohen, 2002).

These programs have shown some advantages over traditional certification routes. First, alternative certification programs have created a broader pool of teachers including mid-career teachers who were experts in another field (Birkeland & Peske, 2004; Roach and Cohen, 2002). Swain & Schmertzing (2011) suggest that these mid-career teachers have a positive impact on student learning in the classroom because of the expertise from their previous field. Additionally, high-quality alternative routes to teacher certification hold a stronger relationship between coursework and teaching experiences, that can lead to stronger teacher development (Roach & Cohen, 2002). Though the research has conflicting results about the retention of alternatively certified teachers, researchers agree that these teachers do not have worse retention than that of their traditionally trained counterparts (Birkeland & Peske, 2004; Karge & McCabe, 2014; Roach & Cohen, 2002). These programs, overall, have added to the teacher workforce, contributed diversity of expertise, and provided an entryway into different training programs for teachers. Despite these changes that alternative routes to certification offer, there have still been significant issues in the teacher workforce. One of these is continued underrepresentation of teachers who identify as BIPOC (Birkeland & Peske, 2004).

BIPOC Teachers

While some alternative certification programs have seen more diverse candidates through their alternative certification programs, teachers who identify as BIPOC are still significantly underrepresented in United States schools (Partee, 2014). Milner (2007) states, "never before have public school teachers in the United States been faced with the challenge of meeting the needs of so many diverse learners, yet the teaching force is White, monolingual, and middle class" (p. 394). In fact, the U.S. Department of Education's National Center for Education Statistics (NCES) (2020) found that 79% of public-school teachers were White. About 9% of teachers were Hispanic (of any race), 7% were Black, 2% identified as Asian, 2% as two or more races, and less than 1% as Native Hawaiian/Pacific Islander and American Indian/Alaska Native (NCES, 2020). In contrast, the K-12 student population attending public schools within the United States consists of 46% White, 15% Black, 28% Hispanic, 1% American Indian/Alaska Native, and 5% two or more races (NCES, 2020). Thus, the United States has a very low population of teachers who identify as BIPOC while our classrooms consist of students from a variety of racial and cultural backgrounds. Not only is there limited representation in the teacher workforce, but the teachers of color in the workforce leave at a higher rate. Grooms et al. (2021) state that teachers who identify as BIPOC leave the education workforce at a rate 25% higher than that of White teachers.

The lack of representation and retention of teachers who identify as BIPOC is a historic issue within education that can be characterized by many forms of inequity (Carter Andrews et al., 2019; Grooms et al., 2021; Partee, 2014) including inequity in teacher education programs and in their experiences as teachers. Teacher education

programs in predominately White institutions have historically been designed to address the needs of White teachers and more specifically, White female teachers (Gay, 2000). This is largely due to the political and social agendas of the historically White-dominated field of research in education (Ladson-Billings, 1996). Milner (2007) states, education has historically privileged the "experiences, needs, and interests of White teachers" often leaving teachers of color ignored (p. 394). For example, teacher education curriculum and textbooks often discuss creating diverse text sets or teaching about white privilege in a way that assumes a White audience (Agee, 2004). Additionally, pre-service teachers of who identify as BIPOC are often subjected to stereotyping (Cole & Stuart, 2005; Griffin, 2018) and microaggressions (Endo, 2015) throughout their program. Thus, teacher education has historically favored White pre-service teachers through both policy and practice, often leaving pre-service teachers who identify as BIPOC ignored and inequitably treated.

Beyond inequities for teachers of color in their teacher training programs, decades of research have documented that there are academic and non-academic (e.g. social-emotional) advantageous of students who have same-race teachers (Irvine, 1989; Ladson-Billings, 1994; Milner, 2011; Redding, 2019). In their study on same-race teachers, Gershenson et al. (2018) use data from the Tennessee Project STAR (Student Teacher Achievement Ratio) that began in 1986 and aligned these same students with long-term data from the state school administration data. In the original project, students and teachers were randomly assigned in disadvantaged schools. Gershenson et al. (2018) found that when Black students were assigned to at least one Black teacher between kindergarten and third grade, these students were 9 percentage points more likely to

graduate from high school and six percentage points more likely to enroll in college than in their same-school, same-race peers.

Studies have also found that White students equally benefit from BIPOC teachers (Blazar, 2021; Pigott & Cowen, 2000). Pigott and Cowen (2000) studied 445 kindergarten through fifth-grade children to examine the congruence between teacher race and student race. They found that African American teachers are more favorable in their view of all students. In their rating of student competencies, African American teachers rate both BIPOC and White students with "more competencies and fewer problems and had more positive academic expectations for all children" (p. 177). More recently, Blazar (2021) studied educational experiences and outcomes of students taught by the same-race/ethnicity teachers. They collaborated with 321 teachers across four school districts to conduct surveys and observations. They then aligned this data to student test scores, absences, and suspension records. The study found that all students who were assigned a teacher of color rather than a White teacher demonstrated significant increases in reading achievement, reported higher levels of self-efficacy and class engagement and were less likely to be chronically absent (Blazar, 2021). Carter Andrews et al. (2019) explains that teachers who identify as BIPOC bring crucial perspective and a variety of life experiences into the classroom for students. In short, BIPOC teachers matter, and they make a significant difference on student academic and nonacademic achievement.

In conclusion, recruitment and retention of teachers who identify as BIPOC continue to be a significant issue in teacher education as the field acknowledges the need

of a diverse teacher workforce. Residency programs are contributing to these efforts to diversify the teacher workforce.

Teacher Residency

Alternative certification programs laid the foundation for variation from the traditional teacher certification programs. One of the significant additions to pathways of teacher certification in the past decade is that of Teacher Residency programs. These were created largely in response to the issue of recruitment and retention of BIPOC teachers and the need for more highly qualified teachers in the field. In 2008, Congress passed the Teacher Quality Partnership Grants Program as part of The Higher Education Opportunity Act of 2008 (Public Law 110-315). Many states used this funding to create Teacher Residency Programs (TRPs) across the U.S. Teacher Residency Programs can be defined as a one-year teacher certification pathway that is a partnership between a university and a high-needs school district in which the residents are hired. The residents attend teacher education courses at the university and work with a mentor teacher within a school district where they will be hired after the program. Residents gradually gain responsibilities in throughout the year, ending in student teaching in which they have autonomy under the supervision of the mentor teacher (Silva et al., 2014). TRPs were modeled after residencies in the medical field, characterized by rich clinical experiences closely connected to their coursework (Guha et al., 2016). Their coursework is accelerated from the traditional teacher certification programs but is designed to directly support the work they do in the classroom (Silva et al., 2014).

TRPs aim to promote "greater gender and racial diversity" in the teaching workforce (Guha et al., 2016, p. 11). In 2015-2016, 45% of residents were people of

color. “This proportion is more than double the national average of teachers of color entering the field” (Guha et al., 2016, p. ii). Guha and colleagues (2016) also reference that the retention rate for teachers who gain certificates through residencies ranges from 70-80% after 5 years as opposed to 20-30% of national averages (p. ii). These programs help increase recruitment and retention of BIPOC teachers through strategic moves (e.g., cohort model, mentor teacher, standardized test reduction) that eliminate barriers and make a more equitable teacher education environment (Guha et al., 2016).

Urban Teacher Residency

In addition to creating more equitable teacher education programs, many states have also acknowledged the need for more highly qualified teachers in their urban school districts. The term “urban” has often been used as a “code” term that might describe school districts from a deficit mindset- a location with significant needs because of students’ racial and linguistic diversity, and higher poverty (Chu & Wang, 2022). The term urban education, however, should be framed, instead, to describe a district in a major metropolitan area with a high population density that typically has inequitable access to finances, and with students who are more likely to be racially and linguistically diverse (Milner, 2012). Teachers in a district that is considered urban require a unique set of skills, attitudes, beliefs, and dispositions to best support the students, schools, and communities (Hollins, 2012). Additionally, there is often an uneven distribution of funding for and resources in these areas (Milner, 2012). Without using “urban” as a deficit term, it is important to recognize the specific characteristics that make up an urban school or school district in order to build the specific teacher skillsets, resources, and provide for the strengths and needs of students within urban settings.

Because of these unique set of skills needed for these schools and the issues of funding, it is often difficult to recruit and retain teachers in these areas. Teacher attrition in urban areas has long been a national issue, particularly for new teachers and those less equipped to handle the unique circumstances that may characterize urban areas (Hollins, 2012; McKinney et al., 2008; Milner, 2012). Though alternative route to certification programs are more likely to have more teachers begin work in urban school districts (Natiello & Zumwalt, 1993), they tend to leave urban schools at the same rate as their traditionally trained peers to move to White dominant suburban schools (Lankford et al., 2002; Murnane et al., 1991). In addition to recruiting and retaining teachers who identify as BIPOC, Urban Teacher Residencies were also designed to create a larger pool of highly qualified teachers who are equipped with the specific skillsets, attitudes, and dispositions to work in urban settings (Berry et al., 2008).

Evaluation of the Residency Model

Since the creation of the residency model around 2010, the Urban Teacher Residency model has spread across the United States and subsequently has increased research interest in these programs (Chu & Wang, 2022). This is a relatively new area of research interest, and therefore few studies have been published to date. Available studies focus on (1) the effectiveness of UTRs in training teacher candidates, (2) the impact on the resident, mentor teachers, and (3) outcomes of students taught by urban teacher residents. Each of these topics are addressed in the next paragraphs.

Research indicates that urban teacher residencies are effective in preparing teacher candidates to teach in urban school districts. In their study, Zugelder et al. (2020) used feedback from school district and residents after one year of the model

implementation and found that the school district personnel found "high favor for readiness to teach". Additionally, residency candidates have reported increased self-efficacy and confidence throughout the year aligned with the increase in responsibility within their clinical experiences (Reynolds et al., 2016; Zugelder et al., 2020). Similarly, many stakeholders in the program such as university faculty, school and district administrators have expressed that urban teacher residents are better prepared to work within the urban school district because of their extensive work in the schools and their better understanding of the district's needs (Beck, 2016; Gardiner, 2011; Garza et al., 2018).

Second, residency models have a variety of benefits for the residents, mentors, and schools in which residents are employed. Quartz & IMPACT Research Group (2014) analyzed a variety of data (interviews, surveys) from 158 residents and 109 mentors working in 32 urban schools and communities. Results indicated that residents benefited from relationships with their cohort members. In this data, residents explained that the strong and important relationships they formed created a network of support both during and after the program was completed. Residents supported each other in their planning and coursework, helped one another process learning, and provided continued emotional and practical support. Moreover, residents felt more prepared for their own classrooms due to the increased time in the classroom. This increased time in the field also added to increased participation in the school community. Residents participated in professional community with other teachers, sustained relationships with students and their families, attended conferences, after-school programs, and other events that connected residents to the school and community culture (Quartz & IMPACT Research Group, 2014).

Mentors also benefited from residency programs. Kawasaki et al. (2014) examined the mentoring process in University of California Los Angeles (UCLA) residency program. They aimed to determine qualifications for an effective mentor and mentor support structures. The mentors were provided with a stipend and professional development as well as additional support in the classroom (i.e., university faculty coming to work with the resident). The research suggests mentors benefited from both the financial and professional development supports, enhancing their own teaching practices (Goodwin et al., 2016; Kawaski et al., 2014; Kolman et al., 2016).

Third, students benefit from urban teacher residency models. Evaluating outcomes of students taught by urban teacher residents requires longitudinal research. As the UTR is a relatively new model of teaching certification, there are very few longitudinal studies. Hunter College Urban Teacher Residency was one of the first Urban Teacher Residencies (UTR) and has therefore been the subject of three longitudinal studies that look at the success of the UTR model. These studies looked at 150 teachers who were placed in some of the "highest-need" secondary schools. Survey and focus group data from both internal and external sources found that residents felt confident in their skills and knowledge and confident in their decision to join the teaching profession. Moreover, student achievement data has shown that students taught by UTR teachers consistently performed as well as their peers and often performed better than their peers. (Sloan et al., 2018).

The Boston Teacher Residency (BTR) is another early residency program. A longitudinal study on this residency revealed interesting findings about student outcomes. Papay et al. (2012) found that BTR teachers were as effective as their traditionally trained

peers in raising student language arts test scores but were less effective in raising mathematics test scores. However, by their 4th and 5th years of teaching, BTR teachers' students outperformed veteran teachers' students in mathematics (Papay et al., 2012). Through longitudinal studies, residents have demonstrated continual growth in self-efficacy and confidence as well as continued growth in their teaching abilities.

In summary, students benefit from teachers who identify as BIPOC, yet these BIPOC teacher candidates have been marginalized in traditional teacher training models. The Urban Teacher Residency was designed to address these two well-established findings. Residency models have been successful in recruiting a more diverse teacher workforce and retaining those teachers and have also produced more confident teachers, growth opportunity for mentor teachers, and subsequent improvement in student outcomes. UTRs are having a positive impact on teachers and students in urban schools. Due to the recency of UTR models, more research is needed to understand how to effectively prepare teachers in this model. This study focused on the mathematics identity of a group of urban teacher residents.

Identity

An individual's identity can simply be defined as their *self-understanding* (Holland et al., 1998). This *self-understanding* is quite complex and multi-faceted and is impacted by factors internal and external to the individual (Mead, 1934; Vygotsky, 1978). In this section on identity, I outline research on identity in the context of academics. I use the term *academic identity* to refer to the *self-understanding* that occurs in the academic setting. This research includes the internal and external influences on academic identity including motivation, race, gender, and relationships and the impacts of

academic identity on achievement. The discussion then narrows to mathematics identity as more specific identity within the academic context. This, again, focuses on both the internal and external influences on mathematics identity. One of the most significant influences on mathematics identity are teachers (Aguirre et al., 2013). As such, it is critical for pre-service teacher programs to address mathematics identity of their students (AMTE, 2017). Therefore, this section concludes outlining the literature that pertains to teacher mathematics identity in pre-service teacher programs.

Academic Identity

The self-understanding that builds an individual's identity can be shaped within various contexts. Holland and colleagues (1998) describe these contexts as *figured world* in which an individual ascertains a specific identity. Holland et al. (1998) describes a *figured world* as "a picture of a simplified world…a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (p. 90). The academic context can be seen as one of these *figured worlds* as an individual ascertains a specific identity as a student and a learner. This identity is influenced socially and culturally by factors both internal and external to the individual (Mead, 1934; Vygotsky, 1978). This section discusses motivation, gender, race, and relationships as factors that can influence academic identity.

Motivation. Motivation in the academic setting is a critical component of academic identity as it contributes to engagement (Blumenfeld et al., 2006; Martin et al., 2011) and resiliency (Martin & Marsh, 2008). Motivation is often cyclical with both ideas of engagement and resiliency (Blumenfeld et al., 2006; Green et al., 2006; Ng,

2018). For example, when a student is motivated within a classroom, they tend to become more engaged in the classroom and therefore become more motivated to engage in the class (Blumenfeld et al., 2006). Additionally, motivation can also help a student's ability to overcome setbacks and challenges in the classroom (Martin et al., 2011). Martin and Marsh's work (2008) describes that academic setbacks and challenges can be significant (learning disability, race tension, suspension, etc.) or "everyday challenges" such as a failed assignment, test pressure, or competing assignment dates. Students who overcome challenges and setbacks effectively, showing resiliency and "academic buoyancy" in turn, have more motivation and engagement in the academic setting (Green et al., 2006; Ng, 2018). This cycle of motivation and resiliency in the academic context have been found as an indicator of positive academic self-concept (Dweck, 2006; Green et al., 2006). There is a large body of work that supports that motivation and therefore engagement and resiliency in the academic setting are critical in the development of academic identity (Blumenfeld et al., 2006; Green et al., 2006; Martin & Marsh, 2008; Martin et al., 2011; Ng, 2018)

Gender. Gender identity is another important influence on a student's academic identity. In a study of 1,265 individuals ages 8-25, Gibb and colleagues (2008) found that while the males and females have comparable IQ scores, the females consistently outperformed males on standardized tests and in measures of school achievement (e.g., grades). While this finding is supported throughout the literature on gender differences in education (Fergusson & Horwood, 1997; Praat, 1999; Weaver-Hightower, 2003), research shows that females consistently have more anxiety in the academic setting. A study using the AEQ questionnaire shows that female students report more "class-related

enjoyment" but a significantly higher level of anxiety in an academic setting than males. (Pekrun et al., 2011). This is consistent with decades of research in the field (Bhansali & Trivedi, 2008; Hembree, 1988; Nunez et al., 2016; Zeidner, 1998). Since both achievement and affect (e.g. anxiety) have an impact on identity in the academic setting (Pekrun et al., 2011; Green, 2006), these gender differences impact an individual's academic identity.

Race. Another identity that influences academic identity is racial identity. Urdon & Munoz (2012) state that racial identity is especially influential on academic identity when students identify as BIPOC. In this work, I use BIPOC to refer to populations that have been racialized within the United States including Black, Indigenous, African American, Latinx, and Asian individuals (Deo, 2023). I acknowledge that these populations have had very different racialized histories within the United States. As such, I identify these populations separately when referring to just one of these populations and collectively as BIPOC when referring to racialized populations as a collective. The academic identities of students who identify as BIPOC are often influenced by their identification within this group due to their racialized experiences in the academic setting (Durant, 2013).

Race inequality is a systemic and endemic issue within the United States, deeply impacting education through the marginalization of students of color (Ladson-Billings & Tate, 1995). The historical pervasiveness of "whiteness" within educational practices (e.g. competitiveness, perfectionism) promotes white culture as the "dominant narrative" and therefore positions students of color as inferior (Dixson & Anderson, 2017). This can have a detrimental impact of the academic identity of students who identify as BIPOC

(Dixson & Anderson, 2017). However, recent studies have suggested that when racial identity is valued as a part of the holistic student in the educational environment, academic achievement and academic identity can grow. For example, Reid (2013) aimed to find the potential relationship between the success of African American undergraduates and their sense of self-efficacy and, racial identity attitudes and institutional integration. The study found that "African American males who have a resolved and stable racial identity and who view their faculty and peer interactions favorably tend to do better in college than students who are less resolved in their racial identity" (p. 87). Reid goes on to explain that when a student had strong racial identity, they had more positive social integration and higher academic achievement. This idea is echoed in a study on Chinese immigrants in Canada that found a better understanding of their own ethnic identity can act as a protective factor against depressive symptoms, low self-esteem, and thus low academic identity (Costigan et al., 2010). It is critical, therefore, that educators consider the role of race and culture and how they manifest in the educational setting to help students improve their academic identity as well (Rouland, 2017).

Peers and Caregivers. Finally, an individual's academic identity is impacted by relationships with peers and caregivers (Pekrun et al., 2011; Reid, 2013; Ishak et al., 2012). Pekrun et al. (2011) found that a trusting relationship with caregivers was a determining factor for positive academic self-concept. Ishak and colleagues (2012) investigated parenting styles and academic achievement. They found that there is a correlation between parenting and academic self-concept. Specifically, if caregivers worked to positively develop a child's self-concept outside of the academic setting, the

child is more likely to positively develop an academic self-concept (p. 6). Research suggests that there is a correlation between student academic achievement/self-concept and parental involvement in their child's academics, especially in the elementary grades (Jeynes, 2003).

It has long been understood that peers have "powerful influence over youth outcomes" and affect behavioral change. This change could be negative or positive (DeLay et al., 2016, p. 903). Blanton and colleagues (1999) found that peer influence can positively impact academic competence and adaptive functioning through modeling, reinforcement, and collaborative learning (Harris, 1995). Reid (2013) aimed to determine if strong peer ties impacted academic identity and found that strong ties to peers, specifically peers who share other identities (e.g. racial/ethnic identities) can be a predictor of academic achievement and positive academic identity.

A student's academic identity is important to consider because academic identity has an impact on learning and academic achievement (Green et al., 2006). The research of Green et al. (2006) describes that a student with a positive academic self-concept has high motivation and engagement within the academic environment. These students have high self-efficacy (Bandura, 1997), value schooling experiences, and position themselves around mastery. On the other hand, students with negative academic self-concept have lower academic achievement. These students experience anxiety, avoid failure, self-handicap, and disengage in academic contexts (p. 539).

In summary, academic identity is an individual's *self-understanding* in the academic context and is influenced by many factors including personality traits, gender, race, and relationships. Factors of identity are developed by both the way a student sees

themselves and their perception of how others see them (Gee, 2000). The academic context can be seen as one of the *figured worlds* (Holland et al., 1998) in which students participated However, the academic context could also be viewed as a larger context with many *figured worlds* (Holland et al., 1998) within. One of these *figured worlds* in which students ascertain a specific identity (Holland et al., 1998) is that of the mathematics context. In the next section, I explore factors that influence a student's identity within a mathematics context.

Mathematics Identity

Separate *figured worlds* (Holland et al., 1998) developed in specific content areas can form based on student interest, motivations, and self-efficacy within those contexts (e.g., Marsh et al., 2002; Pintrich, 2003; Zimmerman, 2000) as well as the interaction of their other identity factors (motivation, gender, race, etc.) (e.g. Martin et al., 2011; Pekrun et al., 2011; Reid, 2013). Identity in mathematics has developed a great deal of attention in the research literature over the past ten years (Graven & Heyd-Metzuyamin, 2019). Mathematics Identity can be defined as an individual's *self-understanding* as a learner and doer of math. This includes a person's disposition and beliefs about their ability to participate and perform in mathematical contexts (Aguirre et al., 2013). While a student's overall academic identity may be an important factor in their mathematics identity development, students who feel confident in the academic setting may struggle with a negative math identity or feel as though they are just "not a math person" (Aguirre et al., 2013). Factors that are both internal and external to an individual influence this identity. Similar to academic identity, I outline factors of motivation, gender, and race in

the development of student mathematics identity. I then discuss teachers as a primary factor in student mathematics identity.

Motivation. Similar to academic identity, mathematics identity is influenced by the motivation an individual has in the mathematics context (Cribbs et al., 2015; Middleton & Tulak, 1999). There are many reasons that students struggle with motivation in mathematics specifically. Historically, students struggle to connect the world around them to the mathematics they are asked to do in the classroom (Middleton & Tulok, 1999). The individual's ability to connect mathematics with social and cultural worlds around them can be due to a lack of interest (Cribbs et al., 2015; Middleton & Tulok, 1999), the perceived usefulness (Middleton & Tulok, 1999; Husman et al., 2004), and their self-efficacy (Cribbs et al., 2015; Usher, 2009). When this occurs, student motivation tends to decrease and there is a lower rate of engagement in mathematics learning (Simpkins et al., 2006). However, when motivation increases in mathematics, resiliency (Martin, 2006) or "hope" (Golden, 2000) subsequently increase in the mathematics context (Middleton & Tulok, 1999). This cycle has a significant impact on academic achievement in the mathematics setting (Murayama et al., 2013) Thus, motivation is a critical factor in the development of mathematics identity.

Gender. Gender identity also plays a role in a student's mathematics identity. Singer & Stake (1986) described mathematics as a traditionally masculine field. They explain that there is higher societal expectation for men to succeed in mathematics than women (Singer & Stake, 1896). Such expectations have created gender stereotypes in the context of mathematics (Cvencek et al., 2011; Cvencek et al., 2021; Durant, 2013; Seymour & Hewitt, 1997). Seymour and Hewitt (1997) were interested in the reasons

minority women were leaving the fields of math and science at the undergraduate level. They conducted focus group interviews with students who switched from science, engineering, and math majors. Their findings described that their feelings of competence, confidence, persistence, and strong interest was lower in these STEM majors. Additionally, they explained that their support systems were not strong in these majors unlike their male counterparts (Seymour & Hewitt, 1997). Lesko & Corpus (2006) examined stereotypes in mathematics in an investigation using stereotype bias. The participants were made of two groups of similar mathematics performing women. One group was exposed to a gender stereotype before a mathematics test while another was not. The women who were exposed to the stereotype threat performed worse on the test than the women who were not exposed to the threat (Lesko & Corpus, 2006). Such gender stereotypes begin influencing children at a very young age. Cvencek et al. (2021) measured implicit and explicit math attitudes and self-concept in 391 children. They found that girl's negative math attitudes and beliefs begin as early as 1st grade. Their work revealed that there are specific cultural stereotypes that are sometimes reinforced by caregivers, leading to these negative attitudes and beliefs about mathematics in girls (Cvencek et al., 2021). Though gender is not an indicator of academic ability in mathematics (Hyde et al., 1990), the perception of gender and gender stereotypes impact a how a student sees themselves as a learner and doer of mathematics.

Race. Racial identity also influences mathematics identity. Martin (2006) in his study of African American parents explains that the systematic racism of African American students may contribute to the formation of mathematics identities. He states,

> I show, via the parents in my research, that the social devaluing of their African American status and their subsequent treatment makes African American status a salient marker for participation in mathematics…this social devaluation, and responses to it, influence the formation of identities of participation and nonparticipation in mathematics (p. 201).

In their study on mathematics identity and its' relationship to racial identity, English-Clarke, et al. (2012) focused on the "racial-mathematical socialization stories" reported by African American youth as they negotiated racial-mathematical stereotypes. One-third of the students interviewed reported hearing racial-mathematical messages from parents, peers, or community members. Almost all the stories shared messages that described racial discrimination in mathematical settings (English-Clarke et al., 2012). This negative racial stereotyping in mathematics has been studied mostly in African American and Latinx students who tend to be stereotyped as "caring less about school" or being "less intelligent" (Okeke et al., 2009). Such negative stereotypes may have a significant negative impact on a student's mathematics achievement (Cvencek et al., 2014).

While race perception and stereotypes can have a negative impact on mathematics identity, there are new studies that find positive mathematics identity is a way to fight against these stereotypes and disparities in mathematics (Gonzalez et al., 2020). In their study, Gonzalez et al. (2020) explored the relationship between mathematics identity and mathematics success (measured by GPA) of Black secondary students. They found that positive mathematics identity is linked to achievement in mathematics, even while controlling for the factors of socioeconomic status and parents' social capital. Thus, the

way students see themselves and their own identities in respect to the discipline of mathematics is critical for mathematics achievement.

Teachers. One of the most important factors impacting how students see themselves in mathematics is how their other identities are valued within the classroom (Gonzalez et al., 2020). Much of the work of valuing a student and their multiple identities within the classroom falls with the teacher. Gonzalez et al. (2020) state "rather than teach mathematics separate from the experiences of students, we must embrace the cultural, social, and historical experiences of our students and teach mathematics in a way that capitalizes on who the students are" (p. 463). Thus, when a teacher values a student's racial, gender, and other identities, embracing these within the mathematics curriculum, the student finds a better sense of belonging within the mathematics classroom, increasing positive mathematics identities (Aguirre et al., 2013). The work of Verelas et al. (2013) examines multiple dimensions of Black students' mathematical identity including disciplinary identity (doers of mathematics), racial identity (what it means to be Black), and their academic identity (as participants in classroom practices). In their research, Verelas et al. (2013) describe the negotiation that occurs as the students grapple with all three dimensions of their identities within the mathematics classroom and the importance of teachers in supporting these multiple identities. Collectively, these studies indicate that teachers play a pivotal role in providing attention to student identities and their multidimensionality in the mathematics classroom.

Teachers also play a pivotal role in designing the mathematics experiences that foster positive mathematics identity. The experiences that teachers provide and decisions they make in their math classrooms significantly influence student math identity (Aguirre

et al., 2013; Leatham & Hill, 2010). To build positive mathematics identity in students, teachers should attend to student-centered approaches that build on student strengths (Aguirre et al., 2013). Starkey-Perret and colleagues (2017) used the AEQ instrument to study the impact of teaching methods on students' emotions and identity in the classroom. They found that a student-centered approach to learning in which teachers are working alongside students and valuing them as co-constructors of knowledge increased positive emotions and decreased negative emotions in the classroom (Starkey-Perret et al., 2017). Thus, designing instruction to build on student strengths and knowledge can lead to positive emotions and therefore positive identities in the mathematics classroom.

In conclusion, many factors influence a student's mathematics identity including their motivation, race, and gender. How teachers address these factors within the classroom and the extent to which teachers design positive mathematics experiences for students also influences how a students' mathematics identity develops. Unfortunately, if teachers possess a negative mathematics identity themselves, they may be hindered in their ability to support students in developing positive mathematics identities (Aguirre et al., 2013). In the next section, I outline research that focuses on building positive teacher mathematics identity, particularly mathematics identity work in pre-service teacher programs.

Addressing Teachers' Mathematics Identities

Many teachers possess negative attitudes towards mathematics, hindering their ability to support students in building positive mathematics identities (Aguirre et al., 2013). This is especially true of elementary teachers (Heffner & Newton, 2018). In her study of elementary pre-service teachers, Johnson (2018) states "although early

childhood and elementary educators teach mathematics to children, many of them possess negative attitudes and beliefs about mathematics such as math anxiety and low mathematics self-concept" (p. 1). Lake and Kelly (2014) further this idea by explaining that many teachers choose to teach younger children due to their lack of confidence in knowledge of mathematics. When teachers possess such negative attitudes towards mathematics themselves, there can be significant negative impacts on students. In their study, Mapolelo, and Akinsola (2015) sought to find the impact of teachers on students in 4 areas. These were (a) the role of subject matter knowledge, (b) teachers' beliefs about mathematics teaching and learning, (c) beliefs and beliefs-in-practice: inconsistencies, (d) teacher education and its impact on instructional practices. They found that teacher's content and pedagogical knowledge were critical factors in student achievement. They also found that "a teacher's memories from their school years are a central influencing factor that affects its mathematics related beliefs and impacts their instructional practices in mathematics" (p. 505).

In summary, teachers' past mathematics experiences impact their attitudes and beliefs about mathematics and therefore their ability to support positive mathematics identities in their students. NCTM has acknowledged the link between teacher mathematics identities and student mathematics identities and has prioritized cultivating positive mathematics identity as a necessary and critical conversation in mathematics education (NCTM, 2020).

Mathematics Identity and Pre-service Teachers

While there are many ways that teachers can begin this work of negotiating the development of their own math identity, it is critical that this work begins in teacher

education programs for pre-service teachers (AMTE, 2017). These pre-service teachers come into teacher education programs with a variety of mathematical identities. Like students in the k-12 setting, pre-service teachers come to this *understanding of self* in the mathematics context through their own social and cultural experiences within mathematics contexts. Many elementary pre-service teachers, specifically, have negative attitudes about mathematics (Kaasila et al., 2012). There is a growing body of research that aims to discover the reasoning behind elementary pre-service teachers' negative mathematics identity and how teacher education can respond to promote positive mathematics identities.

A study by Heffernan (2016), implemented an intervention in mathematics education course for pre-service teachers that allowed students to explore their experiences, beliefs, and attitudes in mathematics through group discussion, identity exploration tasks, reflective writing assignments, interviews, and observations. The pre-service teachers used these interventions to explore the influence of their schooling experiences and how these shaped their beliefs and attitudes in mathematics. The study found that there is an interaction between self-perceptions, beliefs, goals, and actions in pre-service teachers (Heffernan, 2016). Thus, how pre-service teachers see themselves as learners and doers of mathematics impacts their actions as future teachers (Heffernan, 2016; Johnson, 2018; Lake & Kelley, 2014). Moreover, allowing the pre-service teachers to process the influences on their mathematics identity can help pre-service teachers develop a more positive mathematics identity (Heffernan, 2016).

Lutovac and Kaasila (2011) also sought out to address negative mathematics identities in pre-service teachers. They used the therapeutic strategies of narrative

rehabilitation and bibliotherapy in a mathematics course for prospective elementary teachers. The study suggests that addressing negative attitudes about mathematics through therapeutic techniques, coupled with clinical teaching practices, can contribute towards positive mathematics identity. Doing so allows pre-service teachers to move from thinking about their experiences in mathematics toward thinking about themselves as future mathematics teachers (Lutovac & Kaasila, 2011). This framework of future *possible selves* is utilized in Lutovac's (2020) study on pre-service teachers' failures in mathematics and how this shapes their mathematics identities. This study demonstrates that pre-service teachers benefit from using past experiences in mathematics contexts as a framework to think about the future *possible selves*. In this way, pre-service teachers grapple with their own mathematics experiences and the impacts on their mathematics identities in an effort to begin thinking about who they want to be as mathematics teachers for their future students (Lutovac, 2020).

In summary of the literature related to mathematics identity, many mathematics teachers, especially elementary teachers, have negative mathematics identities (Heffner & Newton, 2019) that in turn, negatively impact student identities (Mapolelo et al., 2015). As such, it is crucial that mathematics teacher education programs address mathematics identity in pre-service programs (AMTE, 2017). There are many studies that examine pre-service teachers' math identity and can help inform teacher educators about sources of negative math identity in pre-service elementary teachers and successful interventions (Darragh, 2015; Heffernan, 2016; Lutovac, 2020; Lutovac & Kaasila, 2011). These studies provide evidence of the growth and development that can occur when pre-service programs focus on helping pre-service teachers explore their mathematics identities and

prepare these pre-service teachers to build positive mathematics identities in their future students (AMTE, 2017; Lake & Kelly, 2014). A trauma-informed care framework is implemented in this study to promote positive mathematics identity in the urban teacher residents.

Trauma

Trauma can be defined as "an umbrella term denoting the inability of an individual or community to respond in a healthy way (physically, emotionally, and/or mentally) to acute or chronic stress. Trauma occurs when stress compromises the health and welfare of a person and his/her community" (Wolpow et al., 2009). In this section about trauma, I discuss the understanding of trauma and how history has shaped the narrative around trauma and more specifically, childhood trauma. Within this conversation, I outline research on childhood trauma across history and its effects. There have been many subsequent studies on trauma interventions that have been implemented in multiple settings to mitigate the impacts of trauma. These settings include the areas of medicine, mental health, and school-based care. The section focuses largely on school-based interventions that have been found as effective in positively impacting trauma-exposed students. It is at this point that I shift my focus to trauma that has been enacted in the academic setting, or academic trauma. Specifically, I focus on trauma in the mathematics classroom.

General research shows that there are specific psychosomatic reactions to traumatic situations that impair our cognitive and social abilities. Studies on math trauma in classrooms have found similar effects. When students are exposed to a math traumatic experience, they may have stress reactions that reoccur in the math environment which

may have a long-term impact on their ability to function and learn in the math setting. At the end of this section, I summarize this literature review to frame the rationale for this study.

History

Traumatic circumstances and events have been present throughout history. However, the way that society has acknowledged, accepted, and reacted to trauma has significantly shifted overtime (Van de Kolk, 2015). The concept of trauma was first recognized in the 1860's as war veterans returned home with significant, mental, emotional, and physical stress from their war experiences (Van de Kolk, 2015). Foundational trauma literature written by Freud and Breuer (1893) entitled *Studies on Hysteria* and the subsequent *Beyond the Pleasure Principle* (Freud, 1920) presented trauma struggles as "moral weakness" or "battle fatigue", commenting on an individual's inability to properly cope with their experiences (Thomas et al., 2019).

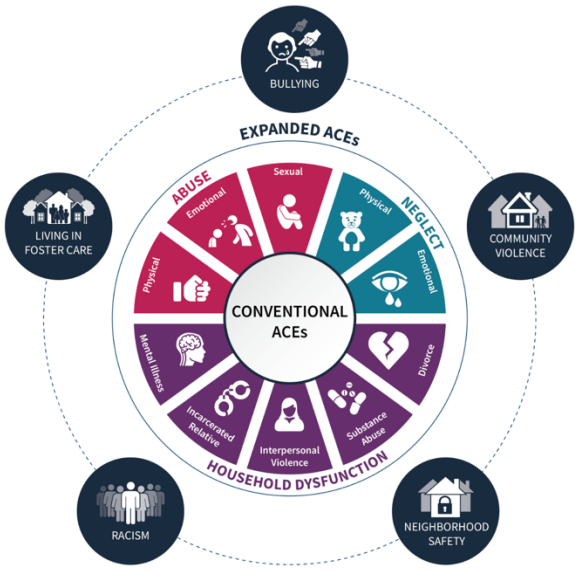
It was not until the 1980's that the American Psychiatric Association recognized Post-Traumatic Stress Disorder (PTSD) as a clinical diagnosis that indicated an experience of a specific tragic event and subsequent maladaptive functioning (American Psychiatric Association, 1980; Center for Substance Abuse Treatment, 2014). As the recognition and acknowledgement of this diagnosis grew, so did the "societal consciousness" that trauma and its' consequences reached beyond war veterans and began to encompass many forms of violence as well as "perceived threat or harm" (Thomas et al., 2019).

Childhood Trauma

The seminal study that launched historic research into trauma and its consequences is the study on Adverse Childhood Experiences (Felitti et al., 1998). This study was a collaboration between the Center for Disease Control (CDC) and Kaiser-Permanente in which 17,000 participants were surveyed and asked about their childhood experiences of maltreatment, family dysfunction, and childhood loss. The study then asked participants about their current health status and behaviors. The ACE study found a direct correlation between adverse childhood experiences and increased health. The more ACE's an individual reported, the more health and behavioral risks they exhibited (Felitti et al., 1998). This study has sparked an immense number of studies that replicate, expand upon, and contribute further findings from the study (CDC, 2022). The Philadelphia ACE's Project, led by Cronholm et al. (2015) expanded the ACE's project. In their introduction, they discuss that the original ACEs survey (Felitti et al., 1998) studied mostly middle and upper-class, White, educated individuals. Cronholm et al. (2015) and aimed to discover if subgroups within Urban populations may be differently impacted by ACEs. Moreover, they wondered if factors outside house-hold level adversities might have future impacts on an individual's life. This study surveyed 1,784 individuals in two areas including the original Conventional ACEs and the new Expanded ACEs which included community-level adverse childhood experiences. They found that 72.9% of their respondents had at least one Conventional ACE, 63.4% had at least one Expanded ACE, and 49.3% experienced both. Figure 4 below is a representation of the Expanded ACEs that are now addressed in many studies involving Adverse Childhood Experiences (CDC, 2022).

Figure 4

Expanded Adverse Childhood Experiences



From: Adverse childhood experiences: Expanding the concept of adversity by Cronholm, P. F., Forke, C. M., Wade, R., Bair-Merritt, M. H., Davis, M., Harkins-Schwarz, M., Pachter, L. M., & Fein, J. A., *American Journal of Preventive Medicine, 49*(3), 354–361. (2015).

Using the data from this study, Wade et al. (2016) found that the relationship between expanded and conventional ACEs and socioeconomic status (SES) was statistically significant. They explain that their data suggests that lower SES correlated with increased ACEs (Conventional and Expanded). They also found that individuals with lower SES also reported increased severity of health and behavioral risks. (Wade et al., 2016). Both studies (Chronholm, et al., 2015;Wade et al., 2016) suggest that there is increased health and behavioral risks in individuals of color and in individuals who have experienced generational/historic trauma (CDC), 2016).

Alongside these studies, there have been several studies that focus on the neurobiology behind these findings (Metzler et al., 2017). In their study about life opportunity associations with ACEs, they state:

> Exposure to chronic stress can induce changes in the architecture of different regions of the developing brain (e.g., amygdala, hippocampus) which can impact

> a range of important functions, such as regulating the stress response, attention, memory, planning, and learning new skills, and also contribute to dysregulation of inflammatory response systems that can lead to negative impacts on organ systems (p. 142).

McCrory et al. (2011) conducted MRI scans of individuals with ACEs and found that ACEs negatively impact early brain development. Colborn (2004) explained that a fetus' exposure to thyroid disruptions in pregnant mothers may increase hyperactivity and attention issues. Roth et al. (2009) used a gene in the central nervous system of rats to indicate that childhood trauma can have "lasting imprints on neural mechanisms of cognition and emotion" (p. 760). These findings are supported by many other studies that demonstrate chronic stress caused by trauma responses can have detrimental effects on the individual's cognitive processes as well as their overall health and well-being (Metzler et al., 2017). Thus, childhood trauma in both the conventional sense (e. g. childhood abuse or neglect) and trauma in the expanded sense (e.g. racism, community violence) (Chronholm et al., 2015) can have significant psychosomatic impacts including disruptions in brain function (Colborn, 2004; McCrory et al., 2011; Roth et al., 2009), emotion (Metzler et al., 2017; Roth et al., 2009) and a decrease in overall well-being (McCrory et al., 2011; Metzler et al., 2017).

Trauma-informed Care

Trauma-informed Care (TIC) is the term that has been given to the mindset and practices utilized to support individuals who have experienced trauma and these negative psychosomatic impacts of trauma (Bath, 2008). This term has been used to describe treatment and support for individuals in many settings including the areas of medicine,

mental health, and education. The Substance Abuse and Mental Health Services Administration (SAMSHA) describes a trauma-informed approach includes acknowledging the presence and prevalence of trauma, recognizing the impact of these experiences on an individual, using trauma-sensitive practices, and avoiding practices that could potentially retraumatize an individual (SAMSHA, 2015; National Center for Trauma-Informed Care, 2015; Thomas et al., 2019).

One of the first and most long-lasting models of TIC is that of the Sanctuary Model (Esaki et al., 2013). This model was created by Bloom et al. (1980). These practitioners worked with individuals who "survived overwhelming and often traumatic life experiences" (Esaki et al., 2013, p. 87). These three practitioners described "'sanctuary trauma' as expecting a welcoming and healing environment and finding instead more trauma" (p. 87). In response to this realization, they created a framework that became known as the Sanctuary Model. The model is described as "a non-violent, democratic, therapeutic community in which staff and clients are empowered as key decision-makers to build socially responsive, emotionally intelligent community that fosters growth and change" (p. 49) and is built on the SAGE framework (Safety, Affect Modulation, Grieving, and Empowerment) (Bloom, 1997). This model has been implemented in many residential and outpatient treatment facilities over the last two decades and now has a significant research base that demonstrates its effectiveness (Esaki et al., 2013). Rivard et al. (2003) conducted the first study that focused on this trauma-informed approach with youth as participants. The staff and patients in the Sanctuary Model treatment group participated in psychoeducation group sessions that focused on trauma theories, cognitive-behavioral approaches to managing emotions and behaviors,

empathy and attachment to others, and problem solving and decision-making skills (p. 141). The patients in this treatment group scored higher on areas of involvement, support, and safety, and lower in areas of anger and aggression than the patients in the delayed treatment group (Rivard et al., 2003).

Similar findings have occurred in other settings outside of residential treatments. Jankowski et al. (2019) found that a TIC approach helped children in the welfare system (i.e. children in foster care and juvenile justice) improve in "attitudes and behaviors" according to their screening processes (p. 94). TIC approach can also be used in the healthcare setting to better identify and mitigate trauma and its' effects as well as improve care and health as for the whole child (Gerber et al., 2019). These findings from the mental health (Bloom, 1980; Esaki et al., 2013; Rivard et al., 2003), child welfare (Jankowski et al., 20019), and the healthcare setting (Gerber et al., 2019) suggest that a focus on trauma-informed care might improve a trauma-exposed youth's overall well-being.

School Based Trauma-Informed Care

Many TIC approaches have developed over the past 20 years that effectively support youth in multiple environments (Thomas et al., 2019). In the past decade, there has been "evidence to suggest that trauma-informed living environments in which healing and growth can take place are a necessary precursor to any formal therapy that might be offered to a traumatized child" (Bath, 2008, p. 17). Other individuals in a child's life such as parents, coaches, and teachers can be important factors in a child's healing process (Greenwald, 2005). Teachers spend a large amount of time with their students and therefore can be a significant change agent in a students' life (Wolpow et al., 2009). As

such, schools have become an important focus of trauma-informed care (Thomas et al., 2019.). In their review of literature on trauma-informed care practices in school, Thomas et al. (2019) found that each of the resources they analyzed that are currently implemented in schools fell into three categories: “Building knowledge and understanding on the nature and impacts of trauma”, “Shifting perspectives and building emotionally healthy school cultures” and “self-care for educators” (p. 427). These categories echo the trauma-informed approaches outlined by SAMSHA (2015) and found as important to healing in non-school treatment (e.g. Sanctuary Model by Bloom, 1997).

While there is not one agreed-upon framework of trauma-informed care implemented in schools, there is a growing body of research that points to trauma-informed approaches that are successful in supporting trauma-exposed students (Thomas et al., 2019a). Hoover et al. (2018) implemented Cognitive Behavioral Intervention for Trauma in Schools (CBITS) with 316 children across their state who had been identified as trauma-exposed and demonstrated symptoms of PTSD. Students participated in group sessions that focused on skill building and cognitive-behavior techniques led by school-based individuals who were trained in the delivery of the intervention. Through a pre-post test measure, students almost universally improved in behavioral problems, PTSD symptoms, with great satisfaction from caregivers in demonstrated increase in function (Hoover et al., 2018). Several other studies using similar trauma-informed programs have demonstrated similar improvements (i.e. Ijadi-Maghsoodi et al., 2017 with implementation of Resilience Classroom Curriculum; Durado et al., 2016 with implementation of Healthy Environments and Response to Trauma in Schools; Bartlett et al., 2016 with Trauma-informed Leadership Teams).

Recent research, however, suggests that such trauma-informed care approaches focus too much on "cognitive function" and "problem behaviors" (Golden, 2020). These approaches assume that attending to trauma in the classroom as a form of self-regulation will result in achievement (Golden, 2020). However, research suggests that student healing requires consideration of the student as a holistic individual (Alvarez, 2017; Golden, 2020; Ginwright, 2018). Teachers who wish to be part of the healing process, therefore, must step away from a prescribed trauma-informed approach and attend to the narrative students share about their trauma (Alvarez, 2017; Golden, 2020) and the students' felt needs (Alvarez, 2017; Ginwright, 2018). Alverez (2017) uses document analysis and interviews to uncover four themes of how teachers might support students in this way. These themes were "(a) recognizing social challenges among students; (b) identifying and understanding traumatic experiences; (c) recognizing the influence of traumatic experiences; and (d) responding to student needs" (p. 60). Throughout the study, it was evident that Mr. Sellers was relying on the narrative that students were communicating and coming to understand themselves. This allowed him as their teacher to make sense of their stories in context of their social and cultural environments and respond according to their felt needs (Alverez, 2017).

Such findings help shift trauma-informed approach to a student-centered and holistic view of healing. Ginwright (2018) furthers this idea by explaining a trauma-informed approach can focus on deficit areas, seeing and defining survivors as victims held captive to their trauma experiences. He states, "like the absence of disease doesn't constitute health, nor does the absence of violence constitute peace, the reduction pathology (anxiety, anger, fear, sadness, distrust, triggers) doesn't constitute well-being

(hope, happiness, imagination, aspirations, trust)" (p. ??). Thus, a trauma-informed approach should not just focus on resolving the negative but enhancing the positive. Ginwright (2018) argues for a shift away from the term trauma-informed care altogether and towards the term "Healing Centered Engagement" (p. ??). Thus, a mindset focused on the holistic view of the student rather than the "behavioral" approaches may be more effective in helping promote healing after trauma exposure (Alvarez, 2017; Ginwright, 2018; Golden, 2020).

Educational and Mathematics Trauma

As noted above, trauma can be defined as "an umbrella term denoting the inability of an individual or community to respond in a healthy way (physically, emotionally, and/or mentally) to acute or chronic stress. Trauma occurs when stress compromises the health and welfare of a person and his/her community" (Wolpow et al., 2009, p. ?). This word, "trauma" can encompass incredibly negative and intense experiences in an individual's life. As I shift towards a discussion on the research behind educational/mathematics trauma, I want to acknowledge that an experience of trauma within the academic setting is not comparable to childhood traumas discussed in the above research (i.e., ACEs). However, the use of the definition of "trauma" can be a useful lens to understand the physical, emotional, and mental response that can result from an intensely negative experience in the classroom.

Olson (2009) explained that she sought out to discover moments of joy and excitement that school sparked for individuals and what educators can learn about these experiences. Instead, the participants in her research shared dark stories of how classroom experiences and the educational system had wounded them. These wounds included a

wide spectrum including teachers' unreasonable expectations, perfectionism, and feeling invisible, as well as stereotyping based on gender, race, social class, or class performance (Olson, 2009). Many of the wounds caused by schools are felt more heavily and frequently by students who do not identify with the dominant culture or narrative (Milner, 2007). It is, therefore, reasonable to assume that individuals who identify as BIPOC are more likely to experience more wounds (Olson, 2009), or trauma from the academic setting. In her book, *Educational Trauma*, Gray (2009) reiterates that the authoritarian view that many teachers hold devalue student voice and can consequently cause educational trauma. Moreover, discriminatory practices perpetuated by teachers and the educational system continue to disenfranchise marginalized populations. Such practices can be sources of great stress, discouragement, anxiety, and frustration, and therefore cause physical, emotional, and mental stress responses that can be categorized as trauma (Gray, 2009; Olson, 2009).

The existent empirical literature does not directly correlate negative mathematics identity with the term trauma. However, the literature around negative mathematics identity development discusses the "physical, emotional, and mental stress responses" (Wolpow et al., 2009, p. ?) that can occur in the mathematics setting due to negative mathematics identity. For example, math anxiety is correlated in the literature with memory disfunction, (Ashcroft & Krause, 2007), decreased concentration (Tobias, 1987), decreased mathematics achievement (Ashcroft & Krause, 2007; Foley et al., 2017; Gonzalez et al., 2020; Leatham & Hill, 2010), Low self-efficacy/ability beliefs (Garofalo, 1989; Parker et al., 2014), negative attitudes towards mathematics (Akin & Kurbanoglu, 2011; Rounds, 1980) and physiological reactions such as sweaty palms, heart

palpitations, nausea, and shortness of breath (Perry, 2004; Tobias, 1987). It is, therefore, reasonable to describe intensely negative mathematics experiences as traumatic. I argue that mathematics trauma has lasting neurological and psychological impacts on an individual's ability to function in the mathematics setting and on their mathematics identity.

Conclusion

A main influence of someone's mathematics identity is their experiences within the mathematics context (Aguirre et al., 2013). These mathematics contexts are vast and include the math experiences a student has in the classroom, in their everyday life (Gonzalez, et al., 2001), and in the attitudes and beliefs that peers, and parents hold about math (Aguirre et al., 2013). Since each individual student holds their own experiences and interpretation of those experiences (Clandinin & Connelly, 1989), each individual student forms their own mathematics identity over time based on their lived experiences. Some students, due to historical stereotypes and inequity in the field of mathematics, are more vulnerable to negative experiences in the math classrooms. These include students who identity as BIPOC (English-Clarke et al., 2012; Martin, 2012); and female students (Cvencek et al., 2021; Seymoure & Hewlett, 1997; Singer & Stake, 1896) as well as students whose peers and parents have negative mathematics attitudes (English-Clarke et al., 2012). Intensely negative experiences could be considered *math trauma* because of their long-lasting "physical, emotional, and mental stress responses" (Wolpow et al., 2009, p. ?) in the mathematics environment. Trauma-informed care frameworks, therefore, might be an appropriate tool to help students begin to process their math trauma and begin moving forward towards more positive mathematics identities.

This work is especially important for elementary pre-service teachers. Research suggests that BIPOC elementary teachers (Heffner & Newton, 2018; Johnson, 2018; Stoehr, 2017) and adult learners (Jameson & Fusco, 2014) are more likely to have trauma from the mathematics classroom and therefore more likely to pass along mathematics trauma and negative mathematics identity to their students (Aguirre et al., 2013). Thus, it is critical for teacher education programs to help pre-service teachers understand their own mathematics identity narratives and work towards more positive mathematics identities (AMTE, 2017). As Urban Teacher Residencies aim to certify teachers who identify as BIPOC and train these teachers with specific skills focused on teaching in urban areas, it is critical for residents to explore their own mathematics identity. By doing so, residents can begin understanding the development of their own mathematics identity and begin to think about their mathematics identity as teachers with the perspective of positively impacting the mathematics identities of their future students.

CHAPTER III

METHODOLOGY

The Urban Teacher Residency (UTR) program is a partnership between an Urban-based university and school district aimed to help prospective candidates achieve a teaching certificate. Residents in this one-year program take classes at the university while working in the urban school district alongside a mentor teacher. Mathematics for Elementary Teachers (MET) is one of the courses that many residents take who are seeking an elementary certification. This required course is often one of the first courses in the residency program. As such, they enter the course with a variety of mathematics experiences and emotions, resulting in a wide spectrum of mathematics identities. To help these residents prepare for future teaching career, the goal of the study is to provide urban teacher residents with opportunities to explore their own mathematics identity development within the context of the MET course. As a researcher, I aim to understand the progression of mathematics identity in urban teacher residents throughout this course when trauma-informed practices are embedded. Additionally, I am interested in how residents connect trauma-informed practices to their mathematics identity development. In this chapter, I discuss my rationale for the selection of a qualitative

design to reach these research goals. I then explain the procedures for my study, followed by the analysis process.

Positionality Statement

I acknowledge that my background, beliefs, values, and experiences influence my research throughout this study (Creswell & Poth, 2018; Glesne, 2011). My experiences as an elementary teacher played an important role in the study and contributed to the work. As a student in grade school and through my undergraduate experiences, I felt confident as a learner and doer of mathematics and therefore held a positive mathematics identity. However, when I began my teaching career, I quickly realized that I had always simply completed problems in math for accuracy but in fact had very little understanding. This was a significant upset to my self-esteem as a mathematics teacher. It was not until I began my master's degree as an Elementary Math Specialist that I considered mathematics through a conceptual lens and cultivated my mathematics identity as a teacher. This experience taught me about the importance of thinking about my own mathematics identity and how it developed over time. Furthermore, my experience taught me that mathematics identity can change, shift, and develop over time based on experiences. As the researcher and instructor (R-I) for the MET course, I desired to provide this experience for residents *before* they enter the classroom. Because of my experiences, I wanted them to explore their own mathematics identity- its development and the way their mathematics identity might change as they consider themselves as teachers.

I also want to acknowledge my relationship with the Trauma-informed Care (TIC) frameworks used throughout this study. I am a parent of two children adopted from foster

care with trauma as a significant part of their stories. In addition, as an elementary teacher, I had many students from similar traumatic experiences in my classroom. I have seen first-hand the detrimental effects of trauma on the brain, learning, and identity (see Wolpow, 2017). Traumatic experiences, both in childhood and in an academic setting such as mathematics, can produce negative psychosomatic effects that impact the ability for an individual to function (Wolpow, 2017). Through experiences with my own children and the children in my classroom, I have seen the benefits of using TIC practices. Therefore, the use of this framework in my study is impacted by my belief that practices based on TIC frameworks can help individuals cope with traumatic experiences to build brain and learning skills as well as build more positive identities.

Finally, I acknowledge that my race and culture have influenced these experiences. As a white female, I acknowledge that my mathematics experiences have taken place in school settings that have historically valued the narrative of my race as the acceptable norm (Milner, 2007). As I work with participants who mostly identify as BIPOC, I acknowledge the inequity and marginality they likely faced in the academic context due to the acceptance of this dominant narrative (Milner, 2007). As a researcher and the instructor for their course, I seek to understand the identities and culture of these individuals in the course. Based on previous experiences with the course, I can do so by getting to know residents on a personal level and making the classroom a safe and welcoming space. I cannot, however, fully understand the challenges they have faced throughout their life, both in and out of the academic context all of which can contribute to traumatic experiences and negative identities in the mathematics classroom.

Qualitative Research Design

A qualitative research design was essential for meeting the research goals of this study. According to Merriam (2009), there are four characteristics key to qualitative research, "the focus is on the process, understanding, and meaning; the researcher is the primary instrument of data collection and analysis; the process is inductive; the product is richly descriptive" (p. 14). This section discusses how this research study exemplifies each of these four qualitative research characteristics.

Merriam (2009) explains, "the overall purposes of qualitative research are to achieve an *understanding* of how people make sense of their lives, delineate the process (rather than the outcome or product) of meaning-making, and describe how people interpret what they experience" (p. 14). Patton (1985) explains that qualitative research is particularly important when this sense-making is occurring in a unique context (p. 1). Throughout the MET course, residents experienced mathematics through the lens of education for the first time. While many have completed math courses in schools or held careers where mathematics was used, this course asked residents to examine the conceptual underpinnings of mathematics in a way that prepared them to teach the concepts. As the researcher-instructor (R-I) in the MET course, I was interested in *understanding* how residents made sense of their mathematics identity as they experienced mathematics in this specific context, making qualitative research the best design.

With *understanding* as one characteristic of qualitative research, the "human instrument, which is able to be immediately responsive and adaptive would seem to be the ideal means of collecting and analyzing data" (Merriam, 2009, p. 15). As the R-I for

the course, I was in the position to become the "primary instrument" (Merriam, 2009, p. 15) of data collection and analysis. I was a *participant-observer* (Glesne, 2011) in this research process. The participant-observer continuum is one that can be problematic (Glesne, 2011). This continuum describes an individual who is close and engaged with participants, an "insider", while simultaneously being "detached" and distanced from the participants and can fluctuate within and between these two extremes (Glesne, 2011). As residents spent more time with me as the R-I, they began to trust the safety of myself, the classroom, and our community. For example, when students did not understand the mathematics they were attempting, I sought to understand their knowledge and perspective and provided multiple tools to help their understanding. This demonstrated my care for them as individual learners and built their trust in me as an individual and their safety in asking questions and growing as a learner in my class.

This trust and safety over time shifted my role to that of an "insider" and therefore into a "participant-as-observer" position (Glesne, 2011, p. ?). I was still seen as the R-I, and therefore never *fully participant* (Glesne, 2011), however, residents were willing to share their experiences and feelings about mathematics openly and honestly. While this *participant as observer* position risks losing perspective of the outsider, it allowed me as the R-I to gain more in-depth learning about the experiences of the participants (Glesne, 2011).

My previous work as an elementary teacher (discussed in the positionality statement) provided me a lens through which I could understand the residents and their work on a deeper level. I acknowledge that this notion of participant-as-observer and the subjectivity that my past experiences bring could lead to researcher bias. However,

Merriam (2009) argues that the acknowledgement of this subjectivity can enhance the research and help mitigate biases that might form when the researcher is seen as the "human Instrument" (p. 15). In fact, Peshkin (1988) argues that the subjectivity researchers bring can in fact be "virtuous" as a subjective researcher can bring "distinctive contributions" (p. 18). Qualitative research, therefore, was the best approach to the goals of this study because my positioning as a human instrument allowed a perspective to the work that could not exist otherwise.

The inductive process of qualitative research allows the researcher to "build concepts, hypotheses, or theories rather than deductively testing hypotheses" (Merriam, 2009, p. 15). Thus, the *understanding* of residents' mathematics experiences as they pertain to their mathematics identities was built throughout the course with data collection and the analysis processes. The framework for understanding this process was "informed by what [I] inductively learn in the field" (Merriam, 2009, p. 16). The product of this inductive process was "*richly descriptive"* and collected data of "words and pictures rather than numbers" (p. 16). A variety of data was collected throughout the course to capture residents' thoughts, experiences, actions, and narratives (how they tell their stories) around their mathematics identities. The inquiry process conducted from this data was shaped from the following research questions:

1. How do residents' mathematics identities change during the Mathematics for Elementary Teachers course?
2. How do residents connect trauma-informed practices embedded in the course design to the transformation of their mathematics identity?

3. How does a Mathematics for Elementary Teachers course with embedded trauma-informed practices impact mathematics identities for residents with and without mathematics trauma?

Qualitative Approach

This inquiry was framed around a multiple-case study design. Case study in the qualitative inquiry field "refers to the intensive study of a case" (Glesne, 2011, p. 23). A case study affords "researchers opportunities to explore or describe a phenomenon in context using a variety of data sources" (Baxter & Jack, 2008, p. 544). Thus, the context of the case is paramount to the phenomenon itself and is relative to the individual's perspective within that context (Baxter & Jack, 2008). According to Yin (2003), a case study design is appropriate when a researcher is asking questions that pertain to "how" and "why," and the phenomenon is dependent upon the context of the case. (p. 10). Since I was focused on the residents throughout the Mathematics for Elementary Teachers (MET) course, a case study was the most appropriate approach as it is bounded by the time, scope, and activities of the course (Creswell & Poth, 2018; Stake, 1995). Moreover, any shifts in mathematics identities of residents were inextricable from the context of the course itself.

There were two categories of residents within the MET course who were selected as participants for this study. The first included residents who expressed mathematics trauma and the second included residents who did not express mathematics trauma. These two categories became the two cases for the study, guided by a multiple-case study design. Through the multiple-case study design, I compared differences and similarities within and between the cases (Baxter & Jack, 2008; Stake, 2005). This methodology

allowed a clearer understanding of how residents, both with and without expressed trauma, connected the TIC framework to any shifts in mathematics identity that they experienced. Throughout the data, the individual narratives of each participant were maintained and acknowledged but were analyzed as part of the case in its entirety.

Procedures

In this section, I first explain the design of the trauma-informed care (TIC) practices that were embedded within the course. I then outline the procedures for participant selection in the study followed by data sources and data collection procedures.

Design of Course Using Trauma-informed Care

In line with my goals for this study, I utilized a trauma-informed care (TIC) framework to design the Mathematics for Elementary Teachers (MET). The use of a TIC framework was designed to promote healing and growth in the mathematics identities of the urban teacher residents. There is a large body of research that demonstrates that a TIC framework can be helpful in supporting students who have been trauma exposed (See Trauma-Informed Care section of the literature review). In the same way, I argue that a TIC framework will be useful in helping support urban teacher residents' mathematics identities. As these residents mostly identify as BIPOC and many identify as female, it can be assumed that many of these individuals have experienced trauma in the academic or mathematics context (Gray, 2009; Oleson, 2009) and therefore face negative attitudes towards mathematics (Akin & Kurbanoglu, 2011; Rounds, 1980). Trauma-informed care frameworks were therefore embedded within the course to engage residents in processing and healing of potential mathematics trauma.

Though there is not one agreed upon framework for trauma-informed care (Bath, 2008, Thomas, 2019), all existent TIC frameworks build on three main pillars (Bath, 2008). These pillars are *safety*, *managing emotions*, and *connections.* These pillars are necessarily interconnected and create a foundation for the healing and growth of an individual who has been traumatized (Bath, 2008). This section describes these three interconnected pillars and explain how they were incorporated into the MET course design.

Safety

The first pillar of trauma-informed care is that of *safety*. The pillar of *safety* includes the physical, emotional, and mental safety that is necessary to help individuals with trauma cope within their environment. For this study, I have defined safety as the feeling of physical, emotional, and mental, well-being. (Downey, 2007; Morgan et al., 2015). Wolpow et al. (2009) explains that building this physical, emotional, and mental well-being within the classroom requires regular structure, routines, high expectations, and adequate support for academic needs. The TIC practices embedded within the course under the *safety* pillar are listed in Table 1 below. These practices are further discussed below.

Table 1

Embedded Trauma-Informed Care (TIC) Practices: Safety

TIC Pillar	Embedded Practices
A. Safety	1. Acknowledging and validating feelings around mathematics (Alvarez, 2017)
	2. Supportive classroom norms (Cole et al., 2005)
	3. Table work and professional learning communities (PLCs) (Wolpow, et al., 2009)
	4. Unconditional positive regard (Wolpow et al., 2009)
	5. Multiple ways to present information (Cole et al., 2005)

6.	"Islands of Competence" (Cole et al., 2005, p. ?)
7.	Formative feedback on math assignments (Wolpow et al., 2009)
8.	Consistent routine and expectations (Cole et al., 2005)
9.	Relevant and meaningful work (Cole et al., 2005)

Regular structures, routines, and high expectations provide safety for students who have experienced trauma by providing consistency (Cole et al., 2005; Downey, 2007; Wolpow et al., 2009). Where trauma creates a lack of order in the brain, consistency in the classroom can help traumatized students create order (Cole et al., 2005; Wolpow et al., 2009). Moreover, holding students to consistent and high expectations communicates to students that they are capable and worthy of the teacher's regard and attention (Wolpow et al., 2009).

The MET course maintained consistency in routine, expectations, and feedback processes to meet these needs of safety. The class met each Friday for six hours. This is a significant amount of time, especially for residents who potentially had mathematics trauma. To provide safety within this time, the course was designed with consistent structure each week. Moreover, the schedule and learning targets were posted and discussed at the beginning of the day and were reiterated throughout the day to define clear learning expectations. Residents were also provided with a schedule of the semester and syllabus prior to the course, outlining each class session and assignments that they would be expected to complete. As the residents completed these assignments, formative feedback was provided in a consistent manner. Residents were given time weekly to reflect and refine their work if it did not reflect a sufficient understanding.

Sufficient academic support is also critical for traumatized students (Alvarez, 2017). This includes understanding the impacts of trauma on academic learning (Alvarez, 2017). As the R-I in the MET course, I focused on the acknowledgement and validation

of feelings around mathematics throughout the MET course. For example, the first-class meeting allowed ample time for residents to talk about their mathematics experiences and emotions around these experiences. Each class meeting also incorporated time to reflect for residents to reflect on feelings as they pertained to the mathematics they were doing.

Academic support for traumatized students also includes instructional support from the teacher that builds on students' previous knowledge. Wolpow et al. (2009) explains that students with trauma can have difficulty organizing new information. Thus, it is critical for teachers to build on previous knowledge as a way to anchor students' new knowledge. Cole et al. (2005) describes this as building on students' "Islands of competence" (p. ?). In the MET courses, the delivery of new content was structured to begin with what residents previously learned about the mathematics (i.e., an addition algorithm), then expanded to the conceptual underpinnings.

It is also critical that traumatized students are presented new information in multiple forms, so they have multiple opportunities and ways in which to build this new information (Cole et al., 2005). As the R-I in the MET course, I continually presented new content through visuals, demonstrations, and work with physical manipulatives. Residents were also continually asked to share their work/strategies in their own words to the class. This allowed the entire class to hear new strategies through the words of their peers.

Traumatized students feel safer in learning new content when the focus is on the progression of learning, rather than performance (Wolpow et al., 2009). This provides them with opportunities for continual growth. As the residents worked through new concepts in the MET course, I responded with affirming comments and utilized their

demonstrated knowledge to build new understandings. Additionally, I provided formative feedback on journal prompts and assignments rather than writing a grade. This feedback focused on effort, attitude, and progression rather than a single performance. Affirming assurances and formative feedback aligns with the principles of *unconditional positive regard* and *empower* that Wolpow et al. (2009) explain is crucial to TIC in the classroom setting.

In addition to academic support from the teacher, students who have trauma need to feel supported by their peers. When students feel supported by peers, they feel safer to take risks and make mistakes (Alvarez, 2017; Cole et al., 2005; Wolpow et al., 2009), a crucial component of positive mathematics identity (Aguirre et al., 2013). To build an environment of academic support amongst the residents in the MET course, residents participated in an activity to build class norms together. These norms were captured on a Support Poster that was referenced throughout the semester (See Support Poster in Appendix E). Residents participated in regular table work and partner talk to help support one another in their mathematics work. In addition, residents participated in Professional Learning Communities (PLC's) each week. These PLCs were designed to provide residents the opportunity to work with a variety of peers with whom they didn't normally sit, allowing them to build a network of academic support with the group as a whole.

Managing Emotions

The second pillar of trauma-informed care is that of *managing emotions*. The pillar of *managing emotions* calls for the incorporation of emotional awareness and emotional regulation strategies to help individuals with trauma cope within their environment (Bath, 2008). In this study, I define *managing emotions* as the ability of an

individual to identify and regulate their emotions. This includes understanding how their brain reacts to these emotions, and how to begin managing emotions and reactions (Siegel & Bryson, 2012). In order to promote healing and growth from trauma, it is also important to empower students to understand and create their own narrative around their trauma and healing (Alvarez, 2017). The practices of TIC that were embedded within the course under the *emotional management* pillar are listed below in Table 2. I discuss these practices below.

Table 2

Embedded Trauma-Informed Care (TIC) Practices: Managing Emotions

TIC Pillar	Embedded Practices
B. Managing Emotions	1. Identifying traumatic experiences (Alvarez, 2017)
	2. Identifying emotions in the math setting (Cole et al., 2005)
	3. Empower students to understand and create their own narrative (Alvarez, 2017)
	4. "Upstairs and Downstairs Brain" lesson (Siegel & Bryson, 2012, p. ?).
	5. "Flip your Lid" poster (Siegel & Bryson, 2012)
	6. Help self-regulation when responses are triggered (Alvarez, 2017)
	7. Validating responses to journal prompts (Wolpow et al., 2009)

Emotional management is not possible without recognizing the emotions and sources of these emotions (Siegel & Bryson, 2012). As such, teachers and students should participate in "identifying and understanding traumatic experiences" (Alvarez, 2017, p. 62). Doing so can demonstrate emotional support for students and empower students to understand their own stories and narratives (Alvarez, 2017). As part of the MET course, residents participated in activities such as the Math Identity Survey (Crowe et al., 2021), table and whole group discussions, and journal prompts to reflect on the emotions and potentially traumatic experiences they have had in the mathematics classroom setting. As

the R-I, I responded to these activities with affirming and validating statements to build trust with residents and promote healing.

In addition to identifying these emotions and traumatic experiences, it is critical for teachers and students to "recognize the influence of traumatic experiences" (Alvarez, 2017, p. 62). Thus, it is important for teachers and students to understand the mental, emotional, and physical impact of trauma (see Chapter 2 on Trauma). This understanding can help promote better coping skills for those who have trauma (Van der Kolk, 2015; Siegel & Bryson, 2012). As such, I embedded three specific mini-lessons to teach and discuss the effect of emotions and trauma on the brain.

The first mini-lesson involved utilizing the Mathematics Identity Survey (Crowe et al., 2021) to help students explore their emotions in mathematics and draw connections to their traumatic math experiences. In the second mini-lesson, I talked about the brain's reaction to strong emotions. I utilized the terminology of *upstairs and downstairs brain* and *flipping your lid* (Siegel & Bryson, 2012) to provide a framework for emotional regulation that was easy to understand. Residents watched a short video based on this framework explaining the negative impacts on the frontal cortex of the brain when an individual feels overwhelming emotions. In the third and final mini-lesson, residents identified their own behaviors that indicated they were beginning to "flip their lid." Residents then identified effective regulation strategies that helped them calm down. These were all charted on a "When I Flip my Lid" poster that is included in Appendix E. These concepts were revisited throughout the semester, particularly when a resident was feeling overwhelmed, stressed, or frustrated with the mathematics.

Finally, residents were given journal prompts each week in which they drew connections between these emotions, behaviors, and their mathematics experiences. These journal prompts were designed to help residents understand their own mathematics identity narratives and begin understanding their own patterns of emotion and regulation (Alvarez, 2017). As the R-I, I provided feedback on these journal prompts weekly, focusing on validation of feelings and questions for further thought that might help residents make a new connection, set a goal, etc. (Wolpow et al., 2009).

Connections

The final pillar of trauma-informed care is *connections*. Though all pillars of TIC are interconnected, the pillar of *connections* provides a critical foundation of the other two (Bath, 2008). If an individual does not feel a safe connection to those around them, they will struggle to feel safe or enter into the work of managing their emotions (Bath, 2008). In this study, I define c*onnections* as personal connection, empathy, and emotional support (Bath, 2008; Cole et al., 2005). This includes personal connection, empathy, and emotional support of the instructor and amongst the residents in the MET course. The TIC practices embedded within the course under the *connections* pillar are listed in Table 3 below. I discuss these practices below.

Table 3

Embedded Trauma-Informed Care (TIC) Practices: Connections

TIC Pillar	Embedded Practices
C. Connections	1. Recognize the holistic individual shaped by social and cultural experiences (Alvarez, 2017)
	2. Build nonacademic relationships (Cole et al., 2005)
	3. "Unconditional Positive Regard" (Wolpow et al., 2009)
	4. Supportive classroom norms (Cole et al., 2005)

	5. Table work and professional learning communities (PLCs) (Wolpow, 2009)

It is critical for traumatized individuals to have positive trusted social relationships (Alvarez, 2017; Bath, 2008; Wolpow et al., 2009). In order to promote healing from trauma, an individual must be seen as a holistic individual- an individual who holds multiple identities that simultaneously influence one another. It is important to acknowledge that these identities are shaped socially and culturally (Alvarez, 2017; Ginwright, 2018). In the mathematics classroom, students' mathematics identities are also influenced by their social and cultural contexts and their relationships with teachers and peers.

In the MET course, I created opportunities for residents to share about themselves and about their experiences inside and out of the classroom. This provided opportunities to build non-academic relationships with residents and build trust and rapport in the classroom (Cole et al., 2005). To build this trust and rapport between the residents and myself as the R-I, I noted non-academic information that I could reference to engage in conversations with the residents.

I also worked to maintain unconditional positive regard for residents (Wolpow et al., 2009). When a teacher maintains unconditional positive regard, they maintain an asset lens rather than a deficit lens and believe the best in a student's potential (Wolpow et al., 2009). This is important for individuals who have experienced trauma as they may struggle to trust the positive intentions of others (Cole et al., 2005). To do this, I continually reflected on conversations and classroom interactions through this lens of positive regard. I worked to believe the best in the residents while encouraging them to

reach their own individual potential. This was evident in the feedback on mathematics content assignments as well as journal prompts and interactions in class.

In addition, to build personal connections among residents, their tablework and PLC time was both structured and flexible. Residents were given mathematics tasks and were given flexibility to plan, work, and help one another in the way that worked best. This flexibility also allowed residents opportunities to collaborate and get to know one another on a personal level. Moreover, while the table groups were formed by the residents' choice of seating each week, the PLCs were selected by grouping residents who did not typically work together. This provided opportunities for residents to build connections with the cohort as a whole, an important part of feeling safe and connected within the classroom (Wolpow et al., 2009).

Such experiences were guided by the class norms created through the Support Poster (see Appendix E). This poster created mutual expectations that I as the R-I and all residents agreed upon. This Support Poster provided language with which the residents could communicate help and support for one another (Cole et al., 2005) and evident expectations for myself as the R-I.

Participant Pool

It is important in specific participant selection to consider access, hierarchy, and the research intentions for the study (Glesne, 2011). As the R-I in the MET course, I had access to 28 students. These students were adult learners attending an urban university in a metropolitan area during the summer semester. Four of the students in this course were pre-service teachers in an Alternative Certification program and two were traditional Master of Arts in Teaching (MAT) students. The other 22 students in the course were

urban teacher residents. 13 of these residents identified as female and 20 identified as BIPOC. Individuals who identify as female and individuals who identify as BIPOC are more susceptible to stereotyping in mathematical contexts (Aguirre et al., 2013) and tend to struggle with greater anxiety in academics than their white, male counterparts (Pekrun et al., 2011). Additionally, Individuals who identify as BIPOC have been historically marginalized in education (Ladson-Billings & Tate, 1995). These factors can lead to more negative mathematics identities (Aguirre, et al., 2013). This population is, therefore, particularly important to the research intentions of this study as this population is more likely to have experienced mathematics trauma. While not all residents selected as participants identified as female and/or BIPOC, all residents participated in the activities that were collected as data and were provided the opportunity to explore how their various identities impact their mathematics identities throughout the MET course.

Participant Selection

At the beginning of the course, students were given a syllabus with an attached document that explained the research sufficiently in participant-friendly language so that the students can be adequately informed about the project before the course began (Creswell & Poth, 2018; Glesne, 2011). During the final class session, a department administrator conducted an informed consent process with all residents. While the R-I was not present, the administrator reviewed the informed consent document (see Appendix D). They explained the research project and provided residents with adequate time to review the document and sign if they were willing to participate. The administrator collected the documents and held them in a secure drawer in their office until grades were posted for the MET course. Once grades were posted, I obtained the

informed consent documents. This allowed me as the R-I to remain neutral towards all students in the course and help mitigate bias towards any individual students who were selected as participants. Of the 22 residents, 19 signed the informed consent document.

Miles, Huberman, & Saldaña (2020) explain that for a multiple case study, between five and ten richly researched cases will provide more than adequate evidence for the study. I randomly selected six residents through a random number generator to be potential participants in the study.

After the selection of potential participants, I emailed each of them, reminding them of the research project and the details of the study that were outlined in the informed consent document. I confirmed that they were still interested in participating and requested a response within one week. Of the six potential participants chosen, five responded within the time frame. I randomly selected one additional potential participant who confirmed participation via email, leading to the six official participants of the study. I then scheduled an interview with each of these participants (Interview described in Data Source section). Prior to the interview, participants self-selected their pseudonym. Table 4 below lists the pseudonym of the participants, their rationale for pseudonym selection, and a brief profile. These participants are discussed more in Chapter 4.

Table 4

Participant Pseudonym and Brief Profile

Participant Pseudonyms	Pseudonym Rationale	Brief Profile
Sunshine	Wanted to bring "sunshine and happiness" to those around her.	Sunshine has participated in coaching school athletics and assisting in classrooms for the last several years. She is approximately 50 years old.
Furious	A character from a favorite childhood TV show, admired for	Furious has a passion for cars and his children. He has worked with cars in past

	his parenting in spite of difficult circumstances.	jobs and continues this as a regular hobby. He is approximately 40 years old.
Whitney	After Whitney Houston, an inspiration for this participant's artistic work.	Whitney has a degree in the arts and has pursued the arts from an early age. She loves connecting her passion with her work. She is approximately 25 years old.
Courtney	Described this name as a sort of "alternate identity" she sees within herself.	Courtney is from the business world and was ready for a job in which she can find a deeper calling. She is approximately 30 years old.
Jonathan	A childhood friend whose name he always liked.	Jonathan was a long-term substitute teacher in another state prior to entering this program. He has a passion for reaching students as teachers connected with him. He is approximately 50 years old.
Kristin	Superwoman's first name. This participant explained that she feels she has to be everything for everyone and hold it all together.	Kristin loves her children and is excited to be able to connect with them through becoming a teacher. She has her own business as a hairdresser. She is approximately 35 years old.

Case Determination

After reviewing the data from the six selected participants, three participants expressed mathematics trauma and three did not express mathematics trauma. This was determined through a preliminary analysis of the data. The participants who were categorized as expressing mathematics trauma discussed strong responses in mathematics settings indicative of the inability to cope physically, mentally, and emotionally (Wolpow et al., 2009) within these settings. For example, in a journal prompt, Furious expressed that he had great "anxiety" and "trepidation" towards mathematics due to past experiences. These three participants also ranked themselves closer to "anxiety," "not confident," and "not good at math" on the Mathematics Identity Survey (Crowe et al., 2021). This demonstrates that these participants' mathematics trauma negatively impacted how they see themselves as learners and doers of mathematics.

On the other hand, the three participants who did not express mathematics trauma did not discuss strong emotional responses in mathematics settings. While all three discussed some negative experiences, these three recalled mostly positive experiences in mathematics settings. Consequently, these three ranked themselves as closer to "peace," "confident," and "good at math" on the Mathematics Identity Survey (Crowe et al., 2021). Thus, these participants did not show evidence of mathematics trauma. These cases of participants are shown in Table 5 below.

Table 5

Cases Determination

Participants	Case Determination
Sunshine Furious Whitney	Participants with mathematics trauma
Courtney Jonathan Kristin	Participants without mathematics trauma

Data Sources and Collection

The design of the data sources used throughout the MET course aligned with these TIC practices. These data sources include a Mathematics Identity Survey (Crowe, et al., 2021), weekly journal prompts, observations and field notes, and interviews. These data sources provided a rich description aimed to explore how residents' mathematical identity changes throughout the Mathematics for Elementary Teachers (MET) course and how they connected the TIC practices to this development. Table 6 below outlines these data sources, the collection method, and examples questions from each data source.

Table 6

Data Sources

Data Source	Collection Method	Example Questions
Mathematics Identity Survey (Crowe, et al., 2021)	Students completed outside of class to provide ample time for thought and reflection. They turned in a copy of the investigation on the course online portal.	*What were the best experiences you have had in the mathematics classroom?* *What were the worst experiences you have had in the mathematics classroom?*
Weekly Journal Prompts	Students completed an entry in their mathematics journal each week using a digital document that they shared with me. I read their responses weekly and responded with positive notes, encouragement and/or follow-up questions, etc.	*When you think about the math work you have completed this week, what are you most proud of? What was the most difficult for you? Why?* *How has your math work this week been different or the same as your previous mathematics experiences?*
Research Memos	Research memos were taken at the break and conclusion of each class. These documented salient discussions and observations of residents as they participated in class activities.	
Interviews	One 60-minute interview was conducted with each participant after the conclusion of the course. This was recorded and transcribed using Otter.io phone application.	*Talk about how you see yourself as a learner and doer of mathematics now.* *What changes have you seen in yourself as a learner and doer of mathematics throughout this course?*

Mathematics Identity Investigation

Before the first class of the semester, residents were be given the Mathematics Identity Survey (Crowe, et al., 2021). This is a five-section worksheet (See Appendix A). The first section asks residents to share about their identities outside of the mathematics classroom. The second section asks them to rank a list of words that describe someone on a range of "good at math" to "not good at math". The third section asks them to rate

themselves several continua based on how they would describe themselves in mathematics. For example, “confident” or “not confident” and “peace” or “anxiety”. The fourth section asks them to select a category of learner that best describes themselves as learners and doers of mathematics. The fourth asks them to describe themselves as learners and doers of mathematics (e.g., mastery learner, creative learner). This leads way to the final section which asks residents to describe their worst mathematics experiences and their best mathematics experiences throughout their lives. Here they are given the opportunity to explain these answers if desired.

This survey provided an opportunity for residents to document how they saw themselves as learners and doers of mathematics as they started the MET course and reflect on the impacts of their experiences on this identity. Residents received this assignment prior to the semester so that they could devote time and sufficient reflection to complete the investigation. They submitted the assignment through the online class portal prior to the first class.

Weekly Journal Prompts

At the conclusion of class each week, residents were given a journal prompt to help them reflect on their experiences. These prompts provided them opportunities to reflect on their thoughts, feelings, and emotions regarding the mathematics work in which they had participated. For example, the journal prompt for week 6 asked, “Describe a time when you *flipped your lid* (Siegel & Bryson, 2012) in a past math experience. How did that make you feel as a math learner and doer?” Additionally, these journal prompts were designed to help residents connect and compare the thoughts, feelings, and emotions between their previous and current mathematics experiences. For example, in week four,

their journal prompt asked, “What specifically about your learning so far in this class has been different from your previous math learning experiences? What has been the same?” Journal prompts were also designed to provide opportunities for goal setting as well as space to share concerns, questions, and needs from week to week. For example, the journal prompt from week three asked, “What are your goals for: (1) yourself as a math learner and doer this week? (2) Yourself as a collaborator this week? (3) Me as the instructor this week?” While these journal prompts had specific intentionality, they were also adjusted week to week to best meet the needs of the students and expand on classroom discussions.

Residents responded to all journal prompts on one digital document that was shared with me. I read each journal entry each week and provided feedback directly on the journal using a different color font. This feedback consisted of positive notes, encouragement, acknowledgement, validation, and/or follow up questions. The journal prompts and feedback were designed using the TIC pillars of *safety*, *managing emotions*, and *connection* to engage residents in the processing and healing of any mathematics trauma. All journal prompts can be found in Appendix C.

Research Memos

Each class session had a significant amount of class discussion throughout. While participating in mathematics content, residents regularly shared how they were feeling and thinking about themselves as mathematicians. For example, if residents were working on a difficult math concept in their group and stated, “I’m just not a math person”, this often suggested that they felt low efficacy about the mathematics at that time. Additionally, throughout the semester, residents were given opportunities to

participate in class discussions around their Mathematics Identity Survey, journal prompts, and other general feelings, thoughts, and attitudes around the mathematics in which they were participating. When appropriate, I wrote or voice-recorded memos digitally. I included general notes about the discussion of the group as a whole. If there was pertinent discussion by a specific resident, I also noted the specific resident and their ideas, words, etc.

In addition to research memos on discussions in class, research memos based on classroom observations were also noted. The way residents completed the mathematics work and participated with the rest of the class could have indicated evidence of and engagement with their developing mathematics identity. Pertinent behaviors and actions of the whole group as well as individuals were noted in the memos. For example, when residents shared their work on the board, all residents regularly cheered loudly for one another. In this instance, I wrote memos about the group's behavior as well as pertinent reactions of the specific resident at the board. Through observation, it is also possible to notice social behaviors and interactions among the group, which helped inform me as the researcher about the social and cultural dynamics of a residents' mathematics identities. Again, like class discussions, I made research memos regarding observations on breaks or immediately after class.

Interviews

The interviews were conducted with the selected participants after the conclusion of the course (see participant selection section) in the two weeks between the university classes ending and the beginning of the residents' school year. One 60-minute interview was conducted with each participant. These interviews were semi-structured and focused

on the narrative that residents' share about the formation and progression of their mathematics identity from the beginning of the MET course to the end of the course. The interview protocol is included in Appendix B.

Glesne (2011) explains that interviews should be positioned somewhere "convenient, available, and appropriate". Since residents were helping in their school classrooms, I gave them a choice of meeting on the university campus or at their school. There were quiet and confidential rooms in both locations, important for participant confidentiality (Creswell & Poth, 2018), and for ease of transcript recording. The interview was recorded and transcribed using the Otter.io phone application.

Data Source and Trauma-Informed Care Alignment

These data sources were designed using a TIC lens. The various data sources provided multiple opportunities for the residents to experience each of the TIC practices. Additionally, this alignment ensured the documentation of each of the TIC practices in the data. Table 7 below shows which TIC embedded practices were evident in each data source.

Table 7

Data Source and Trauma-Informed Care (TIC) Alignment

TIC Pillar	Embedded Practices	Data Source Alignment
A. Safety	1. Acknowledging and validating feelings around mathematics (Alvarez, 2017)	a. Research Memos (1-9) b. Math Identity Survey Part III, IV, & V (1) c. Journal Prompts (1, 2, 3, 4, 5, 6) d. Interview (1-8)
	2. Supportive classroom norms (Cole et al., 2005)	
	3. Table work and professional learning communities (PLCs) (Wolpow et al., 2009)	
	4. "Unconditional Positive Regard" (Wolpow et al., 2009)	
	5. Multiple ways to present information (Cole et al., 2005)	
	6. "Islands of Competence" (Cole et al., 2005)	
	7. Formative feedback on math assignments (Wolpow et al., 2009)	

	8. Consistent routine and expectations (Cole et al., 2005)	
	9. Relevant and meaningful work (Cole et al., 2005)	
B. Managing Emotions	1. Identifying traumatic experiences (Alvarez, 2017)	a. Research Memos (1-7) b. Math Identity Survey Parts I, II, III, & V (1, 2) c. Journal Prompts (1, 2, 3, 6, 7) d. Interview (1-7)
	2. Identifying emotions in the math setting (Cole et al., 2005)	
	3. Empower students to understand and create their own narrative (Alvarez, 2017)	
	4. "Upstairs and Downstairs Brain" lesson (Siegel & Bryson, 2012).	
	5. "Flip your Lid" Poster (Siegel & Bryson, 2012)	
	6. Help self-regulation when responses are triggered (Alvarez, 2017)	
	7. Validating responses to journal prompts (Wolpow et al., 2009)	
C. Connections	1. Recognize the holistic individual shaped by social and cultural experiences (Alvarez, 2017)	a. Research memos (1-5) b. Journal Prompts (1-5) c. Interview (1-8)
	2. Build nonacademic relationships (Cole et al., 2005)	
	3. "Unconditional Positive Regard" (Wolpow et al., 2009)	
	4. Supportive classroom norms (Cole et al., 2005)	
	5. Table work and professional learning communities (PLCs) (Wolpow et al., 2009)	

Data Analysis

This section discusses how data was organized throughout the MET course and upon its conclusion. I then describe the coding processes used to analyze the data and how the cross-case analysis was conducted.

Data Organization

One of the significant drawbacks to any case study is the immense amount of data (Merriam, 2009). This can be especially true for a multiple case study design (Baxter & Jack, 2008). To mitigate the effects of overwhelming data sets at the end of the semester, I created a case study database, also known as a record (Merriam, 2009). Patton states

that a case study record "pulls together and organizes the voluminous case data into comprehensive, primary resource package… Information is edited, redundancies are sorted out, parts are fitted together, and the case record is organized for ready access" (p. 449). As data sources were added each week, I placed them into an independent record for each resident. As I added the Mathematics Identity Surveys, journal prompts, class discussion notes, and observation notes, I sorted these by participant.

As I sorted and edited data, I participated in "jotting" to capture the intricacies and nuances about the data accurately (Miles & Huberman, 2020). According to Miles, et al. (2020), jottings can be seen as an "analytic sticky note" and can be made while a researcher is reviewing data. These included reflections such as "subtextual references on the meaning of what a key participant was 'really' saying", "what the relationship with participants feel like" "a mental note to pursue an issue further in the next contact", etc. (p. 86). By making these notes as I organized data each week, I captured any intricacies or nuances in the data that may be forgotten by the end of the semester. Moreover, these helped me detect gaps or issues in the data collection process, allowing me to collect better data as the semester moved forward.

Along with "jottings", I also participated in analytic memoing. This is "a brief or extended narrative that documents the researcher's reflections and thinking processes about the data… not just descriptive summaries but attempts to synthesize them into higher level analytic meanings" (Miles et al., 2020, p. 88). I used this strategy to begin recording initial thoughts and findings related to emerging themes or existing theories and potential answers to my research questions.

Once participants were selected, I narrowed my case study records from all residents in the MET course, to the participants only. I reviewed each participant's record with them at the beginning of their interview, serving as a preliminary member check (Merriam, 2009). Participants had the opportunity to discuss any component of their record they wanted to further explain, omit, or change, adding to the validity of the study. The transcript of their interview and updates to their record were added after the interview.

After all data was collected, I organized the data from each participant in two ways. First, I used analytic memos and jots to identify data throughout each participant's record that pertained to their narratives as mathematics learners and doers. I sorted these data chronologically for each participant. These data were used to answer research question number one (RQ1) pertaining to the development of the residents' mathematics identities throughout the MET course. Additionally, I used my analytic memos and jots to identify data throughout each participant's record that pertained to one of the three trauma-informed care (TIC) pillars. I sorted these data into the categories of *safety*, *managing emotions*, and *connections* (Bath, 2008). These data were analyzed through an iterative coding process to answer research question two (RQ2) pertaining to how residents connected the TIC practices to their mathematics identity development.

Coding

An iterative coding process was used to analyze the data pertaining to the TIC pillars. I selected two coding methods that best supported my research design and goals (Saldaña, 2016) for my first cycle of coding. The first was In Vivo coding (Charmez, 2014; Corbin & Strauss, 2015; Glaser, 1978). This coding method was selected to

"ground the analysis in [the participants'] perspectives" (Saldaña, 2016, p. 71) and honor their individual narratives. Throughout this first cycle of coding, I utilized participants' words and/or actions that stood out as "salient" for the participant. The second type of coding that I used in the first cycle was descriptive coding (Miles et al., 2014; Saldaña, 2016; Wolcott, 1994). I chose this coding method to capture the residents' descriptions about the MET course, their experiences, and themselves as mathematics learners and doers. In Vivo coding (Charmez, 2014; Corbin & Strauss, 2015; Glaser, 1978) was utilized as the primary coding method and descriptive coding (Miles et al., 2014; Saldaña, 2016; Wolcott, 1994) was secondary and used when there was not a salient word or phrase that accurately captured the participants' ideas.

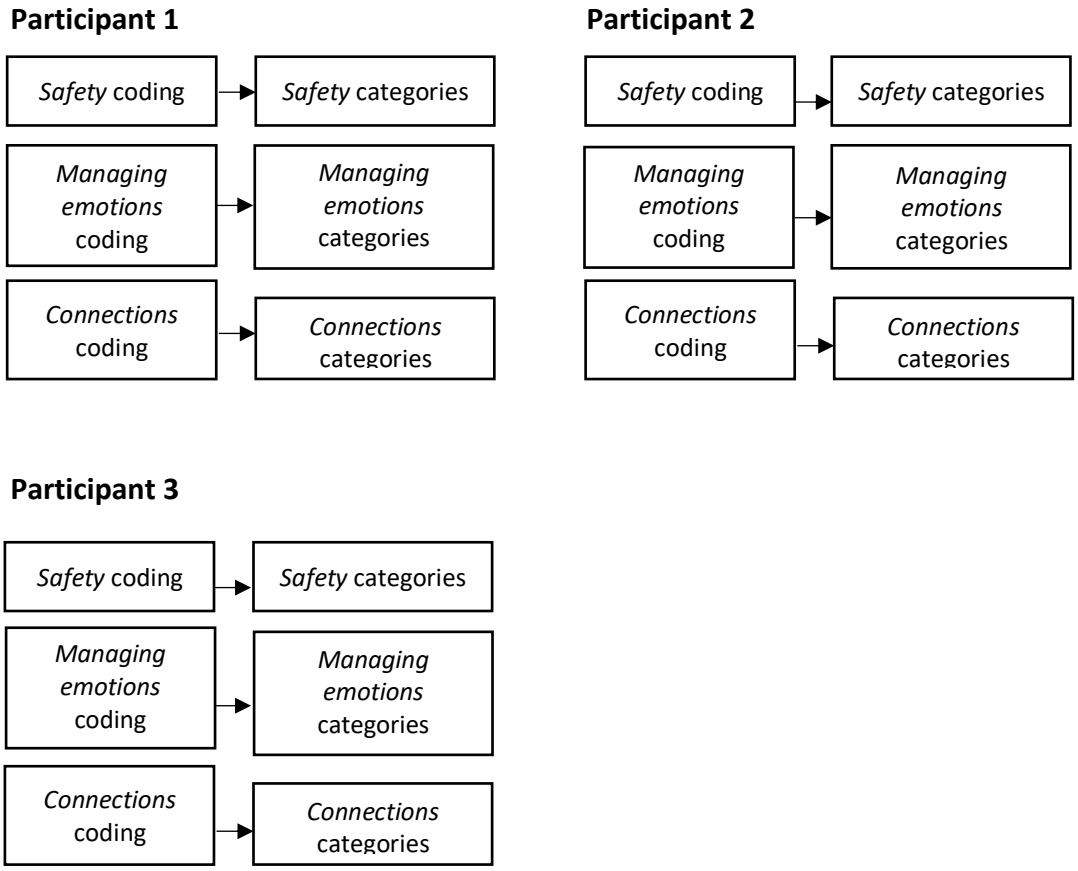
Pattern coding (Miles et al., 2014) was used in the second cycle of coding. Pattern coding can be particularly helpful to, "review the first cycle codes to assess their commonality" (Saldaña, 2016, p. 238). I selected this method of coding to determine the patterns present in the data for each participant. I used this cycle of coding to determine categories that described the TIC practices each participant connected to the development of their mathematics identities.

For the first and second cycles of coding, I coded the data from each TIC pillar for each participant independently. I completed coding for each participant before moving to the next. Throughout these coding processes, I continued my jotting and analytic memoing. Jotting allowed me to note my decision-making processes and code selections (Miles, Huberman, & Saldaña, 2020). Analytic memoing throughout the process helped guide the synthesis of information throughout the process (Saldaña, 2016). Figure 5 below shows an example of the process for these first and second cycles

of coding that led to categories. This figure shows the three participants from one case. The same process was also performed for the three participants in the second case.

Figure 5

First and Second Cycle Coding Example



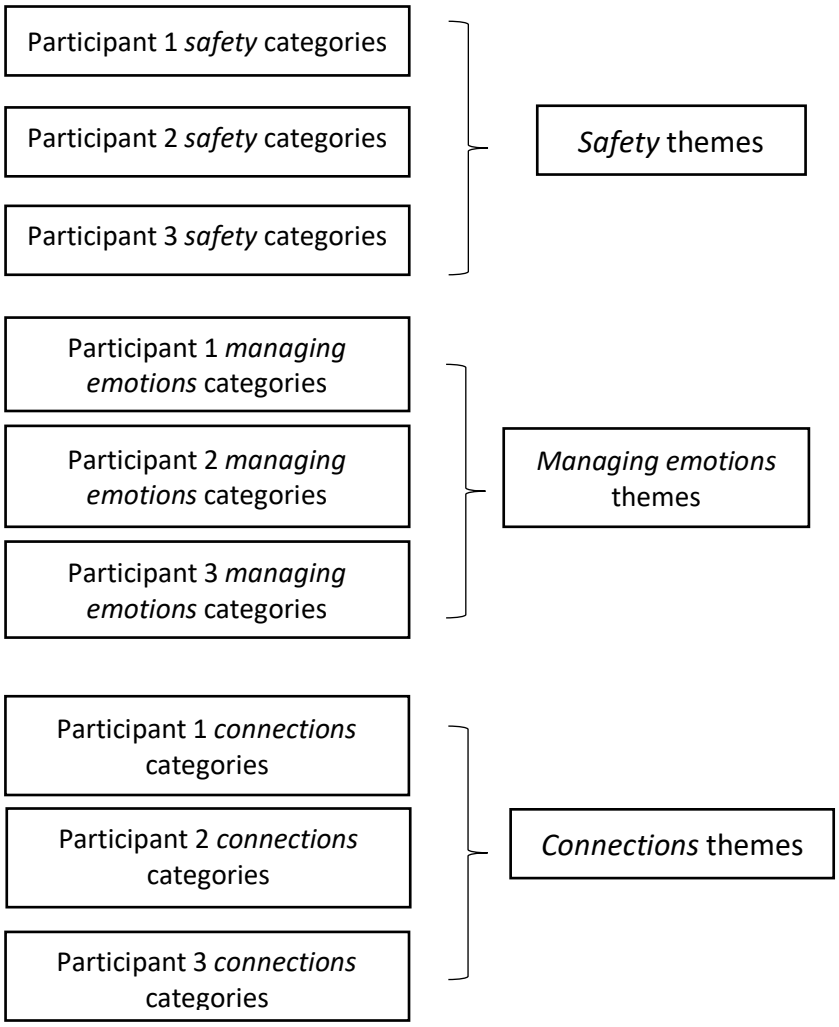
Theme Development

After categories were developed for each participant, I entered into the cyclical process of theme development. Through this final state of coding, I analyzed categories across all participants in a single case for each of the TIC practices. For example, the categories from the *safety* pillar were analyzed across all three participants to develop themes under the pillar of *safety*. When patterns appeared across the categories for at least 2 of the 3 participants for each case, they were included in the analysis for theme

development. This led to themes that described how the case connected TIC practices to the development of their mathematics identities. Figure 6 below shows an example of the process for theme development. This same process was performed for each case.

Figure 6

Theme Development Example



Cross-Case Analysis

Once themes were determined for each case, I conducted a cross-case analysis. For the analysis in this study, I utilized a "variable-oriented strategy" that focused on

"themes that cut across cases" (Miles et al., 2020, p. 97). For this study, themes were developed for each case under the TIC pillars. For the cross-case analysis, I compared the two cases to identify and describe themes that were fundamentally similar between the two cases and themes that were fundamentally different between the two cases. The cross-case analysis answered research question 3 (RQ3) pertaining to the differences in impactful TIC elements between residents with mathematics trauma and residents without mathematics trauma.

Rigor of Study

I attended to "rich rigor" (Tracy, 2010) throughout this study in the data collection, data analysis, and presentation of findings. Throughout the data collection process, I spent an abundance of time with the residents throughout the MET course. Class sessions lasted six hours each week for nine weeks. In addition to these class sessions, I was in continual communication with residents through email and group messaging. These messages included weekly updates, reminders, and a place for residents to ask questions and check in throughout the week. While these communications were not in person, they provided additional time in which I built rapport, trust, and safety with residents.

This amount of time and the variety of data collection sources yielded data that is "interesting and significant" (Tracy, 2010). Each of the data sources described above were designed to capture a complete and significant understanding of residents' developing mathematics identities throughout the MET course and how they connected this development to the TIC practices. For example, the journal prompts were designed to capture how residents are thinking and feeling about the math that they are doing and

how the TIC practices impacted their feelings about mathematics. The research memos captured individual and whole group behaviors discussion as residents completed mathematics activities, providing validity to their journal prompt responses.

I also practiced reflexivity throughout the data collection to enhance rigor (Anfara et al., 2002). For example, during a break in the class sessions, I summarized my understandings and any major findings from the day and reflected on any gaps in the data. These gaps may have included fewer memos on a particular resident or a lack of reflection on the specific activity for the day. I noted these gaps and addressed them before the conclusion of the class session. I also made notes to ensure these gaps did not occur the following week.

Throughout this data collection process, I attended to "appropriate procedures" for data collection (Tracy, 2010). As noted in the data organization section, I organized data by resident for each class session. I recorded research memos methodically with resident and time labels. Such organization allowed the amount of data to be well managed and ready for analysis upon the end of the course. After the conclusion of the course, I interviewed participants one at a time. After each interview, I reflected on the totality of data from that resident.

The transparency and therefore the accountability of the data analysis process is also key to the rigor of a qualitative study (Anfara et al., 2002). As I completed the data analysis, I kept analytic memos (Saldaña, 2016) describing my processes for code selection and analysis as I worked through the iterative coding process. I also used these analytic memos to create a code book that acted as a map to guide coding and category decisions (Anfara et al., 2002). This can be found in the Appendix H. Within the results, I

included tables that demonstrate the alignment of the methods and analytic process used to find themes. These efforts create transparency and accountability in both the process and display of analysis (Anfara et al., 2002).

Summary

This chapter outlined methods used to conduct a research study using a multiple-case study design. The purpose of the research was to explore how teacher residents' mathematical identities change throughout the Mathematics for Elementary Teachers course when a trauma-informed care framework is implemented. Research demonstrates that it is imperative for teachers to examine their mathematical identities because of the impact these have on student mathematical identities. A reasonable entry point for this work is at the pre-service level. It is my hope that this study will help inform structures and activities for mathematics courses designed for adult learners such as those in teacher residency programs and help these residents develop positive mathematical identities.

CHAPTER IV

RESULTS

In this chapter, I present a detailed analysis of the data collected. In analyzing the data from the participants in the study, I classified the two cases of participants as: (1) stories of participants with mathematics trauma and (2) stories of participants without mathematics trauma (See Chapter 3 for details of case determination). Throughout this chapter, I discuss these two cases separately before presenting a cross-case analysis. For each case, I introduce the ways in which each participant described their mathematics identity *prior to* entering the Mathematics for Elementary Teachers (MET) course. Next, I discuss the themes each case connected to the development of their mathematics identity under the three trauma-informed Care (TIC) pillars (*safety, connections, managing emotions*). I conclude the results of each case by returning to each participant's expression of their mathematics identity *at the conclusion of* the MET Course. After discussing each case in its' entirety, I present a cross-case analysis of these two groups of participants.

The data from each participant and each case of this study was analyzed through the lens of Sociocultural Theory (Vygotsky, 1978), see Chapter 2. As such, I recognize that each participants' experiences within the MET course did not occur in isolation, but rather as a part of their greater social context (Vygotsky, 1978) and negotiated as part of

their participation and position in mathematics contexts over time (Harre &Van Langenhove, 1999). Furthermore, I acknowledge that mathematics trauma is one category of trauma that may or may not be impacted by other trauma caused by an individual's personal experiences and that the participants in this study may or may not have other trauma outside of the area of mathematics.

Stories of Participants with Mathematics Trauma

"My math army was weak, it was overrun"

Throughout this study, mathematics trauma is defined as the negative physical, emotional, and/or mental stress responses that prevent individuals from coping within mathematics contexts in a healthy way (Wolpow et al., 2009). The first case of participants I discuss is the case of participants who demonstrated this mathematics trauma. While both cases expressed some emotions attached to mathematics contexts, the three participants in this first case expressed extreme emotions and significant stress responses as they began the Mathematics for Elementary Teachers (MET) course. These participants attributed these stress responses to intensely negative mathematics experiences from their pasts. This included experiences in the mathematics classroom, mathematics teachers, or expectations around mathematics from caregivers or peers. As they entered the course, it was clear that they were ready for battle – a battle within themselves and a battle against mathematics.

I introduce each of these three participants below and their expressed mathematics identity at the beginning of the MET course. I then discuss the themes under each TIC pillar that this case of participants connected to the development of their mathematics identity. I conclude by returning to each participants' expression of their mathematics

identity at the conclusion of the MET Course. The pseudonyms used for each participant were self-selected. The explanation of the pseudonym selection and a brief profile of each participant is included in Chapter 3.

Sunshine

Sunshine arrived at our interview location much like she did the first day of class – reserved, quiet, demonstrating caution with her conversation. She started the interview reminding me "I don't like talking much." I reminded her that we were going to talk about only her personal experiences as a math learner and doer and that I would ask questions throughout to help guide her. "Ok, I can do that" she stated and sat back in her chair.

As she began discussing her past math experiences, they were filled with stories of feeling unseen and unnoticed, with her needs failing to be met in the math classroom. She explained these feelings started early and recognized that a racialized environment may have contributed to these feelings. She stated, "I lived in a predominately white environment, and I was the only black child, so I felt like I was dumbed down and slowed down a little bit because of the cultural difference between me and my teachers." This idea was echoed as she explained that many of her math teachers didn't acknowledge her individual needs, expressing, "I think I would have really enjoyed math if I had someone that was excited about teaching me and not just doing it because they had to or helping kids that grasped it better than the ones who did not. You felt like they treated you at a different pace than other students when they didn't attend to your specific needs."

Sunshine recognized that math, more than other subjects made her anxious because of these experiences. "I've always been anxious with math. I've never been good

at math. I've just been a C student and if I got a B it was because, you know, I understood it better", she stated. This led into her explaining that it was a few specific teachers who used different strategies to better explain math in a way she grasped that helped her understand better. At the beginning of the MET Course, she was not anticipating such a teacher. She remembered instructors from her bachelor's degree, "standing up in front of the board and regurgitating information and expecting us to ingest it and put it on paper." With this in mind, she found herself again anxious when she was told about the course. "When they said I had to take a math course" she explains, "I was like, oh no. I thought I was done with math!" To get through the course, her plan was to get comfortable in her space and keep to herself to "get through."

Whitney

Whitney has been involved in the arts most of her life and completed her bachelor's degree as a theater arts major. She was readily open to expressing herself and her emotions. She was quick to start the conversation about her mathematics experiences, both past and current. She explained that she attended a high school focused on the arts, leading her to be less focused on her mathematics classes. She found the arts and mathematics to be dichotomous and built a great deal of stress around mathematics under this pretense. She explained, "I genuinely feel like I have several memories of being absolutely exhausted working on math homework or even in math class and having a visceral emotional response to not feeling 'successful' in math."

These stressors were affirmed with math teachers who did not acknowledge the stress that Whitney was experiencing with mathematics. described one of her high school math teachers as her "enemy." She stated,

> He ridiculed students who didn't understand right away and was aggressive about knowing math is more important than any other subject. I was already so stressed by his presence, it just felt easier to avoid him and his assignments.

Such experiences led her to this place of avoidance for most of her mathematics, leading to "melt downs" and conflicts with her mother over her math performance.

Throughout these negative experiences with mathematics, Whitney explains that she had "never been terrible" at math, but such experiences built up a "block" over time. She stated, "I have memories over time of math being very stressful, feeling uneasy, and I just always felt like I was not a math person." Such emotional responses give reason to Whitney's anxiety as she entered the MET course. She explained, "My stomach just dropped when I saw that I had a math class on my course schedule." Conscious of these emotions, she reminded herself that as a long-term substitute teacher, she struggled with math and tried to position her mind to be ready to learn with the goal of being a better math teacher. She said "I was confident as far as knowing I would get out of the class. In my abilities, not so much. I was very nervous," so she made it her goal to make herself comfortable in class, learn as much as she could, and not talk to anyone. In her own words, "I was just going to keep my head down, be quiet, and get through."

Furious

Much like the cars Furious frequently works on as his hobby, he took some time to warm up in the interview conversation and the course as a whole. Though hesitant at first, Furious became animated when asked about his mathematics experiences. Furious explained that he had a great deal of "negative math biases" fueled by "aggressive teachers" who convinced him that he was either "100% right or 100% wrong and that's

the end of it." He explained that he always felt like he saw the math differently than others and tried to be creative in the way he was solving problems. Because he didn't do it the way the teacher was asking, he often ended up on the "100% wrong" end of the spectrum, leaving him with negative math feelings and a lot of "trepidation" with math.

This view of math and math teachers as the aggressors led Furious to continue speaking in terms of war and battle against math. He said of himself as a math learner and doer "I was lost. I wasn't the general of my army. My math army was weak. Yeah, we were overrun." He explained that he never felt a sense of control over the work but was subject to whatever was forced upon him by his teachers. Contrary to his chosen pseudonym, he said such negative emotions never led him to feelings of anger or rage, but rather led him to shut down and avoid math work. He recognized for the first time during our conversation that the avoidance and withdrawal he turned to throughout his math experiences were, in fact, forms of extreme emotion. He explained that he hadn't identified this before because his emotions were not as visible as anger and rage.

This avoidance continued in his undergraduate experiences. He stated, "I took statistics which was math that didn't look like math." However, when he learned that the MET course was unavoidable, feelings of math "trepidation" creeped back in. He expected this course to be like all other courses where he was "not going to be able to do it." He tried to cope with these feelings by focusing on the grade he needed to continue in the program and "tuning out the rest of the class" as he started in the course.

Each of these three participants described stress responses in the mathematics classroom that are indicative of mathematics trauma. Their math trauma created an inability to properly cope within a mathematics context. This is evident in their extreme

emotions, withdrawal from others, and their uneasiness entering the MET Course. As described in Chapter 3, the three pillars of trauma-informed Care (safety, managing emotions, and connection) were embedded throughout the course in order to increase capacity of residents to cope with stress the residents may carry from their mathematics trauma.

The Impact of Trauma-Informed Care: Themes from the Three Pillars

As the researcher-instructor (R-I), I designed and taught the Mathematics for Elementary Teachers (MET) course, incorporating the three trauma-informed care pillars (Bath, 2008). This section discusses the data from this case of participants with mathematics trauma. Through their discussion of mathematics identity development throughout the course, these participants expressed connections between this development and the TIC practices. The themes produced through the iterative coding process convey these connections. The themes and sample codes under each pillar are listed below in Table 8. Each theme is discussed in depth throughout the section.

Table 8

Trauma-Informed Care (TIC) Themes: Participants with Mathematics Trauma

TIC Pillar	Themes	Sample Codes
Safety	*Meaningful Work*	Intentional work, High expectations
	Psychologically Safe	Safe to make mistakes, Empathy, Not condescending
	Encouragement	Assurance, Everyone is teachable
	Accessible	Addresses Needs, Not militant
Managing Emotions	*Emotional Responses Impact Math Learning*	Withdrawal when overwhelmed, Emotions block or help absorption

	Learning Regulation Strategies	Take breaths, Processing emotions
	Empowered	Now I have superpowers, Confidence built
	Motivated by Teaching	Understand the work I need to do, Can't get frustrated as a teacher
Connections	*In This Together*	Don't have to be isolated, Shared experiences
	Perspectives for Teaching	See perspectives of others, Good experience for teaching, I can be helpful, Talking builds confidence
	"Instructor Knows My Story"	Instructor connected to my math story, Validates my experiences

Safety

Similar to all three TIC pillars, safety is multifaced. The participants who expressed mathematics trauma discussed the lack of psychological and emotional safety in the majority of their past mathematics experiences. This lack of safety involved the mathematics classroom as well as well as relationships with their teachers and interactions among other students in the class. In the data collected throughout the MET course, participants described specific practices that were effective in increasing their feelings of safety in the class. This included their internal feelings of safety as well as building safety alongside the R-I, and amongst their classmates. The data analysis revealed four separate, but interconnected themes that spanned across psychological and emotional safety and contributed to their ability to cope in the mathematics setting: *Meaningful Work, Psychologically Safe, Encouragement,* and *Accessible*. Below I describe each of these four themes. Table 9 below shows the alignment between these themes and the TIC practices described in Chapter 3. Each theme is coded to the

Embedded Practices in Table 9 using capital letters and numbers (e.g., A.2 for Supportive Classroom Norms).

Table 9

Safety Theme Alignment to Trauma-Informed Care (TIC) Practices

TIC Pillar	Embedded Practices	Theme Alignment: Participants with Math Trauma	Data Source Alignment
A. Safety	1. Acknowledging and validating feelings around mathematics (Alvarez, 2017)	*Psychologically Safe, Accessible*	a. Research Memos (1-9) b. Math Identity Survey Part III, IV, & V (1) c. Journal Prompts (1, 2, 3, 4, 5, 6, 9) d. Interview (1-8)
	2. Supportive classroom norms (Cole et al., 2005)	*Encouragement, Accessible*	
	3. Table work and professional learning communities (PLCs) (Wolpow et al., 2009)	*Psychologically Safe, Accessible*	
	4. "Unconditional Positive Regard" (Wolpow et al., 2009)	*Psychologically Safe, Encouragement*	
	5. Multiple ways to present information (Cole et al., 2005)	*Accessible*	
	6. "Islands of Competence" (Cole et al., 2005)	*Accessible*	
	7. Formative feedback on math assignments (Wolpow et al., 2009)	*Psychologically Safe, Encouragement*	
	8. Consistent routine and expectations (Cole et al., 2005)	*Meaningful work, Psychologically Safe*	
	9. Relevant and meaningful work (Cole et al., 2005)	*Meaningful Work*	

Meaningful Work

The participants in this study who identified mathematics trauma over time expressed that having intentional and purposeful work within the MET course helped them feel safe within the mathematics environment (A.9). Sunshine recalled the "regurgitation of information" that she was anticipating and how that type of environment was not safe because it was not an environment that was meaningful, but rather an environment in which she was just trying to survive. Similarly, all three participants expressed a great deal of "anxiety" and "trepidation" about having a full day of math,ot to

mention a full day of math on *Friday* after a long week of other courses and coursework. They wondered how they would "make it through." A phrase that lacks meaningfulness and purpose.

Throughout the course, these participants recognized that the work they were doing was meaningful to them as math learners and doers. Whitney talked about her fear of having a long day in a math classroom and not being able to "make it through." She stated that after the first class in this math course,

> I couldn't imagine not coming to a class because I felt like that's where it all really came together. It was six hours, but it was six productive hours… Everything was very intentional so made me feel intentional about what I was doing and what I was focused on.

The consistency and intentionality of the work, focused on the conceptual understanding of mathematics directed Whitney's work and gave her purpose in the work she was doing (A.8). Sunshine echoed this idea explaining, "I looked forward to going to math because, I understood what we did last week, and I know we've got to learn some new things again and go back and recall what we did last time. You were always a step ahead of what we needed and what we were going to do." These participants understood it would not be an environment of "survival" but rather a meaningful environment that gave them purpose and intention in their learning.

Furious explained that the meaningful work built trust in the math course. Similar to the sentiments of Whitney and Sunshine, Furious had a perspective of survival at first. Once there was intention to the work, he built trust in the instructional process and with the work he was doing.

> It helped me trust that the instruction I was getting was there to help me get the next problem or idea. There was a theme or pattern. Okay, you got this. How does that make you feel? Do you understand that? Okay, cool. Now we're going to add a little bit more to that. It was like we were making spaghetti and we've got the tomato sauce. I'm going to add a little oregano. Okay, cool. And now we're gonna throw in some all spice or whatever it is.

Furious often spoke in analogies and in this cooking analogy, he acknowledges the meaningfulness of each ingredient to make a great product. Similarly, each lesson adding to his math knowledge to help him develop into a math learner and doer and added to the meaningfulness of his work.

Psychologically Safe

Psychological safety refers to "the belief that you won't be punished or humiliated for speaking up with ideas, questions, concerns, or mistakes" (Edmondson, 1999). For the three participants who have mathematics trauma, this belief has diminished overtime in the mathematics setting. In the MET course, however, these participants reported a new sense of psychological safety in the mathematics setting that they had never before felt.

One of the factors that the participants reported as critical in developing this psychological safety was the openness and empathy of the R-I in the MET course (A.1). This included the willingness to answer questions and the lack of judgment when a mistake was made (A.4). Whitney explained that she used to "panic" when she was asked for a response, mentioning that this class was "nothing like that." She stated,

> I felt like you were always just very empathetic and supportive. When I asked you a question, I didn't feel any condescending tones or annoyance like, 'I just went

over this'. I wouldn't have been able to handle that. I always felt very safe learning. I don't know that I had been around too many environments like that."

The participants agreed that mathematics environments in which they felt criticized for asking questions or making mistakes led them to be anxious and stressed, but that they did not feel this way throughout the course.

Furious noted that the instructor accepting students' mistakes and even making mistakes herself made math safe.

> The body language, the nonverbals indicate empathy. So, if I had a question, I felt safe in asking. You would tell us if you made a mistake too... It showed that you were human, that you weren't a super mathematical robot. You were a human that could make mistakes. I was like, Okay, this is cool, I can get down with this. I don't feel like I have to know it when I really don't.

He went on to explain when the R-I asked students how they felt about their learning, it demonstrated openness to the students and overall psychological safety. He stated, "the magic words to me were: How do you feel about that? And then that created an environment of psychological safety…You created an environment to where we weren't afraid to ask you. We weren't intimidated."

While they all recognized that the support from the R-I was critical to their psychological safety in the math classroom, they also recognized that the psychological safety amongst classmates was necessary. They described times in which their classmates were a safe space for them to share questions, share their thinking, and collaborate with others in a smaller group (A.3). Sunshine explained that "if you had stuck me in another math class, I would have been in the front of the class. I would have been close to you

like a little kid on the leg. I wouldn't have probably talked unless you made me collaborate with others at the table." Instead, the participants felt that there was a positive environment in the classroom that make it comfortable to make mistakes together. Furious explained that everyone, at one point or another, "thought they should have known this stuff" from their past mathematics experiences but that everyone understood "it was okay to not know. It was a kind of vulnerability that was like 'it's okay' and 'I got this' together."

The participants explained that having a safe group to ask questions and make mistakes with allowed them to work through the math and grow in their skills. Sunshine explained,

> Being social it is hard for me. To be social standing up in front of people scares me but I am working on this- looking in the mirror as a shy child, the middle child. Being seen but not heard just became natural. So social will be my new new. Thank you for making me feel comfortable to speak.

She went on to say that the R-I "trying to get us to talk about math, engage in math, and learn to like math" were the goals and being social helped her fulfill these goals.

The participants recognized that the safety of the R-I and classmates would not have helped them feel as psychologically safe if the work did not also align to this goal. According to the Edmonson (1999), psychological safety can be valued in the classroom through learning opportunities rather than a focus on execution. The mathematics trauma of all three participants had roots in an experience in which they felt that it was not possible to be successful. They failed to reach the "end result" the teacher was requiring.

In contrast, this course helped them understand that mathematics is not about one result, but rather a continual learning experience (A.7). Whitney explained this feeling stating,

> I felt like there wasn't an end goal that was there… you explained that as you learn more in the course, you're going to see that this is how others do this or that differently. It didn't feel like there was like such a finite ending to the course. It felt like I didn't need to worry because over time I would understand.

Furious echoed this in his relief that there was no longer the "100% right" or "100% wrong" that he had previously felt about math, but that everyone may have a different way to solve the same problem. He didn't have to be the "weird one" who didn't see the math the way everyone else did but was, at last, safe to try.

Encouragement

Even though the three participants mentioned they felt "safe", they admitted that anxiety returned at times causing them to revert back to their trauma responses in the math classroom. The encouragement and assurance of their peers and instructor helped them cope in these moments and continue their learning (A.2, A.4). This encouragement was delineated from the safety that was discussed in the section above. Instead of help and content support, encouragement was a "cheering on" of one another throughout their learning. I noted the visual and vocal encouragement the residents gave to one another in several of my research memos. One excerpt from these research memos is below.

> The entire class engages in encouragement of their peers as they are sharing their strategy on the board. There are consistently claps and cheers as they approach the board. This encouragement heightens when the individual seems hesitant or unsure. There will be a "you got this" or "come on now" hollered from the back

of the room. These types of encouragement lead to a visible relaxation of the person at the board. The shoulders drop, they return to their work.

When talking about the encouragement of the other residents, two of the three participants acknowledged this as a critical part of their work. Whitney noted that "there was always so much support. I always felt very assured and validated" and helped her continue moving forward in her work.

All three participants who experienced math trauma noted the encouragement of the R-I as critical to their work (A.4). All three said that statements like "you've got this" made them feel encouraged to move forward in their work. Furious stated, "this is gonna sound corny, but your teaching style is like a math hug. Seriously, it's just soft- not 'errr' you have to learn this or else…." He went on to explain that the "math hug" mentality helped him feel at ease and encouraged in the work he was doing. Whitney agreed with the importance of an encouraging atmosphere. She states, "hearing you say everything you're going to need to learn, you're gonna learn it. Don't worry. Just show up and try and I was like, those are two things I know." This encouraged her to come to class and stay engaged in learning mathematics.

Accessible

When speaking about the accessibility of the mathematics in the course, these three participants identified that the mathematics was approachable and responsive to their needs. The approachability of the mathematics was juxtaposed by all three of the participants with aggressive, military language. Furious explained, "your teaching is what I would call non-aggressive. I say aggressive like 'this is how you do it, why don't you get it' kind of teaching. This begins to make you feel like 'why don't I get it? Why am I

not getting it'." Whitney also juxtaposed the course with this type of language. She stated,

> You were precise and blunt, but you weren't aggressive or militant. It was just very like, "this is what we're going to have to do, and this is how we're gonna get there" … I was happy and felt safe – I'm gonna get through this. You weren't doing cartwheels or handing out dollars or doing anything I would consider extraordinary; you were just being really real and preemptively supportive.

Through such juxtapositions, they indicated that they felt the teachers of mathematics in previous experiences were unapproachable and hostile and therefore the mathematics itself seemed unapproachable. Instead, the instructor and therefore the mathematics in this course seemed "light, not heavy" and "attainable" (A.6).

Having their needs addressed was also critical in these participant's feelings of the accessibility of the mathematics. These needs were both emotional (A.1) and academic in nature (A.5). Sunshine explained, "I really had to see if you were going to teach me something and not just say something to me. You spoke to me in a way that I could understand math better." Reflecting on this math course in comparison to his previous experiences, Furious noted other teachers said, "this kid's defective. These five kids got it but this one doesn't. Do you just leave them by the wayside and have them floating off into the abyss? No, you have to come up with a way to help them." Similar to the felt experiences of the other participants, Furious explained that the additional help and representing math in a way he could understand helped him not be the one left out.

In addition to the academic needs of the students, the mental and emotional needs of the participants were met. Furious stated, "When we did get overwhelmed you would

say, ‘take a break, go’. I’ve never seen that before. Even in my mind I’m like, ‘suck it up, buttercup and do it’. But then the emotion becomes, ‘I don’t get all this, I can’t do it’.” He explained that having the emotional and mental break helped him refocus in a new way. All three participants mentioned how important it was that their mental and emotional needs were acknowledged.

One of these mental and emotional needs that was mentioned across all participants was the consistency of routine (A.8). Whitney stated,

> There’s power in the organization and power in knowing there’s a plan for everything. Having a plan laid out was really good… I always know what was going to happen. Having that structure, I know is going to help me have that structure in my classroom.

This was echoed in Sunshine’s and Furious’ felt need for consistency and organization, both stating that these were critical in their feelings of safety within the classroom.

All four of these interconnected themes reportedly supported these participants in feeling safe within the mathematics context and positively contributed to their mathematics identity.

Managing Emotions

All three participants explained that they had never before related emotions and mathematics together. They found relief in the recognition and acknowledgement of emotions they had in the mathematics setting. As a pillar of trauma-informed care (TIC), *managing emotions* involves the recognition of emotion and learning coping strategies to help with the regulation of emotion. Interestingly, the four themes that emerged under this TIC pillar pertained to these areas. Two themes involve the participants’ recognition

of their own emotions in the mathematics setting and the impact of those emotions. The two remaining themes involve the regulation of these emotions. Each of these four themes are described below. Table 10 below shows the alignment between these themes and the TIC practices described in Chapter 3. As each theme is discussed, the embedded practices are coded using capital letters and numbers as delineated in Table 10.

Table 10

Managing Emotions Theme Alignment to Trauma-Informed Care (TIC) Practices

TIC Pillar	Embedded Practices	Theme Alignment: Participants with Math Trauma	Data Source Alignment
B. Managing Emotions	1. Identifying traumatic experiences and impacts (Alvarez, 2017)	*Emotional Responses Impact Math Learning*	a. Research Memos (1-7) b. Math Identity Survey Parts I, II, III, & V (1, 2) c. Journal Prompts (1, 2, 3, 6, 7) d. Interview (1-7)
	2. Identifying emotions in the math setting (Cole et al., 2005)	*Emotional Responses Impact Math Learning, Learning Regulation Strategies*	
	3. Empower students to understand and create their own narrative (Alvarez, 2017)	*Learning Regulation Strategies, Empowered, Motivated by Teaching*	
	4. "Upstairs and Downstairs Brain" lesson (Siegel & Bryson, 2012).	*Learning Regulation Strategies*	
	5. "Flip your Lid" Poster (Siegel & Bryson, 2012)	*Learning Regulation Strategies*	
	6. Help self-regulation when responses are triggered (Alvarez, 2017)	*Learning Regulation Strategies, Empowered*	
	7. Validating responses to journal prompts (Wolpow et al., 2009)	*Empowered*	

Emotional Responses Impact Math Learning

All three of these participants who reported prior math trauma talked about the acknowledgement of their emotions on the first day of class (B.2). Whitney talked about her shock at the conversation explaining,

> You started talking about math identity and you were immediately like, 'well, how does everyone feel? About math? And everyone was like "oh!" and then I was like "I'm just not gonna tell the truth." But there was no room for that. When I said I was scared you were just like, yeah, everything you are feeling is valid, accurate and I started to calm down a bit.

With this acknowledgement of the emotions they were feeling, participants shared they began to recognize the impact of their emotions on their math learning (B.1). Furious told several stories of withdrawal when overwhelmed with mathematics. He stated, "Well, I withdrew thinking 'I'll never get this' and then I started daydreaming about all kinds of stuff." On the other side of the emotional continuum, Whitney discussed the impact of what she called her "tantrums" in past mathematics experiences saying, "I would just have a breakdown because I really don't like not knowing things the first time." They recognized that these emotions-whether withdrawal or breakdowns-impacted their absorption of the mathematics. Furious explained, "I can think of my emotions. I think they will cause a student to either absorb or block it out. You can't do what you think you can't do, or you tell yourself you can't do and same thing with what you can do." This concept was reiterated by both Sunshine and Whitney as they explained that their emotional reactions to the mathematics setting hindered their learning of mathematics.

Learning Regulation Strategies

As these three participants discussed their experiences throughout the MET course, regulation strategies were often mentioned in context of the regulation mini-lessons in which they participated (See Chapter 3). The participants discussed the

importance of recognizing triggers to their emotions (B.2) and learning regulation strategies to cope with their responses to these triggers (B.4, B.5, B.6).

Regulation strategies that all three participants mentioned were physical calming strategies such as deep breathing and taking a break (B.6). Furious explained that once he was able to recognize and acknowledge his withdrawal tendencies, he had an awareness that allowed him to take a break. He stated, "I may zone out for a little bit, but I will come back to it... telling myself 'Just keep absorbing as much as you can and take good notes.'" Sunshine relied on deep breathing in several situations in which she found herself anxious about the mathematics. She explained, "I take a deep breath first… to me big problems are overwhelming but if I breathe and break them down, small little bits at a time, that's how I would go at math… if that didn't work, I would take a break and do something that wasn't so overwhelming."

Both Sunshine and Whitney described an assignment that was particularly challenging to them within the course and their use of regulation strategies (B.6). Whitney explained,

> I'm like making tantrum noises. My husband is peeking his head in the door like, "everything ok?" I was not calm. I was so flustered and just wanted to get it done … It took me a long time to get out of that space. But I didn't break down. I went to sleep which was very different for me. I'm very committed to my tantrums.

Sunshine shared a similar feeling in which she became frustrated. She said "I flipped my lid. I did. I cried and was shaking." She said she took breaths and took a break and was able to return another time.

These participants explained that their journal prompts were useful in tracking and processing these emotions (B.3). Sunshine explained,

> I felt like I was regurgitating how I felt on the paper… I felt like it was almost a therapy session where you could just go and just leave it all in the journal… I think it was super cool, like processing emotions, get that frustration out, get the happiness out if you had happiness. Processing the emotions in the journal was really helpful.

Whitney agreed that the processing of emotions was helpful and that "being prompted to track progress was very eye opening" to her own processing of emotions.

While all three participants described regulation strategies that helped them reengage in the mathematics, these strategies did not take the trauma away for these participants. Instead, the regulation strategies eased these stress responses to allow the participants to learn and continue their mathematics work (B.6). Whitney explains,

> It wasn't stressful, and even when I would get frustrated, I wouldn't feel overwhelming doom or stress, which is very different for my feelings and just me as a person too. My anxiety is so bad so it's easy for me to make the worst, but it was just a space where I didn't dread Fridays.

Thus, there was still frustration and anxiety, but calming strategies and emotional regulation helped her cope with the more overwhelming feelings.

Motivated by Teaching

While each participant discussed different regulation strategies that worked best for them, they each referenced teaching as a primary factor in motivating them to calm themselves and reengage They all stated that emotional regulation during mathematics

could be difficult because of their previous experiences and therefore current assumptions about a mathematics classroom setting. However, as they thought about themselves as future teachers, they were able to find motivation to work on this aspect of their mathematics identity (B.3). Whitney explained,

> I'm worried about how I'm going to be as a teacher, which is a different lens for me. I don't care about how many panic attacks I have because I'll figure it out. Do I want to have a panic attack while I'm teaching fractions, no I don't. So, I was trying to put into practice what you had taught us about math identity.

Furious reiterated this idea stating, "I can't get frustrated as a teacher. Although I'm doing a little better with math because I understand better, they're probably feeling how I felt about math or whatever subject I'm teaching" he explained that this motivates him to maintain empathy for himself and his students.

Empowered

Practicing these regulation strategies, alongside the safety, led these three participants to feel empowered in their work. For examples, Sunshine described a time she "flipped her lid" on an assignment. She explained, "I was frustrated that I didn't have you there, but I know you couldn't be there for me and I had to be there for myself, so I learned a lot of independence and when we came together, I felt like I was confident to give answers." She continued explaining that her ability to regulate her emotions helped build her to a place that she felt empowered to continue, even after the math course (B.6).

Whitney described that the journal prompts helped her to be empowered by her progress emotionally (B.7). She stated,

> I couldn't deny that I had changed a lot. Seeing what I would write before and then seeing what I would write scrolling down, I was like 'oh my god, I don't feel like that anymore'. And just reflecting. I'm already a reflective person so I enjoyed it. I enjoyed also thinking about how this tied to my identity as an educator. I feel so strong.

As in the statements from both Sunshine and Whitney, the participants connected their empowerment to the growth in their mathematics proficiency and their emotional regulation together. When Furious said he now had a "good feeling" about math, he said, "there's no pain in it… I'm almost at peace with it because I understand what I have to put into it." Thus, Furious also tied his proficiency and emotional regulation to empowerment within mathematics. All three attributed such empowerment to a more positive mathematics identity.

Connections

All three pillars of TIC are interconnected. *Connections* is the pillar that supports the other two (Bath, 2008). If students do not have connections with safe individuals, peers, and adults, it is difficult for healing to occur (Wolpow et al., 2009). The themes under this pillar relate to the participants' connections between their peers and their instructor. While the themes found under the other pillars described participants' interactions with peers and the instructor, the data sorted into these themes focused on the participants' connections with these groups. For example, the theme of *Psychologically Safe* under the safety pillar highlighted the importance of help in the form of academic support from both peers and the instructor whereas the theme of *In This Together* pertains to the shared personal connections between the participants and their peers. In addition to

personal connection with peers, participants discussed the importance of working alongside peers in providing perspectives for teaching and personal connections with the instructor. This section describes four themes that emerged under the pillar of *connections*. Table 11 below shows the alignment between these themes and the TIC practices described in Chapter 3. As each theme is discussed, the embedded practices are coded using capital letters and numbers as delineated in Table 11.

Table 11

Connections Theme Alignment to Trauma-Informed Care (TIC) Practices

TIC Pillar	Embedded Practices	Theme Alignment: Participants with Math Trauma	Data Source Alignment
C. Connections	1. Recognize the holistic individual shaped by social and cultural experiences (Alvarez, 2017)	*"Instructor knows my story", In This Together*	a. Research memos (1-5) b. Journal Prompts (1-5) c. Interview (1-8)
	2. Build non-academic relationships (Cole, 2005)	*"Instructor knows my story", In This Together*	
	3. "Unconditional Positive Regard" (Wolpow, 2009)	*"Instructor knows my story"*	
	4. Supportive classroom norms (Cole, 2005)	*In This Together*	
	5. Table work and professional learning communities (PLCs) (Wolpow, 2009)	*In This Together, Perspectives for Teaching*	

In This Together

As noted in the previous two pillars, all three of the participants who reported mathematics trauma described the importance of the help and support of their peers. Two of the three, however, discussed the importance of personal connections to their mathematics success (C.1, C.2). Both Whitney and Sunshine discussed that feeling personally connected through shared experiences helped them feel more confident in their mathematics identity. When talking about the creation of our support poster (C.4),

Whitney explained, “When we did the support poster, just hearing everyone, you know, I don’t know if it was just our class, but I felt like everyone was on the same page… everybody’s coming from different levels of content mastery so there’s no judgement.” Sunshine described this saying, “you felt like you were part of the bigger classroom. You got to work with people, and you’d have to contribute to what was actually taught.” Both participants demonstrated, therefore, that feeling connected to the group as a whole made it more comfortable to learn and work on mathematics.

Being a part of this “bigger classroom” connection helped Sunshine to feel safer in asking for help and working with her peers (C.5). Whitney explained that the shared personal experiences throughout the course promoted her learning and helped promote a more positive feeling towards mathematics.

> I just felt like I was making all these discoveries and I’d come down so hard on myself, like “just keep your head down.” Then, when I realized I didn’t have to keep my head down and I could participate, the participation helped me so much – like when we all understood something as a class – it made me feel so good!

These shared experiences were supported by the cohort model in which the residents participated. They knew each other through other classes and through the school in which they were going to work (C.1). Sunshine noted, “we’re following each other. So, most of the people that were in my class were in all my other classes. We were forced to get to know each other and collaborate together.” She continued explaining, “even though we had different opinions, we had to respect those opinions, but then we were friends. Now it’s like we’ll always be friends and we understand that.” All three participants acknowledged the importance of the cohort model for connections and

Sunshine and Whitney particularly valued the personal connections built through this model in the development of their mathematics identities.

Perspectives for Teaching

While Furious explained that personal connections were not his priority, he acknowledged that working alongside peers helped him see their various perspectives in mathematics (C.5). All three participants explained that connections with peers, the participants explained, was helpful in understanding their math work in new and different ways. Furious stated,

> I guess I developed a new understanding…I think the group learning helps because everybody looks at it differently. You can't know what each other person knows in the group or their expertise of how they see the problem or solution. It does help me look at it differently.

Whitney and Sunshine explained that there were several times in which their group work helped them see a new way of thinking or learn a different strategy than the one they used.

As they spoke about these different ways of thinking, they acknowledged the usefulness of these perspectives to their future teaching. Sunshine explained "we all learn strategically different. So when we all sat down and we came together and we talked about this way, that way, how we learned it…it taught us something different." In having this experience, she goes on to explain, she was able to see different strategies and ways to teach. Whitney explained that connections with peers around her helped her learn different strategies that she could implement in the classroom. All three felt better

prepared to understand different perspective and strategies students might have in the mathematics setting.

Beyond seeing the different strategies students might use, all three participants discussed that building connections and seeing the perspectives of others in the class helped them understand a new way to teach. Rather than treating students as a whole group, they wanted to see students as individuals. Instead of valuing one "right" answer, they wanted to teach in a way that helped students develop various strategies. The participants desired to build positive mathematics identities for their students rather than the negative experiences they had in the past.

Instructor Knows My Story

Personal connection with the R-I was also a critical factor in building a more positive mathematics identity for the participants. All three mentioned that having personal connections with the R-I allowed them to feel safe and helped promote positive relationship with mathematics (C.2). This personal connection for these participants began with the instructor simply acknowledging and validating their lived experiences in the mathematics setting (C.1). When talking about what factors contributed to her experiences in the course, Whitney said, "I think your demeanor. The warmness and openness as far as being empathetic to the fact that we were all feeling stressors from stuff that was 15 years ago." This was echoed by the others in their statements about the R-I's empathy and understanding. Furious wrote, "the empathy part is getting an understanding where they're coming from, what their experience is. Your experience is different than mine which is different than yours." Thus, the R-I's acknowledgement of math identities and math trauma helped build connections with the students.

These safe connections constructed between the participant and the R-I helped promote a cycle of support within the mathematics context (C.3). The connection and empathy Whitney felt from the R-I allowed her to feel safe in sharing her struggles with anxiety. Having struggled with anxiety myself, I was able to speak with her about coping strategies in mathematics. In my research memos I explain,

> Whitney stuck around after class today. I could tell she was a little anxious about the work she was taking with her. I shared with her about my personal anxiety struggles. She was visibly relieved that I understood and had empathy for how she was feeling with the math. We discussed calming strategies, and she expressed appreciation for the connection. She then shared that she greatly valued my feedback, explaining that she continually looked back at assignments in which I wrote "excellent" and pulled this out for motivation when she was overly anxious about the math.

Sunshine also experienced improved attitudes and beliefs in mathematics as we built more of a connection. She said, "I felt warm towards you because you are bubbly. You liked math. You really liked teaching math and I can tell you like teaching math. It felt passionate for me like it felt passionate for you. I was like 'well, I want to do this too'." These participants expressed safety in the connection with the R-I which subsequently prompted additional support and more positive relationship with mathematics.

Stories of Healing

"Now I have superpowers!"

In the previous section, the themes under the three pillars of TIC described the course-embedded practices that helped these three participants cope with their math

trauma. Subsequently, better coping within the mathematics environment contributed to additional motivation to learn mathematics and to continue the process of healing from their mathematics trauma. This section describes transformation that occurred in their mathematics identity because of this healing, ability to cope within the mathematics setting, and their new-found motivation at the conclusion of the course.

At the conclusion of the MET course and again at the end of their interviews, the participants were asked to reflect on their current mathematics identity and any shifts or changes they felt had taken place. The responses for those participants who expressed mathematics trauma were quite liberated in nature- no longer the language of battle but that of superheroes.

Sunshine

As she thought about her current mathematics identity, Sunshine began by reflecting on her motivation throughout the course of learning to teach math. She stated "I feel like I have put effort in getting better at doing every subject so that I can teach but l feel like math is not as difficult as I thought it was going to be for me. It's going to be so much easier." She mentioned all the notes she has kept and all the strategies she has added to her repertoire in order to best teach her students in the coming school year. She wore a huge smile and was excited to share about the math notebook from the course that now resides beside her teacher desk. She mentioned "I saw those manipulatives over there in the library. I was like – I know what those are! Oh my god, I can't wait!" Such expressions were quite contrary to the quiet uneasiness with which the conversation began.

As she continued to talk, she acknowledged that a shift towards a positive mathematics identity extends beyond her work as a teacher. She stated, “I am thankful for this opportunity to get the chance to actually love math and not be scared of it, not shriek when I hear the word or have the work placed in from of me.” She spoke of herself as an adult learner who didn’t know about the math she needed to learn. She stated, “it is possible to get better in math as an adult. I’ve never been great at math, and I thought badly about the subject, even fearful. But now I feel better because I have become better.”

We concluded our interview conversation with her ambition to bring positive mathematics identities to her students. As a coach and a former athlete, she sees herself as a motivator and role model for her athletes. She expressed her desire to be a role model and motivator for her students in the math classroom.

Whitney

In her reflection on her current mathematics identity, Whitney excitedly shared “math is my new party trick.” She told stories of recent social gatherings in which she had her friends compute a multiplication problem using the standard algorithm and then taught them the conceptual underpinnings of the procedures. She said,

> It’s a different kind of joy. I feel like a little kid. I loved seeing how it worked and I went and showed everyone…. Just making those connections felt so good and showing them to people and watching their minds open up felt so good.

This excitement about the math itself and sharing this excitement with others helped Whitney build confidence as a future teacher. She shared,

> I have been feeling a lot more confident as a math teacher… I feel much more equipped not only in techniques and procedures, but in teaching a foundation of a positive math identity as well. I feel like I am in a really great place to grow as an educator with my students in math.

As she worked on her own mathematics identity throughout the course, she built strategies in math and strategies for developing a foundation of positive math identity for her students. Moreover, she developed a confidence to continue to work and grow in the area of mathematics.

Furious

When Furious thought about his current mathematics identity, he turned to an example of transformation that he has seen within himself as he has worked on his cars. He stated,

> I've dealt with fractions my whole professional career in automotives. It's in everything. If it's not metric, it's in fractions, but it's really just sizing. After half, I would always get stuck. What's after that? I would have to pull out a sizing chart. And then for some reason now, I actually picture the number line in my head. Now my nut and bolt drawer is organized everything by fractional size.

He went on to explain that math suddenly makes more sense, much like his nut and bolt drawer in his garage. He realized that the "disdain" he held for mathematics was "perceived" based on the negative mathematics experiences and instruction he had previously received. As he explained this he said "epiphany. Boom – light bulb just went off. It really wasn't the math; it was the instruction." He reflected on his experiences

throughout the course, acknowledging that because of the instruction and the way the course was structured,

> I shifted to not hating math. I may not be enamored with math… but I'm cool enough with it. It's like math is my homeboy from the other block. I don't hang out with him, but we cool. Like, "what's up math" and I keep moving. You know, we can get something to eat but I'm not gonna hang out with you forever.

This transformation in his own mathematics identity, much like Whitney and Sunshine, directed his thinking towards his career as a teacher. In thinking about where his mathematics identity is now, he said, "I believe I can teach math with confidence. I will need to practice the work I plan to teach, or what the new standards suggest I teach, so I can be a subject matter expert to my students… I will get better with time and practice." Furious pointed to his improved mathematics identity, leading to his improved motivation to work on his math skills. Additionally, his desire to create a positive mathematics experience for his students added to his motivation to better understand mathematics.

Furious ended his reflection on his current mathematics identity by stating, "it's not the boogeyman in the corner-it's not the monster under the bed. It can be enjoyable. It was enjoyable because I was understanding it and I was cool with myself understanding it." He felt at ease that he was understanding the mathematics and that he allowed himself to enter the space to do so.

Within Case Summary: Participants with Mathematics Trauma

Here I summarize key similarities and differences among the participants with mathematics trauma.

Mathematics Identities

All three participants in this case expressed positive shifts in mathematics identities as a result of the impactful elements of TIC embedded within the MET course. These included feelings of increased mathematical competency, a decrease in negative emotions, and an increase in the ability to cope with stress responses in the mathematics setting. All three participants discussed an increase in conceptual understanding of the mathematics that led to an increase in feelings of competency. Moreover, all three participants explained that their "anxiety," "fear," and/or "trepidation" around mathematics decreased by the end of the MET course. They also explained that, though they still had some stress responses in the mathematics setting throughout the course, they had better coping strategies to manage the stress and reengage in the mathematics.

Trauma-Informed Care: Themes from the Three Pillars

The themes that were discussed in this section outlined the most impactful elements of the TIC practices embedded in the MET course as described by the participants who expressed mathematics trauma. I used the TIC pillars to analyze these impactful elements. From this analysis, 11 themes emerged, four under each of the pillars of *safety* and *managing emotions*, and three under the pillar of *connections*. To be included as a theme, codes from at least two of the three participants must be present for a theme to be included. Of the 11 themes that described the impactful elements of the TIC pillars for the participants in this case, 10 themes included codes from all three participants. Thus, the elements of *safety, managing emotions*, and *connections* that were most impactful to these participants were impactful to all three participants' mathematics identities.

The theme that included codes from only two of the three participants was that of *In This Together*. While both Whitney and Sunshine expressed the importance of personal connections to their peers, it is important to mention that the third participant, Furious, spoke about his peers quite differently. He stated that this connection was not his priority. He explained,

> Some you may trust some I didn't, I just did not want to risk my learning to them… but for the most part, I was focusing on my learning. Yeah, not my colleagues. I can be friendly, but they weren't my mission.

He went on to discuss that the Professional Learning Community (PLC) in which he worked each week was a positive experience in which they all worked for the mutual benefit of one another. However, he concluded by mentioning that the other cohort members "don't pay my bills." This alongside the statement of "they weren't my mission" imply that he did not feel that he was responsible for them as individuals and therefore did not engage in personal connection-building during the class.

Beyond this one theme, the other 10 themes were evident in the data from all three participants. This points to two important points. First, for each of the participants, all three pillars of *safety*, *managing emotions*, and *connections* had an impact on their emerging mathematics identity. Second, there was more than one element within each pillar that mattered to them as learners of mathematics.

Motivation

Motivation was also an important factor that all three participants discussed in both their mathematics identity growth and the impactful elements of the trauma-informed care practices. All three participants in this case expressed that they would

attempt to engage in the mathematics of the course because of the requirements of the program. While they expressed that they would "get through" the class, as the MET course progressed, they explained a desire to understand the content because of their future career as teachers. Thus, though they may have started with a goal to "get the grade" they needed for program requirements, their motivation progressed to thinking about themselves as teachers during the MET course.

The participants in this case also expressed motivation that they developed within each of the trauma-informed care pillars. The pillar of *safety* helped motivate the participants continue to engage in the mathematics. For example, as they felt "psychological safety" in the classroom, they were more motivated to try, make mistakes, and ask questions. This progressed to better understanding of the mathematics and increased motivation to invest in learning the next math concept.

The participants expressed that they held specific motivations that helped them manage their emotions and build connections as well. When the participants experienced an intense stress response in the MET course, all three participants explained that they were motivated to work on managing their emotions when they thought about themselves as future teachers. Additionally, when the participants talked about building connections in the MET course, they expressed that they were motivated to connect with one another because of the year long program in which they were participating. Moreover, they explained that the residents motivated one another to engage and put forth effort in the mathematics. Thus, motivation was a key factor in the participants' engagement in the math, emotional management, and building connections, leading to growth in their mathematics identities.

Stories of Participants without Mathematics Trauma

"I always found comfort in math"

The second case of participants expressed emotions around mathematics but did not express the extreme emotions or stress responses associated with mathematics trauma. These three participants placed their mathematics identity towards the "good at math", "confident", and "peace" side of the continua on the Math Identity Survey (Crowe et al., 2021) at the beginning of the Mathematics for Elementary Teachers (MET) course. While not all of their stories pertaining to mathematics contexts are positive, their interpretation and internalization (Martin, 2006) of their experiences helped these participants develop more positive attitudes and beliefs about themselves as math learners and doers (Aguirre et al., 2013).

Although these three participants did not exhibit mathematics trauma, they expressed emotional and academic development of their mathematics identities. Each of these three participants are introduced below as well as their expressed mathematics identity at the beginning of the MET course. I then discuss the themes under each TIC pillar that this case connected to the development of their mathematics identity. I conclude by returning to each participants' expression of their mathematics identity at the conclusion of the MET Course. The pseudonyms used for each participant were self-selected. The explanation of the pseudonym selection and a brief profile of each participant is included in Chapter 3.

Jonathan

Jonathan entered into the interview with his typical easy-going persona. He sported a big smile along with a baseball cap, both of which he consistently wore

throughout the course. Jonathan explained that math was always something that "came very easy" to him. As an English Language Learner in school, he said, "I can see numbers and it just made sense as opposed to reading and words that were a lot harder. So, I always found comfort in math in my school days."

When he started as an elementary teacher in California, he expected to again find mathematics as a comfort. However, he found it difficult to explain concepts that seemed to "just make sense" to him, but with which his students continually struggled. He stated, "I think the thing that was the hardest for me to get over was my understanding of math. I though like, 'why is this so hard?'" Overtime, he watched other teachers and how they built students' understanding over time and tried to find that connection with them. While he implemented these strategies in his classroom, in his interview and throughout his journal prompts, he said he would not label himself as a "math teacher".

At the beginning of the MET course, Jonathan felt confident in his number sense and his ability to complete the work in the course. He stated, "this is not going to be a piece of cake, but it's not something I have to worry about." He explained that his previous experiences in a mathematics classroom helped prepare him for the academic content and that mathematics instructors he had in the past helped ease frustration and confusion he felt in math settings.

Kristin

Kristin also felt a sense of comfort in mathematics. She stated, "I really liked math. I get bored easily." She explained that her past math classes were filled with what she described as "busy work" that kept her mind and time occupied, making her feel relaxed. Kristin went on to explain that she did have some math challenges along her

journey. She said, “It wasn’t until college that I realized maybe I didn’t retain as much as I thought I did.” She said in college, she realized there were many topics in which she felt comfortable and others that had always been more difficult. She explained,

> I thought math was my favorite subject, which it still is, but I didn’t feel okay about everything. For algebra I was like, ok, this is algebra again and I remember this, I remember some of the formulas but when I started to work, I was like, “no”. But I tell you, I always hated fractions since I was in grade school.

Even though she remembered some struggles in math, Kristin felt comfortable enough in the math setting that she was “worried, but not overly worried” about taking the MET course. In a journal prompt that asked about worries and support needs at the start of the course, she said she worried because, “sometimes my way of understanding is completely different” and “I usually am kinda shy and don’t like feeling embarrassed, so I don’t always ask for help when I should.” Thus, her biggest worries for the class didn’t involve content but rather the group setting and feeling embarrassed in front of the group.

In our interview and throughout the class, Kristin also shared that she had a great deal of stressors in her personal life during that time. This was also a source of worry as she started the class. She expressed that she wanted to do well but had to exert extra effort to focus on the class rather than the heavy stress external to the class.

Courtney

Rather than expressing comfort or emotion tied with math, Courtney simply expressed that she “liked math”. When talking about her past experiences in mathematics, she did not mention any experiences throughout her K-12 experiences but began talking about some negative experiences in college. She stated “I struggled to get a C in college

algebra and then for my business degree, they needed a B in math… I also took statistics three times." She explained that she felt this was largely due to her focus on her grades. She said, "I really struggled trying to get the grade I needed verses trying to really grasp the concept."

Going into the MET course, she felt she had a better sense of purpose for understanding rather than focusing on the grade itself. She responded to a journal prompt saying,

> I believe something that would a difference in my math experience this summer is wanting to understand that math is more than numbers. As a student taking a math class in undergrad, I just wanted to get it done. I didn't really care about why it was important to understand. So, in this class I am hoping to understand math beyond numbers and equations.

Thus, going into the course, she desired to not just "get the grade" throughout the course but rather to understand the mathematics.

These three participants did not express extreme emotions or stress responses in the mathematics setting. In fact, they described feelings of comfort and calm in past mathematics settings. Entering into the MET course, therefore, these participants felt calm and assured of their mathematics abilities.

The Impact of Trauma-Informed Care: Themes from the Three Pillars

The MET course incorporated the three trauma-informed care pillars (Bath, 2008). I used these pillars to analyze each participant's narratives around their experiences in the course and how they see themselves as learners and doers of mathematics. Through their journal prompts, interviews, and interactions throughout the

course (noted in my research memos), these participants expressed that shifts in their mathematics identity occurred because of the safety, connections, and integration of emotional management within the course. While these three participants did not express mathematics trauma or exhibit the extreme emotions or stress responses of mathematics trauma, they did express shifts in their mathematics identity throughout the course. The themes and sample codes under each pillar and are listed below in Table 12.

Table 12

Trauma-Informed Care (TIC) Themes: Participants without Mathematics Trauma

TIC Pillar	Themes	Sample Codes
Safety	Positive Class Environment	*Class was bright, positive energy*
	Instructional Trust	*You're gonna learn something, Lightbulb in every class*
	Helpful Support	*Not frustrating, backup support*
	Built Confidence	*No question is dumb, confidence motivates*
Managing Emotions	"My brain can get overwhelmed"	*Like hitting a brick wall, being careless*
	Can Control Emotions	*Take a break, what you think=what you focus on*
	Motivation as a Teacher	*Confidence for students, less restless as a teacher*
Connections	Personalized Instruction	*Personal relationship, individualized teaching*
	"We spoke the same language"	*Motivated one another, I could help*
	"We will be together for a year"	*Strengths where I am weak, have to build a relationship*

Safety

These three participants did not discuss a lack of safety in past mathematics settings but did express uncertainty about how the class would build on their prior learning as well as their future careers as teachers. Additionally, they expressed

reservations about how their learning might be impacted by the instructor and the group as a whole. In the data collected throughout the MET course, all three participants in this case discussed the ways in which the class felt "safe" to learn and develop their understanding and created a safe environment to ask questions and learn as a group. The data analysis revealed four separate, but interconnected themes: *Positive Class Environment, Instructional Trust, Helpful Support, and Built Confidence*. I describe each of these four themes below. Table 13 below shows the alignment between these themes and the TIC practices described in Chapter 3. This table also includes the sources that collected data leading to these themes.

Table 13

Safety Theme Alignment to Trauma-Informed Care (TIC) Practices

TIC Pillar	Embedded Practices	Theme alignment: Participants without Math Trauma	Data Source Alignment
A. Safety	1. Acknowledging and validating feelings around mathematics (Alvarez, 2017)		a. Research Memos (1-9) b. Math Identity Survey Part III, IV, & V (1) c. Journal Prompts (1, 2, 3, 4, 5, 6, 9) d. Interview (1-8)
	2. Supportive classroom norms (Cole et al., 2005)	*Helpful Support*	
	3. Table work and professional learning communities (PLCs) (Wolpow et al., 2009)	*Helpful Support, Built Confidence*	
	4. "Unconditional Positive Regard" (Wolpow et al., 2009, p. ?)	*Positive Class Environment*	
	5. Multiple ways to present information (Cole et al., 2005)	*Helpful Support*	
	6. "Islands of Competence" (Cole et al., 2005, p.?)	*Helpful Support, Built Confidence*	
	7. Formative feedback on math assignments (Wolpow et al., 2009)	*Helpful Support, Instructional Trust*	
	8. Consistent routine and expectations (Cole et al., 2005)	*Instructional Trust*	
	9. Relevant and meaningful work (Cole et al., 2005)	*Instructional Trust*	

Positive Classroom Environment

These three participants all expressed a type of skepticism coming in the classroom on the first day. They were concerned with how this specific classroom environment was going to be when compared with their other experiences. In his interview, Jonathan talked a great deal about a beloved math professor he had in his undergraduate experience. He identified this professor as a mentor and someone who "just got me" and was unsure if he could find something similar. However, he expressed that the passion of the instructor in the MET course, like his previous experience, made the class a positive space to learn (A.4). He stated, "Your passion and love for mathematics just glows in your class, it was like walking in the classroom, it felt a little bit brighter." He was thankful that the space was positive like his previous experiences.

Kristin, similarly, explained that she analyzes any mathematics setting to determine what to expect from the class and found this class to be a positive environment. She said, "I'm gonna walk in and analyze the room and the content and then kind of adapt. So, if I had come in and you seemed very strict, and very stern, I would have probably had a little more worry." Kristin explained that the positive environment helped to "direct her attention to the positive energy in the room," regardless of her other struggles outside of the classroom.

Courtney explained that the positive environment came from the instructor and the cohort. She said,

> Everyone was warm, willing to share. You didn't get frustrated with anybody who wasn't getting it. Everybody was respectful and you know, not rude. I really

> enjoyed the atmosphere… it is definitely a different college experience that I've ever had.

This warm and positive environment allowed these participants to feel more comfortable and ready to learn. Kristin stated that after analyzing the classroom and feeling the positive environment, "I kind of came in just open minded and ready to see what we were gonna learn."

Instructional Trust

These three participants explained that they were unsure of what they were going to learn within the course but developed trust in the instruction. This trust was built as they began to understand the purpose and "usefulness" of the course (A.9). Jonathan had already taken a mathematics course designed for elementary teachers prior to this course. He was concerned that he would not learn anything new. Over the first few weeks, he built trust in the usefulness of the course. He explained,

> The previous courses weren't focused on explaining. Your course focused more on ok, 'I don't care if you get the algorithm, I care about how you use math language and the words you are going to use to explain to the kids… How can you better convey it to them or make a connection that they might understand. That helped me a lot.

Kristin also expressed uncertainty of the usefulness of the work before the course began. She explained if she had come in and we were "just working through a workbook or a textbook, I would have either been like, 'oh shit, we're gonna go over all this' or I would have been frustrated that we didn't get to it all." She said "instead, I felt like you only introduced what you were going to go over…you kept it very organized like okay, this is

what we are working on and we were focused" (A.8). Both participants explained that the learning in the course they found to be useful, allowing them to trust the instruction.

For all three participants, having this trust in the usefulness of the instruction helped them engage in the work and develop their mathematics identity in different ways. Jonathan explained,

> Just being in your class and learning the words and getting, not unlike rejuvenation, like growth in a different direction. I've always loved math… I just never thought of myself as a math teacher. Where now, I've learned how to express the way we would teach it and how to come up with creative ways to teach. I think it would eliminate a lot of the heartbreak I would have at night to where I could see myself now, being a math teacher.

Similarly, Kristin explained that growing trust in the usefulness of the work "made it more intriguing to want to learn it rather than something I had to learn." Thus, the more these participants trusted that they would learn from the work they were doing, the more the engaged and put forth effort in that work.

Helpful Support

The support provided by both the R-I and the other residents in the course helped these three participants overcome their insecurities within the group setting (A.2, A.3). Kristin stated she was "afraid to be embarrassed or for a question to be considered silly." However, she expressed safety in asking questions in the MET course. She said,

> If I feel like I can ask the question and get an answer I understand, I'm gonna ask the question. I felt like if I asked you a question, I would get an answer close to or

> exactly what I needed to understand. It was just feeling like I was actually going to get something back that I could use.

Thus, she felt that the answers she received from her questions were helpful in supporting her understanding in a positive manner and therefore she felt safe to ask them (A.4).

All three participants recognized that the R-I was there for support, regardless of where they started in their math understanding (A.6). Kristin explained, "you met us where we were… you reflected on our needs. The needs of us as math learners". Courtney noted that when someone didn't understand, "you just scaled it back… so that everyone can understand." She said that when she received that type of support, it made her "feel confident about [the math] enough to enter into the next thing." Help from the R-I, therefore, made the participants feel supported in their work and safe moving forward to the next topic.

In addition to support from the R-I, the three participants expressed that helpful support from their peers aided their math learning. Both Courtney and Kristin described comfort in knowing they had others to turn to for support (A.2). Kristin explained, "I was never concerned about whether or not I was getting something when you were explaining because I knew we would be able to talk about it and review with peers and catch on." Additionally, in a journal prompt that asked if this class was different than previous mathematics experiences, Courtney wrote, "Mrs. Morris and the classmates around me. Everyone is helpful."

Jonathan was often in the role of providing support to others, especially at the beginning of the course. However, a shift occurred during the third class when he began asking more questions of his group. In my research memos from class three I wrote,

> Jonathan has always been the first to jump in and help his group mates. I noticed today that he recognized a mistake he had made in his work. He worked for several minutes with the base ten blocks to understand his mistake but was not understanding the root of his mistake. _____, [the individual at his table who consistently turned to Jonathan for help] was enthusiastic to explain her strategy to him. Jonathan was highly receptive of her help and their entire small group celebrated together.

After this third week of class, residents were asked if there had been any shifts in how they feel as math learners and doers. Jonathan had already described himself as an interpersonal math learner, but in this journal prompt added, "I love working with a group of people. It allows me to help others where I am strong and also lets me tap into others for help where I am weak." He recognized that the mutual help from peers was an important part of this coursework that made him more comfortable in the learning (A.2, A.3).

Built Confidence

Throughout the data collected, these three participants expressed a gradual building of confidence in their mathematics work that increased their feelings of safety within the math work. They attributed this confidence building to their increased mathematics skills and their experiences helping peers (A.3). Kristin explained, "Before this class, I allowed myself to just feel like, 'I don't get it and I'm just gonna guess.' Versus now, I try to look for what I connect with and build from there. It's an empowering thing for me" (A.6). Courtney described this feeling in a cyclical way, explaining that when she was able to grasp the math work, it made her more confident to

enter into the next topic. She stated, “going to the place of like, ‘I feel confident about this enough to kind of enter into the next thing.” All three described this type of iterative confidence building in their math skills. Kristin this by stating, “If I feel like I can do something, I feel like I’ll work harder. It’s like a self-reward.”

These participants also found that their confidence grew as they helped their peers. All three participants related these experiences of helping others in the class to their building of confidence as a future teacher (A.3). Jonathan explained that “it felt rewarding to see the light bulb” when he was helping his peers. When asked about how she experienced the group work in class, Kristin explained,

> I’ve learned a lot about how I want to apply myself as a teacher to make sure that I give students confidence to come to me with questions even knowing that I’m not always going to know the exact answer but I’m willing to tell them that I will do my best to get them an answer to help. So, I think that helping others in class was a good thing.

By helping peers, she expressed an increase in knowledge of how to help others and build confidence within them. Jonathan said his experience helping peers in this class made him feel more confident in himself as a math teacher. He stated, “I’m the person who’s going to be able to help and show that [confidence] and teach that to them, so that they can go on and teach each other and others in the future, maybe their own kids.” In building confidence in himself as a math teacher, Jonathan also acknowledged that helping others build confidence in the mathematics setting was a crucial part of growth in the mathematics setting.

Managing Emotions

Though these three participants did not identify mathematics trauma in their past mathematics experiences, they did identify many emotions within the mathematics classroom. Some emotions were rooted in the mathematics while others were related to personal struggles external to the mathematics course. In analyzing the data from these three participants, three themes emerged: "*My brain can get overwhelmed", "I can control my emotions",* and *Motivated by Teaching.* I describe each theme in this section. Table 14 below shows the alignment between these themes and the TIC practices described in Chapter 3.

Table 14

Managing Emotions Theme Alignment to Trauma-Informed Care (TIC) Practices

TIC Pillar	Embedded Practices	Theme alignment: Participants without Math Trauma	Data Source Alignment
B. Managing Emotions	1. Identifying traumatic experiences (Alvarez, 2017)		a. Research Memos (1-7) b. Math Identity Survey Parts I, II, III, & V (1, 2) c. Journal Prompts (1, 2, 3, 6, 7) d. Interview (1-7)
	2. Identifying emotions in the math setting and impact (Cole et al., 2005)	*"My brain can get overwhelmed"*	
	3. Empower students to understand and create their own narrative (Alvarez, 2017)		
	4. "Upstairs and Downstairs Brain" lesson (Siegel & Bryson, 2012, p. ?).	*"I can control my emotions"*	
	5. "Flip your Lid" Poster (Siegel & Bryson, 2012)	*"I can control my emotions"*	
	6. Help self-regulation when responses are triggered (Alvarez, 2017)	*"I can control my emotions"*	
	7. Validating responses to journal prompts (Wolpow et al., 2009)	*Motivation as a Teacher*	

"My brain can get overwhelmed"

These three participants had not previously connected emotions to mathematics. As they worked through class sessions, journal prompts, and reflected in their interviews, they acknowledged that they did, in fact, have emotions in the math setting (B.2). The first journal prompt of the MET asked residents to share anything they wanted after completing one class session. Jonathan wrote, "I really like how we were asked about past experiences in math. We all can relate to good and bad educators in our own lives. I am looking forward to putting emotions into mathematics." In his interview, he expanded this saying he hadn't previously been made aware of his own emotions in association with his math experiences. He stated,

> If you walked up to someone on the street and asked, 'what emotions would you connect to math?' most people aren't going to connect much… you're not going to get very many feelings or emotions that people are going to connect to.

In research memos from the first day of class, I noted that in small group conversations, students expressed that it was a relief to talk about their true emotions about math.

Thinking about the emotions they experienced in math settings, Courtney explained that when she used to get frustrated with math she said, "I was bad 'ahhh,' slamming the pencil. I quit, you know, blurting it out loud and things like that. I think one time I just walked out." Similarly, in this discussion she outlined a class session in which the work was overwhelming. She explained, "I remember making a screeching sound of frustration and wanting to cry." Jonathan also explained that he experienced frustration with some math work explaining, "I don't think I ever associated sadness [with mathematics] but there could be maybe a little bit of frustration. But I actually think it

was more like drive." Thus, Jonathan experienced frustration which drove him to move forward in the mathematics.

When asked about her emotions in the MET course, Kristin explained that emotions she experienced in the mathematics setting was associated with extreme personal stressors. She returned to a memory of one specific class recalling,

> I had at least one day when I was overwhelmed. I don't think it was just math class. I had a rough morning and then the confusion about math came and I was like, 'nope, no, no more.' [My brain shutting down] was a coping mechanism. I can absorb a lot, but my triggers are my triggers and once they capture that frontal lobe, I have to decide whether to react or pause.

She acknowledged that her brain was already overwhelmed coming into class and the math added an additional layer of stress that caused her brain to "shut down." She described as "hitting a brick wall" that prevented her from moving forward. Whether the emotions were caused by factors external or internal to the mathematics setting, all three participants acknowledged the importance of recognizing their emotions.

"I can control my emotions"

These three participants explained that identifying the emotional connection with mathematics was important in learning control of emotions throughout the course. All three participants referenced one of the three mini-lessons on regulation strategies and referenced them throughout the semester (B.4, B.5, B.6). In research memos, I noted,

> The residents identified that by recognizing the emotion they have created a space to manage and grow in their emotions around mathematics. After watching the video about "flipping your lid" [see chapter 3], whether they seemed to have a

positive relationship with mathematics or a negative relationship with mathematics, all residents nodded in agreement. They talked in their groups about times in which they flipped their lids and had to calm themselves. They also noted how important they feel this is for their future classrooms."

In her interview, Kristin explained that the lessons on managing emotions helped her act on them in a positive way. She stated, "the thing your mind focuses on is what controls your mind, and I did not want negative things, so I found an outlet that worked out." This outlet for Kristin was "taking a pause" and "putting the pencil down and try to clear my mind." Similarly, Courtney said, "you can control what you want to do in your emotions, you know. When there's something you have to do, you have to find a way to grasp it and not let it beat you up. So just taking deep breaths and taking a break helped a lot." All three participants discussed times in which they had to calm themselves, take a break, or practice deep breathing.

Motivated by Teaching

These three participants expressed that they were motivated by their future teaching career to work on managing their mathematics emotions. Courtney explained that she would say to herself, "if you want to be what you want to be, you have to do this and you know, you can't let it beat you or defeat yourself." She was motivated to manage her emotions by seeing herself as a future teacher. Jonathan said that he would have "fewer restless and sleepless nights" as a math teacher because he "wouldn't have the frustration of "why can't they just get it!" Because of his own explorations about his own emotions in mathematics, he felt better equipped to understand his students' emotions.

Additionally, these participants were motivated help their students manage emotions. Kristin explained,

> You just put me in those perspective of what I would want to be as a teacher. I want them to feel confident in themselves to try even if they sit there and feel like 'I don't understand nothing you saying.' I want to build a confidence to have a starting point, so that they know that they can get better.

Similarly, Jonathan explained that if he had a student who was getting frustrated with mathematics, he would step in to help the student manage emotions in a way that was similar to what worked for himself. He said, "I would definitely let him vent and stop what he was doing but stop with intention of coming back to something he had already completed. I would try to reinforce him and validate his feelings." All three participants explained ways in which managing emotions in the math setting is an important part of their future careers as math teachers (B.2).

Connections

The themes under the pillar of *connections*, like before, refer to the participants' personal connections with the R-I as well as their peers. These themes do not involve academic support, but rather personal connections built with individuals in the course through the math work or through growth of personal relationships. The themes that emerged from the data under the *connections* pillar include *Personalized Instruction, "We spoke the same language", "We will be together for a year"*. I describe each theme in this section. Table 15 below shows the alignment between these themes and the TIC practices described in Chapter 3.

Table 15

Connections Theme Alignment to Trauma-Informed Care (TIC) Practices

TIC Pillar	Embedded Practices	Theme alignment: Participants without Math Trauma	Data Source Alignment
C. Connections	1. Recognize the holistic individual shaped by social and cultural experiences (Alvarez, 2017)		a. Research memos (1-5) b. Journal Prompts (1-5) c. Interview (1-8)
	2. Build nonacademic relationships (Cole et al., 2005)	*Personalized Instruction, "We spoke the same language"*	
	3. "Unconditional Positive Regard" (Wolpow et al., 2009, p.)	*Personalized Instruction*	
	4. Supportive classroom norms (Cole et al., 2005)	*"We spoke the same language", "We will be together for a year"*	
	5. Table work and professional learning communities (PLCs) (Wolpow et al., 2009)	*"We spoke the same language"*	

Personalized Instruction

The personalized instruction these three participants described was not academic in nature, but rather instruction that acknowledged and built connections with them as individuals (C.2). Courtney described the class stating, "I think it was very personal… that definitely makes a difference. And so, it was more to me that I felt like you had a relationship with everybody." In a journal prompt asking the difference in this class when compared to previous math experiences, Courtney said,

> Mrs. Morris is very passionate about what she does and is committed to her students in wanting to improve her students' knowledge in math. This is shown in being able to text her, staying after class, or come to her office during the week.

For Courtney, the availability of the R-I showed personal investment in the residents' individual learning. In her interview, Kristin was asked the same question regarding the

difference she saw in this experience when compared with previous math experiences. She explained,

> It was just your approach on how you teach math… I feel like you individualized teaching to me. There were what, 30 students? That's a lot of different types of learners and I think you made it very clear that you were here for everybody. I know a lot of teachers want to be that way but sometimes those biases can make it easier for them to engage with people who understand. I don't feel like we had that. It was a really healthy balance.

Kristin also found that a personal approach to mathematics instruction helped make a difference for her in the course. For all participants, this personal investment and connection to the R-I helped them develop in the mathematics identities. In her interview, Courtney said that though she had never hated math, math sometimes gave her a "bad feeling." However, she felt that the personal relationship the R-I made with the residents helped her build a more positive feeling about mathematics (C.3).

"We spoke the same language"

In the data that led to this theme, participants expressed the personal connections and personal support they felt among their peers (C.2, C.4). These personal connections were especially important for Jonathan who recently had moved to the state. He explained that he didn't have any friends locally until he began classes with this cohort. throughout the course, he had a few residents in particular that he connected with stating, "they were in my PLC and we've really connected while we were working" (C.5). He went on to say about the entire cohort, "It's helped a lot. I got 30 new friends." Jonathan felt that these connections helped his understanding in mathematics. Jonathan expressed

that being a part of one cohort and connecting with individuals within the cohort helped him grow socially and also helped him learn in the math setting. He said, "it's broadened my thinking… it's helped me be able to tap in and see everyone's an individual. Learning is never one way but we're all learners." His learning was enhanced through his connections.

Similarly, Courtney felt that connections with peers helped improve her mathematics identity. She explains,

> Even though you guys were saying the same thing, it's just that sometimes the wording was different. So to me, that, you know, sharing those ideas… others are willing to help and suggest things to help others get it."

All three participants expressed that the connections shared with fellow residents allowed them to "speak the same language" when it came to mathematics, which contributed to growth in their mathematics understanding.

Instead of a collective connection, Kristin valued the connection of a few individuals. There was evidence throughout the data of her hesitancy in big groups and fear of being "embarrassed" in a whole group setting. In her interview she stated that there were some "outspoken cohort members" who made her feel frustrated. She said there were a few times where she felt that "if I asked a question, someone dismissed it before you even answered." She explained she was "a little sensitive" to such interactions, especially when her current life circumstances outside the classroom were more difficult. She explained of the whole cohort, "people just don't know what you go through" There was one resident, however, that Kristin described as her "safe person". She said, "____ is my safe person. She can read me with no words. If I made eye contact

with that person, I might have been able to release a feeling like, 'it's not a good day.'" She explained that having this safe person helped her get through a few days that were especially difficult due to her life circumstances and helped her remain engaged in the mathematics (C.2).

"We will be together for a year"

All three participants expressed that one motivation for building connections was the cohort model that kept the residents together for a year (C.2). When Courtney was asked to explain her experience working with peers throughout the course she explained,

> It's just really having that relationship with the [residents]. Like saying, 'we're gonna be with each other for the next year so I might as well go ahead and help.' We're here to help each other and we've established that kind of early on in other classes too. It's not a race, it's not who gets the best score, the greatest motivation is each other.

Jonathan used similar language stating, "for me, it's not about seeing who can get to the mountaintop first, but rather let's all get there together." These participants spoke of focusing on the collective end goal of becoming a teacher over the next year (C.4). This led them to assert collective effort to achieve this goal. This was also evident throughout class time. In the research memos, the R-I mentioned the collective group effort that helped motivate one another in every class session.

Stories of Math Identity Shifts

"I can see myself as a math teacher now"

In the previous sections, the themes under the three pillars of TIC describe the course-embedded TIC practices that contributed to shifts in these three participants'

mathematics identities. At the conclusion of the MET course and again at the end of their interviews, the participants were asked to reflect on their current mathematics identities and any shifts or changes they felt had taken place. This section describes the responses of those participants who did not express mathematics trauma.

Jonathan

When reflecting on his experiences at the end of the MET course, Jonathan felt a shift in both his mathematics content knowledge and how he saw himself as a math learner and doer. He explained that he learned "a lot of new techniques and new terminology" in mathematics. He stated,

> In past course loads, it wasn't so much about explanation, but your course focuses more on, 'I don't care as much about the algorithm or the solution. I care more about how you explain, the language, the words you are using to express the math to show to the kids.'

With work focused on the conceptual understanding of mathematics, Jonathan felt that he could better reach students. He stated that new strategies and ways to explain math helped him "find better connections and better convey it to [students] and they might like that and find it's easier for them so that helped me a lot."

Growing in his conceptualization of mathematics and seeing that he can better help students in mathematics led to his biggest shift in his mathematics identity-seeing himself as a math teacher. In his final journal prompt Jonathan wrote,

> I feel now like I completely would enjoy being a math teacher. Math has become more enjoyable for me and given me less animosity towards doing arithmetic. Furthermore, I believe that my math identity has done a complete 180 turn. I

> never saw myself as a math teacher. Don't get me wrong, I love math. I get it and it comes very naturally to me. I just never felt like I could be the one to teach math to another individual and/or group of students.

Seeing himself as a math teacher was a major shift in his mathematics identity and helped him become enthusiastic for teaching over the next year and into his career.

Kristin

Kristin explained that she felt a sense of relief now understanding what she described as "new math". During the Covid-19 pandemic, Kristin struggled to help her children with their mathematics at home. She explained that she struggled to understand the concepts behind the math in which she had always felt fairly confident. Now, she explains,

> I've actually been telling people like, 'ya'll know why we got this so called New Math.' They'd be like, 'oh, that makes a lot of sense' and I'm like 'I know.' So I've literally been telling people, 'we've been learning the algorithm and we have to know where that even came from. It's not new math, it's just the stuff before you get to the algorithm.

She explained that making this connection made her feel more confident in her work with her children and in her future classroom. The first day she was in her classroom, she explained that she looked at the math workbook her students were expected to complete. She said, "I felt confident. Confident in the math and excited because I looked at our workbook and I said, 'okay, thank you Ms. Morris' because, wooohhhh." She explained that before the course, she would have been overwhelmed by the workbook. She was

relieved that she felt confident in the math she saw and was excited to teach it to her students.

Courtney

Courtney experienced a shift in her mathematics identity as she grew in confidence of her understanding behind mathematics. She explained,

> Why did you do the work that you did? That's the important point. That's the part that I'm grasping about math. Like I said, it's beyond the operation. You want to think why you did this step. And even if you get it wrong, you know, if you explain why you did it that way somebody can understand and try to help.

In a journal prompt, she explained that this type of understanding made her "more interested in this class than any math class I've had".

This interest was also because of her future career as a teacher. While she did not feel confident in learning "new math" before this course, she explained that she was focused on wanting to be a teacher and that this helped her desire to learn at a deeper level than before. At the end of the interview she explained, "I'm ready to teach math. Yeah, I feel pretty confident, especially with the new math program they have and with my knowledge." Her mathematics identity had shifted to seeing herself as a teacher in mathematics and she felt confident in doing so.

Courtney ended her last journal prompt stating, "I am still willing to learn and not just do it because I have to, but because I want to so that I can be an effective teacher." In ending with this, she expressed that she will be motivated to continually improve and no longer desired to "just get it done."

Within Case Summary: Participants without Mathematics Trauma

Here I summarize key similarities and differences among the participants without mathematics trauma.

Mathematics Identities

All three participants in this case expressed shifts in mathematics identities as a result of the impactful elements of TIC practices embedded within the MET course. These included feelings of increased mathematical conceptual understanding, an understanding that mathematics involves continual growth, and identifying themselves as mathematics teachers. All three participants discussed an increase in conceptual understanding of the mathematics that led to an increase in feelings of competency. Moreover, all three participants described a new understanding of Growth Mindset (Dweck, 2006). They recognized that mathematics isn't something to be achieved, but rather something in which they can continually grow. Additionally, while all three discussed themselves as future teachers at the beginning of the MET course, they began identifying themselves as mathematics teachers during the MET course.

Trauma-Informed Care: Themes from the Three Pillars

The themes in this section describe the most impactful elements of the trauma-informed care practices embedded in the MET course as described by the participants who did not express mathematics trauma. I used the TIC pillars to analyze these impactful elements. From this analysis, 10 themes emerged, four under the pillar of *safety*, and three under each of the pillars of *managing emotions* and *connections*. Codes from at least two of the three participants were present for a theme to be included. Of the 10 themes that described the impactful elements of the TIC pillars for the participants in

this case, nine themes included codes from all three participants. Thus, the elements of *safety, managing emotions*, and *connections* were impactful to all three participants' mathematics identities.

The theme that included codes from only two of the three participants was that of *"My brain can get overwhelmed."* Both Courtney and Kristin expressed times in which their brains became overwhelmed. Courtney explained a few instances in which she was overwhelmed with the math in the MET course and the resulting emotions and behaviors. Similarly, Kristin explained times in which personal stressors caused her to feel overwhelmed during the MET course. They both acknowledged that recognizing this feeling was helpful in understanding how to cope with a feeling of being overwhelmed in the mathematics setting. Unlike these two participants, Jonathan did not discuss a time in which his brain was overwhelmed during the MET course. Though he identified useful regulation strategies that aid in the control of emotions in the mathematics classroom, he did not identify a time in which he felt overwhelmed in the mathematics setting and utilized these strategies.

The remaining codes related to the elements of *safety, managing emotions,* and *connections* were impactful to all three participants' mathematics identities. Though they did not identify negative mathematics identities at the beginning of the MET course, these impactful elements allowed the participants without mathematics trauma to begin identifying themselves as mathematics teachers.

Motivation

Motivation was an important factor in the growth of these participants' mathematics identity throughout the course. All three participants in this case expressed

that they were motivated to take this course by their desire to be a teacher. They explained that they wanted to gain a better conceptual understanding of math in order be a good math teacher. However, they did not yet identify themselves as a mathematics teacher. Throughout the MET course, these participants shifted to discussing themselves as mathematics teachers. They began describing their work in context of themselves as teachers. This shift in identity became a motivating factor in their math work. All three participants expressed that they were motivated by teaching to continually provide helpful support to their peers in the class. They explained that they were able to see the perspectives of others and develop various ways to engage in math with their peers. This, in turn, motivated them to continue to grow in their own conceptual understanding.

While participants expressed specific motivations that catalyzed mathematics identity growth, they also expressed specific motivations they held to participate in each of the TIC pillars. Seeing themselves as mathematics teachers motivated the participants in this case to engage in managing emotions and building connections. These participants discussed that their motivation for engaging in emotional regulation was to help their students manage emotions in mathematics. They also share motivation to build connections within the MET course. They recognized that they would be in the program together for a year and that it was critical to build support within the MET course and as they continued in the program. Thus, motivation was a key factor in the participants' engagement in the math, emotional management, and building connections, leading to growth in their mathematics identities.

Cross-Case Analysis

The two cases for this study were comprised of three participants each. The first case included three participants who expressed mathematics trauma. The second case included three participants who did not express mathematics trauma. As they shared about their mathematics identity and their experiences in the Mathematics for Elementary Teachers (MET) course, there were many similarities and differences in the participants' data from the two cases. I first compare the data pertaining to the mathematics identities of each case before and after the MET course. I then compare the connections each case made between their mathematics identity development and the TIC practices embedded within the MET course.

Mathematics Identity

Each of the participants in this study shared narratives about their mathematics identity and factors shaping that mathematics identity. These narratives included experiences they felt were formative to their mathematics identity before the MET course as well as shifts in this identity during and after the course. While each narrative is unique to the individual, there were several characteristics that were distinctly different for the participants with mathematics trauma and the participants without mathematics trauma. Additionally, there were several characteristics that were similar across the two cases. Table 16 below shows the comparison of these characteristics of the two groups' narrative around their mathematics identities. The similarities and differences shown in this figure is discussed below.

Table 16

Development of Mathematics Identity Cross-Case Analysis

	Before MET Course	After MET Course
Participants With Math Trauma	• Extreme negative emotions in mathematics settings. • Negative math experiences before college-age • Focus on "getting through"	• Desire to build positive math ID in students
Both		• Shift to identifying self as teacher. • Confidence in conceptual Understanding • Desire for continual growth
Participants Without Math Trauma	• Comfortable in mathematics settings • Negative math experiences at or after college-age • Focus on "becoming a teacher"	

Before the Mathematics for Elementary Teachers Course

There were significant differences between the two cases prior to the MET course in participants' emotions, experiences, and motivation. The differing emotions and experiences of the participants in these cases were a fundamental difference that led to the designation of the cases. The participants' motivation at the beginning of the course was not fundamental in the designation of the two cases but was a consistent difference between the participants in the two cases. This discussion explains these differences.

Emotions. The fundamental difference between the two cases was participants' responses to the mathematics context. For the participants with mathematics trauma, the mathematics context was a trigger for extreme emotions that inhibited their ability to cope physically, emotionally, and/or mentally. As such, the obvious difference in these two cases was their reactions within the mathematics context. By these reactions, it was clear that the participants with mathematics trauma carried extreme negative emotions.

They all spoke of “fear”, “anxiety”, and “trepidation.” Throughout their previous math work, they described “tantrums”, “withdrawal”, and “avoidance” as well as feelings of insecurity in their mathematics abilities. Throughout the MET course, they explained they still had these tendencies, but were able to better cope and calm themselves.

The participants without math trauma shared that they were comfortable within the mathematics context. All three participants stated that they “enjoyed math” or it “just came easy.” The narrative Jonathan shared around these feelings included a comfort in the subject of mathematics when reading and writing presented a significant language barrier. For Kristin and Courtney, this comfort came from feelings of competency in mathematics that started at an early age. These feelings of competency developed into a “like” of math for Courtney and a “love” of math for Kristin.

Experiences. All participants attributed these reactions to their experiences within the math context. An interesting finding is that all six individuals, those with and without math trauma, had significant negative experiences in a mathematics context. However, the timing of *when* these negative experiences occurred was significant. The participants who expressed mathematics trauma spoke about significantly negative experiences in their elementary, middle, and/or high school experiences. Sunshine spoke of the racialized experiences she had as an elementary student. Jada described a lifelong avoidance of mathematics that culminated with a severely negative experience with a high school teacher. Interactions with this teacher solidified the negativity she saw within herself as a math learner and doer. Furious described a continual feeling that he “just saw math differently” throughout middle and high school, which he internalized as a lack of competency.

In contrast, the three participants who did not express mathematics trauma had negative experiences in mathematics while they were college-aged and most within their undergraduate experiences. Courtney described her struggle with college algebra and a statistics class she needed for her business degree. She explained "For my business degree, they needed a B when I tried to go back to school. So, I really struggled trying to get that B verses trying to grasp the concept. I took statistics three times." Similarly, Kristin said that "it wasn't until college that I realized maybe I didn't retain as much as I thought I did." Jonathan's negative mathematics experiences involved his year of long-term substitute teaching in another state. During this time, he felt that he did not understand conceptual strategies to teach mathematics. Whether or not the participants developed trauma within their negative mathematics experiences, therefore, might be dependent upon the time in which their negative experiences occurred.

Motivation. Whether they had extreme negative emotions or felt comfort in entering the MET course, participants in both cases held a different motivation for doing well in the course before it started. This motivation for the participants with math trauma was focused on "getting the grade" at the beginning of the course. These participants wanted to "get through" the course to become a teacher. Furious said, "My bias towards the class was like, 'I'm not gonna be able to do this, but I will try my best to get through it. I need the grade.'" All three participants who expressed mathematics trauma said they were initially motivated by the grade and the requirement to get a "B" in the class. They knew they had to maintain the grade in order to continue in the program. Jada explained about the course, "It felt like the stakes were a little higher. I really was like, 'I just want to get done with this." Though they had a great deal of anxiety and fear coming into the

course, these participants were motivated to "get the grade" and "get through" the course. Though two of the three mentioned that this class was required to stay in the Urban Teacher Residency Program, these three participants did not acknowledge themselves as future teachers as a motivator at the beginning of the course.

In contrast, the three participants who did not express mathematics trauma were motivated by understanding the concepts behind the mathematics. Jonathan was motivated to understand the concept behind the numbers and algorithms so that he could better teach and assist his students. In the first journal prompt that asked the residents what they needed in the course, Courtney wrote, I want to understand that math is more than numbers. As a student taking math in undergrad, I just wanted to get it done, I didn't really care on why it was important to understand, so in this class I am hoping to understand math beyond numbers and equations." In her interview, she expanded on this stating that she wanted to understand in order to be a good teacher. She said,

> I feel like for me, I'm finding my purpose finding myself and so I know that I want to be great at being a teacher… So I think it's just me actually wanting to take the time to learn and do it. I feel like that helped me to be able to understand the math process.

Although these three participants felt comfortable and confident in mathematics, they recognized that they lacked a conceptual understanding that was essential for teaching. They were motivated to learn these conceptual underpinnings in order to be good teachers.

After the Mathematics for Elementary Teachers Course

The similarities between these two cases arose when analyzing the mathematics identity narratives of the participants at the conclusion of the Mathematics for Elementary Teachers (MET) course. Participants in both cases demonstrated a common shift in their mathematics identities, grew confidence in their conceptual understanding, and discussed a desire for continual growth in mathematics. In addition to these similarities, there was one significant difference that surfaced between the two cases. All participants who had experienced mathematics trauma identified building positive mathematics identities in their students was a significant goal for themselves as teachers. The participants without expressed mathematics trauma did not mention this. I discuss similarities and this difference below.

Shift to Identifying Oneself as Teacher. All six participants described a shift in their mathematics identities towards seeing themselves as mathematics teachers. The participants without trauma began thinking about themselves as teachers at the beginning of the course but did not identify themselves as mathematics teachers. Instead, they spoke of their desired learning in order to become a teacher (see the Motivation Before the MET Course section). The participants with mathematics trauma did not mention becoming teachers until the middle of the course. Whitney explained that within a few class sessions, she no longer wanted to "just get through." She explained, "But then I was like, 'Oh my god, I'm gonna have to come back and take the Praxis and I'm also going to be teaching for the next umpteenth years… so I can't forsake this information." This realization was shared by the three participants with mathematics trauma around the same time. However, they still did not identify themselves as mathematics teachers.

By the completion of the course, all six participants identified themselves as mathematics teachers. In the final journal prompt all six participants used the phrase, "as a teacher" or "as an educator" where these phrases were previously absent. Additionally, five of the six told stories of entering into their new classrooms and schools and seeing math materials for the first time. They spoke about seeing the math curriculum, student math notebooks and/or math manipulatives. They spoke of excitement in understanding these materials and confidence in teaching the mathematics. Furious explained that when he first went into his school, he noticed the math manipulatives and was excited that he recognized them, "I was at _____ for the first time and I saw the blocks. I saw them in the totes and then I saw one teacher asking about Cuisenaire rods. It was pretty interesting. I felt good that I had been exposed to that." Sunshine explained that when she saw the materials she noted, "I can't wait! I had this math course, but I didn't think I needed it. But I did need it. I wouldn't be able to teach if I did not have the class." For these five participants, perhaps seeing the materials allowed them to picture themselves as math teachers for the first time. Identifying themselves of as mathematics teachers was a shift in their mathematics identity at its' foundation.

Confidence in Conceptual Understanding. Another similarity between all participants' mathematics identity narratives was the development of confidence in their mathematics conceptual understanding. The participants described a growth in confidence in "understanding the why behind the math." Whitney explained,

> I know how to do math. And I know how to do accurate math. And that feels good. I might have to draw boxes, but I will find the right answer and I feel good

> about that. And just confident. I feel confident about my demeanor and my disposition, too which I was really worried about.

Whitney, Furious, and Sunshine agreed that they felt more confident in understanding the mathematics conceptually and grew in general confidence around mathematics as well. Similarly, the participants who didn't express mathematics trauma felt more confident in understanding the reasoning behind the "numbers and algorithms." Though they had previously felt confident in completing algorithms with accuracy, they grew in their conceptual understanding of these algorithms. Courtney explained, "I can say that I am more confident in explaining math problems using concrete and semi-concrete explanations."

All participants related this new confidence in conceptual understanding to growth in confidence as a teacher. Jonathan explained,

> I think I am more confident now in the things that I've learned in the course to be able to go even further with students, where I didn't have that knowledge of finding concepts or other connections for them to learn…. That's where I've definitely grown as a teacher.

As the participants understood the mathematics conceptually and built their own confidence within this work, they felt equipped and more confident for doing the same for their students.

Desire for Continual Growth. At the conclusion of the MET course, both cases of participants expressed a desire for continual growth in mathematics. Upon entering the course, the participants with mathematics trauma expressed that they were "not a math person." These participants spoke as if mathematics was not accessible to them but was

something they would merely “get though in the course.” The participants without mathematics trauma felt they were “good at math” and it “just came easily.” Such statements are rooted in a belief that their mathematics identities were stagnant rather than fluid on a continuum. At the conclusion of the course, all participants mentioned that they look forward to continually growing in mathematics and as mathematics teachers. In a journal prompt that asked residents about how they have grown throughout the course. Whitney explained,

> There are a lot of procedures in math that can be intimidating, but they are not impossible. Math is full of building blocks. We will need to build on our understanding as opposed to completely grasping a concept immediately. I wish I knew that math was more accessible than I previously thought but I’m glad I know now.

Whitney as well the other participants acknowledged that mathematics learning and teaching is a continual process rather than something that can be or must be understood at one given time.

In this acknowledgement, the participants identified an ability and desire to continually learn in mathematics. Furious wrote in his journal prompt,

> I believe I can teach math with confidence. I will need to practice the work I plan to teach, or what the new standards suggest I teach, so I can be a subject matter expert to my students. Review and/or help from my professional learning community is okay, I will only get better with time and practice.

Thus, not only is mathematics proficiency something that builds over time but is also something that is attainable with “time and practice.”

Desire to Build Positive Mathematics Identities in Students. There was one significant difference that emerged between the two cases after the MET course. The participants who expressed mathematics trauma shared a desire to build positive mathematics identities in their students while the participants who did not express mathematics trauma did not mention the mathematics identities of their students. Whitney explained,

> To see this version of myself is empowering. This joy and sense of pride is why I know my mindset has changed. And I cannot wait to show my future students this joy that has flourished within me about math as I hope to pass it on to them.

Whitney, Furious, and Sunshine saw the negative impact some mathematics teachers had on them as mathematics learners and doers. They discussed how important it was to break that cycle and provide positive and joyful mathematics environments for their students. Sunshine talked about this from the perspective of a coach. She explained that when coaching her athletes, it was her responsibility to encourage them and help them feel positive about themselves as athletes and as individuals. She felt that she had the same responsibility as a math teacher. It is an interesting finding that the participants who had mathematics trauma were particularly sensitive towards positive mathematics identities within their future students.

Trauma-Informed Care Pillars

Both cases of participants described practices embedded within the course that were most impactful for the shifts that occurred in their mathematics identities. Themes emerged from these descriptions, each describing practices that were important for the participants in their respective cases. These themes were categorized into the three pillars

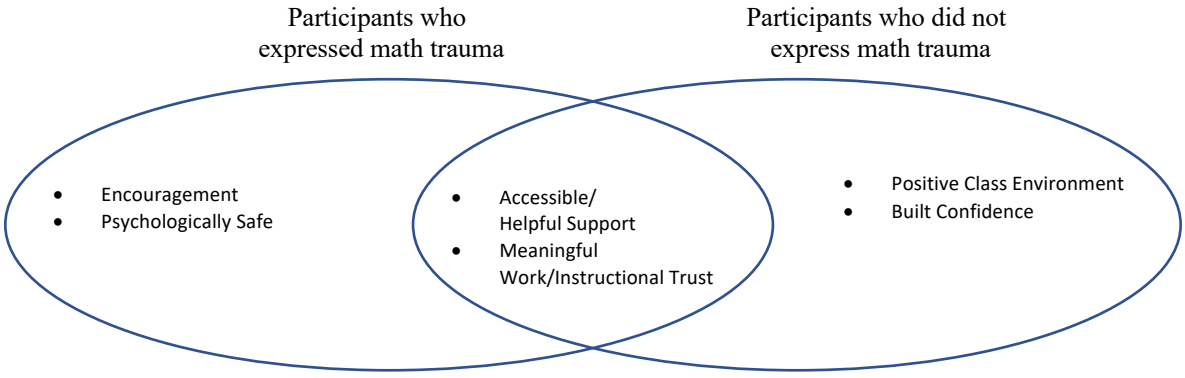
of TIC (*safety, managing emotions, connections*). Across the two cases in this study, there were themes within each pillar that were distinctly different and themes that were similar. This discussion focuses on the differences and similarities in themes between cases under each pillar.

Safety

The coding process for the data resulted in a similar number of codes across the two cases under the pillar of *safety*. After the second cycle of coding, there were 44 codes within the pillar of *safety* from the participants who expressed mathematics trauma and 50 codes from the participants who did not express mathematics trauma. These codes resulted in eight total themes, four from each case. While the themes within each case were unique, they had some common features which are discussed later in the section. This section compares these eight themes and discuss the nuances that created similarities or differences among them. Figure 7 below shows the comparison of themes under the trauma-informed care pillar of *safety*.

Figure 7

Impactful Elements of Safety Across Cases



Differences. There were four themes that are categorized as distinctly different between the two cases under the pillar of *safety*. Some of these themes were entirely

different, while others had elements that could be construed as similar. When looking at the context of the data, it is clear that these themes had characteristics that were fundamentally different between cases, even if some elements were similar. This section describes the differences between the themes of *Positive Classroom Environment, Encouragement, Psychologically Safe*, and *Built Confidence.*

The themes of *Positive Classroom Environment* and *Encouragement* both contained components that pertained to positive atmosphere. However, *Positive Classroom Environment* was primarily descriptions of positivity within the classroom while *Encouragement* pertained to specific assurances that propelled the participants forward. The participants who expressed mathematics trauma discussed encouragement as an essential element of motivation to continue work that was difficult. These participants discussed the importance of assurances they received from the R-I and from their peers, particularly when they were struggling with a mathematics concept. This was especially evident in the participants' responsiveness to cheers from the other residents when they were stuck on the board or to a comment from the R-I. When asked about differences in the MET course, Whitney described that feedback on homework and journal prompts was an encouragement. In her interview she explained,

> Your feedback meant a lot to me over the summer. I think that's a huge reason why my confidence got stronger as the summer went on. Because, I mean, I just really loved hearing what you had to say, even in our journals. I just loved reading it and feeling assured after you responded.

Thus, assurances from others in the course was encouraging for Whitney and contributed to her growth in confidence. Furious and Sunshine also talked about similar assurances and the importance of this encouragement in continuing their work.

Encouragement for participants in this case provided specific boosts for their self-efficacy when they were feeling particularly discouraged. Furious described that encouragement helped him internalize the phrase "you got this!" He explained that assurances helped him understand that he could grasp the harder concepts and encouraged him to keep putting forth effort. Thus, the encouragement was a catalyst for these participants' growth in mathematics identity.

Positive Classroom Environment was a theme that emerged from the participants who did not experience mathematics trauma. The theme of *Positive Classroom Environment* was used primarily as a description rather than a catalyst for these participants. Kristin and Jonathan both stated, "I always looked forward to Fridays." Kristin went on to explain, "you always came in with positive energy" and Courtney stated, "It was a really enjoyable atmosphere." Jonathan stated, "walking in the classroom, it felt a bit brighter." The participants in this case labeled elements of a positive environment within the course as identifying descriptors but did not pair this with the impacts these elements had on their actions as mathematics learners and doers.

Psychologically Safe was the theme with the greatest number of codes for the participants who expressed mathematics trauma. These participants felt that mental and emotional safety in asking questions and making mistakes was critical to their mathematics identity development throughout the MET course. This included psychological safety from the R-I and their peers in the class, and work focused on

pursuit of understanding. These participants acknowledged that their sensitivity to "harsh tones", criticality of peers, or work that was "100% right or 100% wrong" would have been triggering in the mathematics environment. The psychological safety, however, led them towards a willingness to try, make mistakes, and learn the mathematics. Furious explained, "For me, that was like, man, this is gonna work out. I can do this. Because when I say psychological safety, I mean you created an environment to where we weren't afraid to ask you weren't intimidated."

This sense of psychological safety in asking questions and making mistakes was not mentioned by the participants who did not express mathematics trauma. Kristin mentioned not wanting to feel "embarrassed or silly" for asking questions but was making a general statement about her personality as part of a large group. Additionally, Courtney explained that the R-I, "didn't get frustrated with anybody who wasn't getting it" as she was describing the helpful nature of the course. However, the participants without mathematics trauma did not describe sensitivity to the instructor or peers when asking questions or making mistakes. Consequently, they did not mention psychological safety as a critical factor in their shift in mathematics identity throughout the course.

While the participants with mathematics trauma were working to find confidence in mathematics, the participants without mathematics trauma described how safety within this mathematics course helped them build on their confidence in mathematics. These participants explained that the conceptual nature of the MET course was quite different from the mathematics these participants had previously learned. Thus, they had to work in a different way to understand the mathematics. As they pursued this understanding, they built on their previous confidence in mathematics. Courtney stated, "I'm going to

the place of like, 'I feel confident about this enough to kind of enter into the next thing.'" The other participants without mathematics trauma also spoke of their ability to add conceptual understanding to their previous mathematics learning and the confidence they build in doing so.

These participants also explained that being able to teach and help peers in their small groups and Professional Learning Communities (PLC's) helped them build confidence in teaching mathematics. The participants with mathematics trauma also played a critical role in helping peers and participating in these small groups/PLCs. They spoke of how critical help in these groups were for safety and support in the mathematics setting. They also described the importance of this help in building their understanding of the mathematics content. They did not, however, discuss the building of their confidence in helping their peers. They also did not equate helping peers with building confidence in themselves as future teachers.

Similarities. When analyzing the data under the pillar of *safety*, two themes from each case shared fundamental similarities. While there are nuances in each case that are unique, *Accessible* and *Helpful Support* shared foundational similarities and *Meaningful Work* and *Instructional Trust* shared foundational similarities. This section discusses these similarities as well as the nuances that make these themes slightly different.

The themes of *Accessible* and *Helpful Support* were foundationally focused on the help that supported the work all participants were doing within the MET course. All six participants described that the help from the R-I was responsive to their individual needs within the course. Kristin explained that when she asked a question in the course, it was important that she received "an answer close to or exactly what I needed to understand."

Similarly, Sunshine stated, “I really had to see if you were going to teach me something and not just say something to me. You spoke to me in a way that I could understand math better.” Participants in both cases explained that help from the R-I was helpful in addressing their needs and moving their understanding forward.

While help that was responsive to participants’ needs was the fundamental similarity in these two themes, there were a few elements that were different between these two themes. The first was the mention of peers. The helpfulness of peers within the class was mentioned by participants in both cases. However, for the participants with mathematics trauma, this was coded into the theme of *Encouragement*. These participants described that encouragement, as part of academic support, was the most important support that their peers provided. Whitney noted, “there was always so much support. I always felt very assured and validated.” Thus, when support from peers was mentioned from the participants with mathematics trauma, it was associated with the positive assurances from peers that helped them feel encouraged.

On the other hand, when peer support was mentioned by participants without mathematics trauma, it was academic in nature. All three of these participants mentioned how helpful their peers were with the mathematics content and in supporting their understanding of the material. For example, Kristin stated, “I was never concerned about whether or not I was getting something when you were explaining because I knew we would be able to talk about it and review with peers and catch on.” Thus, the math content support of peers was a critical factor for the participants without mathematics trauma.

While participants from both cases focused on the help and support from the R-I, only the participants with mathematics trauma discussed the mental and emotional support of the R-I as a part of the support structure in the course. This support from the R-I included attending to the mental and emotional needs of the students, especially when they were frustrated or overwhelmed. Furious stated about the R-I, "when we did get overwhelmed you would say, 'take a break, go' I've never seen that before." Additionally, all three of these participants recognized that the R-I's structure and routine within the course was supportive of their mental and emotional needs. Whitney mentioned, "there's power in organization and power in knowing there's a plan for everything." These mental and emotional aspects of the course were not mentioned as support from the R-I from participants in the other case.

Finally, the way in which the R-I delivered this help was a critical component of support mentioned by the participants with mathematics trauma. These three participants discussed the "empathy" and "non-aggressive" style of support from the R-I. They talked about the help given in the course through a juxtaposition with their previous experiences, noting that math tended to be "militant" and "aggressive." They found it critical that the help throughout this course was the opposite. Sunshine described it as "light, not heavy" and something that was "attainable." The participants without math trauma, on the other hand, did not discuss the specific ways in which the support was given.

The other two themes under the pillar of *safety* that are similar between these two cases are *Meaningful Work* and *Instructional Trust*. Both themes pertained primarily to the purpose of the work and learning that was completed throughout the MET course.

The three participants with mathematics trauma spoke of the "fear," "anxiety," and "trepidation" that they held coming into the course. These participants explained that these feelings had been exacerbated in previous classes when the work did not have a purpose or intention. However, they explained that the work in the course was not a "regurgitation" of knowledge. Instead, the learning was intentional, one concept leading to another, making the work meaningful.

The participants without trauma explained that coming into the class, they were usure of what they would learn. They were skeptical of the usefulness of the work and if it would be different than their previous mathematics learning. Like participants in the mathematics trauma case, they were hesitant about the format of the class and how the mathematics would be taught. However, also like the participants with mathematics trauma, they found the instruction to be "useful" and "intriguing to want to learn." Participants in both cases explained that the usefulness and meaningfulness of the work motivated them to engage and subsequently built their motivation to learn and grow as math learners and doers.

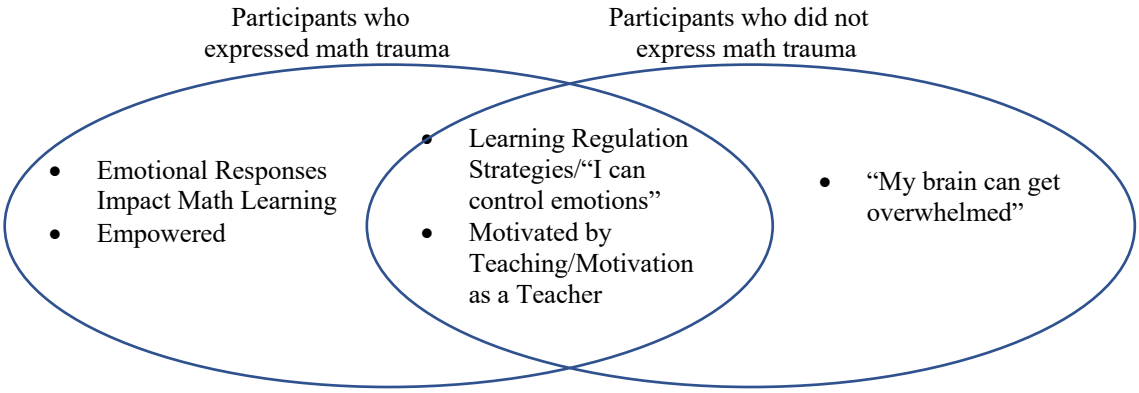
Managing Emotions

The trauma-informed care pillar of *managing emotions* was the pillar with the greatest differential in the number of codes. After the second round of coding, there were 72 codes under the pillar of *managing emotions* from the participants who expressed mathematics trauma and 43 from the participants who did not express mathematics trauma. These codes resulted in seven themes. Four themes from the participants who expressed mathematics trauma and three themes from the participants without mathematics trauma. These themes pertained to participants recognizing the relationship

between their emotions and the mathematics setting as well as learning strategies for coping with these emotions. While the themes within each case were unique, they had some common features which are discussed later in the section. I compare these seven themes below and discuss the nuances that created similarities or differences among them. Figure 8 below shows the comparison of themes under the trauma-informed pillar of *managing emotions*.

Figure 8

Impactful Elements of Managing Emotions Across Cases



Differences. The first two themes that were fundamentally different under the pillar of *managing emotions* were *Emotional Responses Impact Math Learning* and *"My brain can get overwhelmed."* Participants made different realizations about the connection between emotions and the mathematics setting. The participants without mathematics trauma connected their emotions to mathematics learning for the first time. The participants with mathematics trauma connected their extreme emotions to their mathematics learning. This discussion focuses on these differences. For the participants with math trauma, one additional theme of *Empowered* emerged. Therefore, I also discuss the data that led to this theme as a fundamental difference between the two cases.

The participants without mathematics trauma had not previously acknowledged emotions in the mathematics setting. Throughout the MET course, these participants recognized that they did have emotions in the mathematics setting. As they talked through previous experiences, they recognized various emotions they had when their brains were overwhelmed. When asked about his past emotions with mathematics, Jonathan stated, "I don't think I ever associated sadness [with mathematics] but there could be maybe a little bit of frustration. But I actually think it was more like drive." Jonathan recognized that he did have emotions in the mathematics classroom. In this example, he acknowledged that he experienced frustration with math, but perhaps interpreted this as drive or motivation that pushed him forward in the mathematics. Courtney also recognized times in which she had strong emotions in the mathematics setting when her brain was overwhelmed. As she talked about these experiences, she said she remembered "slamming my pencil down" or "just walked out" of previous mathematics courses. While she had not previously connected these actions to emotions, she now recognized this as of anger and frustration because she was overwhelmed. Such stories led to the theme, *"My brain can get overwhelmed."*

The participants with mathematics trauma expressed that they had long known that they had extreme emotions in the mathematics setting. Throughout the MET course, they recognized that their emotions impacted them as mathematics learners and doers overtime. All three spoke about their "tantrums," "anxiety," and "withdrawal" that they had experienced for a long period of time in the mathematics setting. Throughout the MET course, these participants began to understand the impact of these emotions on their mathematics learning. Through their interviews and journal prompts, all three participants

acknowledged that the absorption of information was more difficult with these extreme stress responses. Moreover, they acknowledged that over time, these emotions led them to avoid the mathematics setting altogether, deeply impacting how they saw themselves as mathematics learners and doers. Thus, the theme *Emotional Responses Impact Learning* emerged.

Another significant difference between these two themes was the source of the overwhelming emotions. Unlike those with mathematics trauma, participants without mathematics trauma attributed overwhelming emotions to circumstances both inside the mathematics classroom and outside the classroom in their personal lives. Kristin, in particular, was vocal in her interview and journal prompts that her circumstances outside the mathematics classroom were overwhelming. In the interview she said she came to the realization that her "brain shutting down… was a coping mechanism." She explained, "I can absorb a lot, but my triggers are my triggers and once they capture that frontal lobe, I have to decide whether to react or pause." She explained that this realization came after the class video and discussion about "flipping your lid" (see chapter 3). Like Kristin, the other two participants talked about times when their "brain was overwhelmed" by personal or academic struggles. When talking about their extreme emotions, the participants with mathematics trauma did not mention sources of stress or emotion outside of the classroom but focused on the stress of the mathematics setting itself.

While participants in both cases recognized fundamentally different connections between their emotions and the mathematics setting, both acknowledged the importance of recognizing their emotions within the course. All six participants mentioned that talking about emotions in this way was "new" and "different" than previous mathematics

courses. They all mentioned that it was refreshing to talk about how they were feeling in the mathematics setting. For the participants with mathematics trauma, they felt these conversations "validated" their feelings and created an atmosphere of "empathy." The participants without mathematics trauma explained that it was important to understand how the brain responds to being overwhelmed in order to best "decide whether to react or pause."

The theme of *Empowered* emerged from the data of the participants with mathematics trauma, creating another difference between the two cases. After drawing connections between their emotions and their mathematics identity, these participants learned regulation strategies (discussed in the similarities section below) to help them gain control of their emotions. Once these participants were able to implement these strategies, they were able to reengage as mathematics learners and doers. This, in turn, built confidence and competence within the mathematics setting. These three participants explained that doing this helped them feel "empowered" as math learners and doers. In a journal prompt asking residents to reflect on their current learning in the course, Whitney explained,

> My learning experience in this class has been extremely positive. I find myself eager to come to class and learn more which is not something I have felt before in regard to a math class. It feels really good to combat all of the negative speech I've told myself about math with techniques to help make me better.

Combatting her negative self-talk was important in regulating her emotions in the mathematics setting. Continuing to work on this helped Whitney continue to positively engage with the mathematics. Similarly, Sunshine explained that she was able to calm

herself and engage in the mathematics. She said, “I felt kind of empowered because I felt [calming in math] gave me a sense of direction of how to do it.” Sunshine was able to pause and redirect her learning when she was overwhelmed. The participants without mathematics trauma did discuss feeling “empowered” by managing their emotions. However, they focused on how they felt empowered as future teachers. Thus, this is discussed in the similarities section below.

Similarities. There were four themes, two from each case of participants, that were similar under the pillar of *managing emotions*. The themes of *Learning Regulation Strategies* and *“I can control my emotions”* were derived from data focused on the participants learning strategies to control their emotions in the mathematics setting. *Motivated by Teaching* and *Motivation as a Teacher* were also similar themes in which participants from both cases discussed the importance of managing emotions as future teachers. This discussion explains the similarities between the data in these themes as well as the nuances that made them slightly different.

Participants in both cases did not discuss experiences in which they practiced regulating their emotions in the mathematics setting. All six participants described experiences in the MET course that helped them recognize and utilize strategies to regulate their emotions. All participants mentioned using strategies that were posted on the “when we flip our lids” chart [see chapter 3] including “deep breathing,” “take a break,” “positive self-talk,” etc. In either their journal prompts or the interview, all six described a time in which they “flipped their lid” in the MET course. Without being asked, all six reported using a regulation strategy to calm themselves and return to their work. Whitney wrote in a journal prompt,

> Truthfully, that area and perimeter moment was a huge trigger for me because I had only known a nice amount 'success' in that previously. Before I completely flipped my lid, I just made the executive decision to take a moment to settle down and relax.

She went on to explain that for the assignment, taking a break helped her be able to better think through the math and identify areas in which she needed to ask for help. The other 5 participants also discussed times in which they used regulation strategies to help them refocus and reengage with the mathematics.

The participants in both cases utilized these regulation strategies at varying degrees. The participants with mathematics trauma were learning these calming strategies in the mathematics context and intentionally utilizing them for the first time. Sunshine explained about one assignment early in the course,

> It took me a long time and I flipped my lid. I did. I cried. I was really frustrated at the fact I didn't have you there. But I knew you couldn't be there for me. I had to be there for myself. I learned a lot of independence and when we came together, I felt like I was confident enough to give me answers.

In practicing regulation strategies, throughout the course she learned independence in these strategies, building her confidence in the mathematics setting. The other participants with mathematics trauma shared similar experiences in which they learned the importance of calming themselves when they were overwhelmed with the math.

The participants without mathematics trauma mentioned the same regulation strategies but shared less urgency in their experiences. They simply acknowledged that they could and should use regulation strategies. Kristin, Jonathan, and Courtney spoke of

times in which they became frustrated and had to take "deep breaths," "take a walk," or "relax my mind" and were subsequently able to move forward.

Another difference in the two themes involving emotional regulation was the mention of journal prompts. The participants without mathematics trauma mentioned the journal prompts as part of the assignments required of the course. On the other hand, all three participants with mathematics trauma talked about the journal prompts as "math therapy" that was critical to the processing of their emotions in the mathematics setting. Sunshine explained,

> I felt like it was almost like I was regurgitating how I felt on the paper at that moment with that question you gave me. Like, 'how did it make you feel. Well, I feel this way.' And so it was almost like a therapy type session. Where you could just go and just leave it all in the journal… like processing emotions, get that frustration out if you had frustration, get the happiness out if you had happiness at that moment. The journal was really helpful.

All three participants with mathematics trauma described the journal as an important part of the grown in their mathematics identity throughout the course.

Participants in both cases expressed that teaching was a significant motivator in helping them control their emotions in the mathematics setting. In order for all to be successful with this, they stated that they were motivated by teaching. The participants with mathematics trauma explained that they had previously been unmotivated to work on their extreme emotions they experienced in the mathematics setting. However, all three of these participants explained that they were motivated to work on their emotions because they recognized that they would be in front of students doing math soon. In a

journal prompt, Whitney explained, “As someone who struggles with perfectionist ideations, this class has opened my eyes to releasing that pressure in order to actually grow in my learning.” She explained that these “perfectionist ideations” led her to negative head space and negative responses. She said,

> There is no way for me to get every single problem correct or to be able to teach perfectly. I really need to remember this as I go into my journey as a teacher of record. I really don’t want to model that type of behavior, so I will be intentional in working on my language around mistakes.

In understanding the importance of regulating her own emotions, she recognized the importance in modeling this for her students as well. Furious and Sunshine similarly stated that they were motivated by teaching to regulate their emotions in the mathematics setting. This data resulted in the theme *Motivated by Teaching*.

The participants without mathematics trauma also mentioned that they were motivated to regulate their emotions by the idea of themselves as future teachers. Slightly different than the participants in the other case, however, these participants focused on helping students regulate their emotions. Kristin explained,

> I want to go to [the students] and like we’ve learned, allow the kids to calm down without saying ‘calm down.’ Kinda, like evaluate the situation and approach the kid. I think I would say, ‘what are you having trouble with.’ If they were more stand-offish I would hope to find the encouraging words to, like you did, convince them that it’s okay to not know what you’re doing. Let’s just try to start with what you do know.

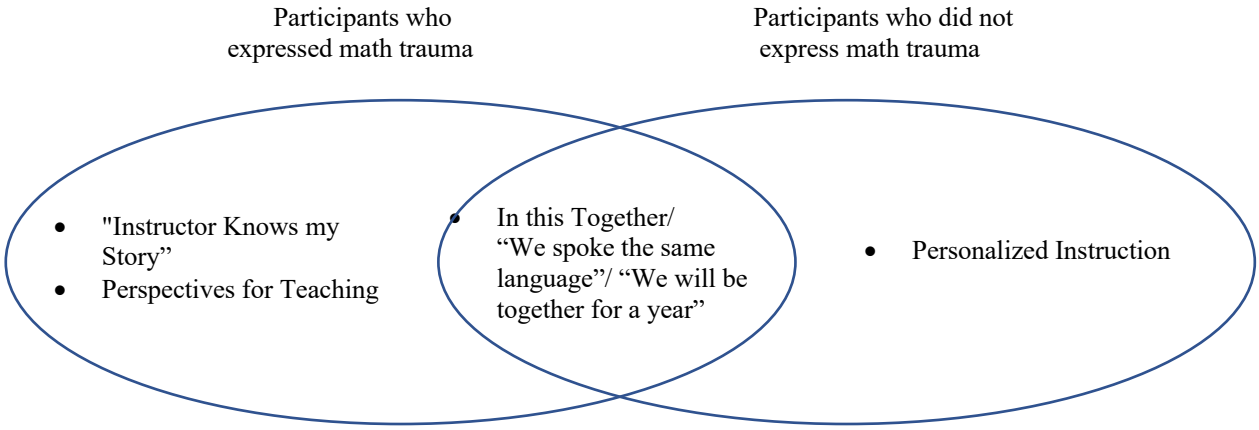
These participants identified ways in which they wanted to bring their regulation strategies to their students. Thus, they were not motivated by teaching to control their own emotions, but they had *Motivation as a Teacher* to work on regulation strategies to help their future students. These participants explained that helping themselves regulate their emotions when overwhelmed and the ability to help their future students regulate was "empowering." They explained they felt more equipped to help students in the mathematics classroom.

Connections

Similar to the pillar of *safety*, the coding process for the data resulted in a comparable number of codes across the two cases under the pillar of *connections*. After the second round of coding, there were 48 codes under the pillar of *connections* from the participants who expressed mathematics trauma and 42 codes from the participants who did not express mathematics trauma. These codes resulted in seven total themes, three themes from the participants with mathematics trauma and three from the participants without. While the themes within each case were unique, they had some common features which are discussed later in the section. The themes that were similar included four themes that were interconnected. I compare these seven themes below and discuss the nuances that created similarities or differences among the themes. Figure 9 below shows the comparison of themes under the trauma-informed care pillar of *connections*.

Figure 9

Impactful Themes of Connection Across Cases



Differences. There were three themes that were fundamentally different between the two cases under the pillar of *connections*. The themes of "*Instructor knows my story"* and *Personalized Instruction* pertained to the personal connections with the R-I. However, the way these connections were discussed were quite different between the two cases. I discuss these differences in this section. Additionally, the theme of *Perspectives for Teaching* emerged from the participants who expressed mathematics trauma. The ideas addressed in this theme were unique to the case of participants with mathematics trauma. I also discuss this as a fundamental difference.

The themes of *"Instructor knows my story"* and *Personalized Instruction* were both referring to connections with the R-I throughout the MET course. These two themes were fundamentally different, however, because of the focus of the connection. For the participants who expressed mathematics trauma, the focus of the connection with the R-I was on the personal story of the participants. Furious talked about empathy he experiences throughout the MET course. When asked to expand on what he meant by "empathy" he stated, "the empathy part is just getting an understanding where they're

[the residents] coming from. What their experiences were, which will be different from mine, which is different from yours." The participants with mathematics trauma explained that the R-I knowing their personal math stories made them feel validated. They felt "empathy" and "compassion."

In turn, this connection with the R-I helped them feel connection within the mathematics classroom and helped the development of their mathematics identity. For example, when Whitney was asked what was different about her math experience in this course, she responded, "I think your demeanor and warmness. Just the openness as far as like, I just feel like you were super empathetic to the fact that we were all feeling stresses from stuff like 15 years ago." She explained that this empathy helped her feel connected in the classroom and made the biggest impact on her mathematics learning.

For the participants without mathematics trauma, the personal connection with the R-I focused on instruction that was directed toward the individual learner. Courtney recognized that the class was personal. She explained, "I think it was very personal… it was more to me like it felt like you had a personal relationship with everybody and was willing to help everybody." Kristin explained that this "personal relationship" helped the residents feel connected and led to "individualized teaching." She explained, "I think it was just your approach on how you teach math. I think it was, I mean, you definitely knew your content, but I feel like you, even more, had individualized teaching for each person." Thus, more than just academic support and help, these participants felt that the R-I's personal connection with the student helped individualize their needs in the classroom. These participants, however, did not discuss the R-I's acknowledgement of their personal or past mathematics experiences.

The theme of *Perspectives for Teaching* emerged from the data of participants with mathematics trauma. All three discussed that connecting with the other residents throughout the course helped them develop different perspectives in thinking about the mathematics. While they may have struggled with finding one strategy on their own, connecting with a group in the class helped them understand many different strategies. Furious explained,

> I think the group learning helps because everybody looks at it differently. You don't know what each other person knows in the group or their expertise or angle of how they see the problem or the solution. I think it helped me just look at it a little differently. Like, 'okay, I see where you're coming from.'

All three participants explained that in seeing these perspectives they felt, for the first time, that they could understand that there were many perspectives that students could hold about mathematics. They also recognized that connecting with their students, much like they did with their peers, would help them understand these perspectives. Furious stated,

> The benefit for me is seeing other personalities and how they see and view math or the task at hand. You see different levels of anxiety. You see super confidence to super the exact opposite, whatever the work for that would be… Going into teaching young children the personalities part and dealing with group management, you know, that's the biggest part that was beneficial in the group setting.

Thus, building connections with peers in the MET course helped these participants see the various mathematics perspectives that might exist. Moreover, the connections they

built helped them understand how to build connections with students in order to understand their mathematics perspectives.

While the participants without mathematics trauma discussed the importance of seeing various strategies of peers, the context of these discussions was around the academic support of peers rather than personal connections. Thus, these conversations emerged in the *Helpful Support* theme.

Similarities. The remaining 4 themes under the pillar of *connections* were intertwined. The theme of *In This Together* had similarities to the themes of *"We spoke the same language,"* and *"We will be together for a year."* This discussion focuses on these interconnected similarities.

In the themes, *In This Together and "We spoke the same language,"* the participants described connections that built their social and academic experience. Jonathan talked about personal friendships that he built working in his PLC. Kristin explained that her "safe person" in the course helped her feel connected in the course. The participants in both cases explained that these personal connections helped them better engage in the mathematics learning. Jonathan explained that his friendships helped him connect and engage in the class. Kristin explained that a connection with her "safe person" helped her better regulate her emotions and engage in mathematics. The participants discussed these social and personal connections helped them feel connected as part of a "bigger classroom."

In the themes, "*In This Together"* and *"We're together for a year,"* participants in both cases recognized that these connections were important because of the time they will spend with one another within the cohort model. Sunshine noted, "we're following each

other… we were forced to get to know each other and collaborate together." Similarly, in the theme, *"We're together for a year,"* Courtney stated, "we're gonna be with each other for the next year so I might as well go ahead and help." In both cases, participants were motivated by this cohort model to build and maintain positive connections. Sunshine stated, "even though we had different opinions, we had to respect those opinions, but then we were friends. Now it's like we'll always be friends and we understand that." Similarly, Courtney explained that working as part of the cohort was a motivator to build connections and help one another. She explained, "We're here to help each other…It's not a race, it's not who gets the best score. The greatest motivation is each other." Participants in both cases expressed their desire to work on building and maintaining these connections to support one another within the Mathematics for Elementary Teachers course and throughout the remainder of their program.

Summary

This chapter summarized the data from the six participants of this study, three of whom expressed mathematics trauma and three who did not express mathematics trauma. These participants explained shifts within their mathematics identities throughout the Mathematics for Elementary Teachers (MET) course. Participants made connections between this mathematics identity development and the trauma-informed care (TIC) practices embedded within the course. The data resulted in themes that each case described as impactful under the pillars of *safety*, *managing emotions*, and *connections.*

The participants who expressed mathematics trauma explained that these practices did not eliminate the trauma that they had experienced, but helped them better physically, mentally, and emotionally cope within the mathematics setting. These participants

expressed dramatic shifts in their mathematics identities. They explained that they felt "confident" and "empowered" in their mathematics abilities and how they feel as mathematics learners and doers at the conclusion of the course. The participants who did not express mathematics trauma also explained shifts in their mathematics identity. These participants expressed a shift towards identifying themselves as teachers of mathematics and built confidence in their conceptual understanding of mathematics and their preparedness to teach their future students.

Thus, this study suggests that TIC practices embedded in this MET course had an impact on the development of residents' mathematics identities. Residents both with and without math trauma demonstrated a shift in their mathematics identity. Moreover, residents identified specific TIC practices that were impactful to these shifts in their mathematics identities.

CHAPTER V

DISCUSSION

Mathematics identity is multi-faceted and is shaped by many factors over time (Aguirre et al., 2013). This multiple-case study followed the transformation of six urban teacher residents' mathematics identities throughout their Mathematics for Elementary Teachers (MET) course. This course was in the first summer of the residents' year-long urban teacher residency (UTR) program in which they were seeking teacher certification. Residents in this UTR primarily identified as BIPOC and were primarily second-career teachers. Previous research has suggested that students who identify as BIPOC are more likely to have experienced negative stereotypes in the mathematics setting (e.g., English-Clarke et al., 2012; Martin, 2006; Okeke et al., 2009), negatively impacting mathematics achievement (Cvencek et al., 2014) and mathematics identities (Gonzalez et al., 2020). Thus, students who identify as BIPOC may be more likely to have experienced mathematics trauma. As such, trauma-informed care (TIC) practices positioned around the three pillars of TIC were embedded within the MET to facilitate the development of residents' mathematics identities. Sociocultural Theory (Vygotsky, 1978) was the lens through which these practices were designed and embedded within the course. This design was purposed to promote coping strategies and healing from potential mathematics trauma and subsequently strengthen residents' mathematics identities.

The experiences of participants during and after the MET course were captured through multiple data sources. The data from these participants was categorized into two distinct cases; participants who expressed mathematics trauma and participants who did not express mathematics trauma. The data from each case was analyzed separately through an iterative coding process. This analysis identified elements of the TIC framework that were particularly impactful to the mathematics identity development of participants in each case.

In this chapter, I present a discussion of the findings presented in Chapter 4. This discussion is guided by the research questions for the study:

1. How do residents' mathematics identities change during the Mathematics for Elementary Teachers course?
2. How do residents connect trauma-informed practices embedded in the course design to the transformation of their mathematics identity?
3. How does a Mathematics for Elementary Teachers course with embedded trauma-informed practices impact mathematics identities for residents with and without mathematics trauma?

This chapter examines the findings by describing the interconnected nature of the TIC practices. Additionally, factors that impacted the engagement within the TIC practices and the subsequent development of mathematics identities are considered. I conclude the chapter with implications, limitations, and directions for future research.

Discussion of Findings

This study found that TIC practices embedded in a Mathematics for Elementary Teachers (MET) course had an impact on the development of residents' mathematics

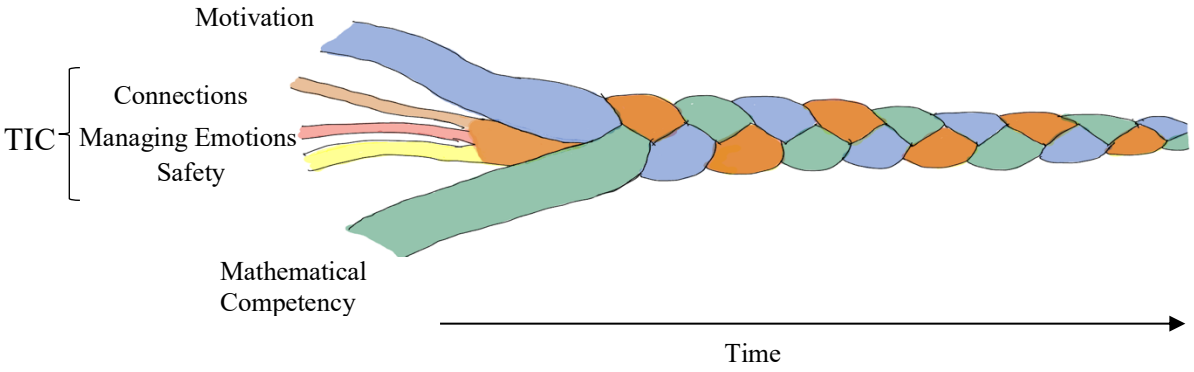
identities. Residents both with and without math trauma demonstrated a positive shift in their mathematics identity and connected specific TIC practices to these shifts. Thus, this study suggests that TIC practices within the mathematics course of a UTR program can be a useful framework to help residents both with and without mathematics trauma develop their mathematics identities and heal from potential mathematics trauma. Residents with mathematics trauma demonstrated dramatic shifts from "fear" and "trepidation" with mathematics to "confident" and "empowered". Residents without mathematics trauma demonstrated a shift from "getting through" mathematics to identifying themselves as mathematics teachers.

Furthermore, this study suggests that the interconnected pillars of TIC embedded within MET course helped the residents cope in a mathematics classroom setting when learning new or challenging content. Whether or not they expressed the extreme physical, mental, and/or emotional stress response associated with trauma, all residents expressed that they were able to cope in the mathematics classroom when they became overwhelmed or frustrated with the mathematics. They related this increased ability to regulate themselves to the specific TIC practices implemented in the course.

While there are many factors that can contribute to the development of mathematics identity, this study found that the TIC pillars interact specifically with motivation and mathematical competency to affect mathematics identity development. TIC, motivation, and competency are, therefore, interwoven and work together to promote mathematics identity development. These three interwoven strands are exhibited in Figure 10 below. In this section, I discuss these interactions within the context of residents both with and without mathematics trauma.

Figure 10

Mathematics Identity Development



Trauma-Informed Care Pillars

Residents communicated the elements of TIC that were impactful to them. For the residents with mathematics trauma, these elements did not eliminate the trauma that they held in the mathematics setting. However, as they felt safer, learned regulation strategies, and built meaningful connections, they were able to better cope in the mathematics setting. This is congruent with current research on TIC implementation. Research indicates that TIC approaches can help individuals better cope with anger and aggression (Rivard et al., 2003), and improve "attitudes" and "behaviors" (Jankowski et al., 2019) as reported by participants, teachers, and caregivers. Additionally, TIC approaches have contributed to improved PTSD symptoms and increase in function (Hoover et al., 2018). Similarly, the residents with mathematics trauma in the Mathematics for Elementary Teacher (MET) course expressed decreased symptoms of trauma in the mathematics setting. The residents with mathematics trauma explained a higher threshold of frustration, anger, and the ability to cope with strong emotions that were triggered by

mathematics (See *Managing Emotions* themes) throughout this course. They also expressed feelings of safety and connections within the mathematics classroom (See *Safety* and *Connections* themes) that contributed to their ability to cope throughout the course, particularly when learning new or challenging content.

Data from residents without mathematics trauma indicated that TIC may also be helpful in reducing stress responses in the classroom not related to trauma. When students experience negative emotions such as anxiety and low self-efficacy about mathematics, they can experience physical, emotional, and mental stress responses (Akin & Kurbanoglu, 2011; Garofalo, 1989; Parker et al., 2014; Perry, 2004; Rounds, 1980; Tobias, 1987). Residents in this study without mathematics trauma did not initially acknowledge that emotions are a part of mathematics learning. Throughout the MET course however, they acknowledged that emotions are present in the mathematics setting and can be related to the mathematics itself, particularly when learning new or challenging mathematics. They expressed that they did feel emotional and mental responses to mathematics that was challenging.

In addition, these residents acknowledged that stressors outside of the classroom created emotions that impacted their mathematics learning. There is a growing body of research that discusses the significant impacts that outside stressors cause in the academic classroom (e.g., Alverez, 2017; Cole et al., 2005; Ginwright, 2018; Wolpow et al., 2009). The residents in this study expressed negative emotional and mental impacts to stressors both inside and outside of the mathematics classroom. At the end of the MET course, the residents without math trauma expressed that TIC was an important part of their growth in the course as they learned to cope with their emotions. They identified ways in which

they were able to better regulate their emotions when they were angry or frustrated (see *managing emotions* themes) and ways in which the safety and connections in the classroom helped them cope with challenges (See *safety* and *connections* themes) both inside and outside of the classroom. Thus, while these residents did not express mathematics trauma, the TIC practices embedded in the course helped them cope with the stressors that can be typical in their personal lives as well as learning new and challenging mathematics.

Mathematical Competency

The increased ability to cope with trauma responses and stress within the mathematics classroom was a primary factor in the strengthening of mathematical competency within the MET course. Residents both with and without mathematics trauma related their ability to feel safe, connected, and calm to their ability to engage in mathematics. For any element of TIC that residents identified as impactful, they described their increased engagement in the mathematics. For example, under the theme of *Psychologically Safe*, residents with mathematics trauma explained that the safety they felt to ask questions and make mistakes allowed them to work through mistakes and subsequently grow in their math skills. Similarly, under the theme of *"I can control my emotions,"* residents without mathematics trauma explained that learning to calm their feelings of stress helped them to reengage and refocus on the mathematics in front of them.

The ability to increase engagement and effort within the MET course allowed residents to build mathematical competency. As the residents built mathematical competency, their confidence increased, leading to further development of math

competency. Thus, the TIC practices allowing residents to better cope within the mathematics setting seemed to strengthen their overall competency.

Motivation

The results of this study indicate that motivation played a critical role in the residents' engagement in the TIC practices and their growth in mathematical competency. This discussion explores motivation's interactions with the TIC practices and mathematical competency.

An individual's ability to connect their academic work to useful and real-world contexts can increase their motivation (Cribbs et al., 2015; Middleton & Tulok, 1999). Moreover, as motivation increases, self-efficacy, resiliency, and hope within the academic context increases, further strengthening motivation (Golden, 2020; Martin, 2006; Simpkins er al., 2006). The residents' recognition of the meaningfulness of their work and their future career motivated them to engage in the TIC practices and the work to improve mathematical competency.

Themes describing the impactful elements of the TIC pillars included specific motivations residents expressed for engaging in the TIC pillars. For example, under the *managing emotions* pillar, residents expressed the importance of recognizing themselves as future teachers. For the residents with mathematics trauma, this meant engaging in practices to regulate their own emotions (*Motivated by Teaching*). For the residents without mathematics trauma, this meant identifying emotions that students may have in the mathematics classroom (*Motivation as a Teacher*). Under the *connections* pillar, residents expressed motivation for building connections with other residents within the course. The residents with mathematics trauma were motivated by the need to build

connections of support for their future career (*In This Together*) and to gain other mathematical perspectives (*Perspectives for Teaching*). The residents without mathematics trauma were motivated to maintain relationships with the other residents because of the cohort model (*"We will be together for a year."*). These findings substantiate the claims of research evaluating the residency model. Such research indicate that cohort models are important for connections and support in the classroom and coursework (Quartz & IMPACT Research Group, 2014). These patterns suggest that motivation strengthened resident engagement in the TIC practices and therefore the development of coping skills within the mathematics setting.

Similarly, the recognition of themselves as future teachers also motivated the residents to engage in mathematics that was new or challenging. Research focused on increasing mathematics identities of pre-service teachers has found similar trends of increased motivation using the framework of future *possible selves* (Lutovac, 2020; Lutovac & Kaasila, 2011). This framework of future *possible selves* provides opportunities in which pre-service teachers can explore themselves as future mathematics teachers. Pre-service teachers demonstrated increased motivation and engagement in mathematics when connecting their work to their future careers as teachers (Lutovac & Kaasila, 2011). The data from the residents in this study exhibited that they wanted to understand the conceptual underpinnings of mathematics in order to best teach their students (*Meaningful Work, Instructional Trust*).

When motivation increases, students can experience greater resiliency (Martin, 2006) and "hope" (Golden, 2020) in academic competencies, leading to increased academic achievement (Murayama et al., 2013). Residents in this study experienced this

cyclical nature of motivation. As they were motivated to engage in the TIC practices, they experienced increase resiliency to engage in challenging mathematics, leading to increased mathematical understanding. They subsequently experienced more motivation to continue engaging in the TIC practices and the math itself.

Mathematics Identity Development

Studies of both in-service and pre-service teachers have demonstrated that mathematics self-efficacy, beliefs, and goals interact with teacher actions (Heffernan, 2016; Johnson, 2018; Lake & Kelley, 2014). In addition, Mapoelo and Akinsola (2015) found that these interactions as well as a teachers' personal mathematics memories impact their instructional practice (p. 505). This study suggests that trauma-informed care (TIC) could be a critical component in processing and healing extremely negative or traumatic mathematics memories. When these practices were interwoven with motivation and increased mathematical competency, residents' self-efficacy, beliefs, and attitudes about themselves as learners and doers of mathematics had positive shifts. This section discusses shifts in mathematics identities across the two cases within this study.

Research around TIC practices in various settings have shown decreased PTSD symptoms and an increase in ability to cope with stress responses (Hoover et al., 2018; Rivard et al., 2003). While their traumatic mathematics experiences still impacted their thoughts around mathematics, the residents with mathematics trauma expressed decreased stress responses and an increase in ability to cope in the mathematics classroom. This led to more positive attitudes, beliefs, and emotions in the mathematics classroom (see *Stories of Healing* discussion). Thus, TIC practices, aided by motivation

and increased mathematical competency improved their mathematics identities as learners and doers of mathematics.

The residents without mathematics trauma expressed a shift to identifying themselves as mathematics teachers. While these residents expressed "comfort" and "confidence" in mathematics prior to the MET course, they did not identify themselves as mathematics teachers. They expressed a lack of understanding of the conceptual underpinnings and "new math" and therefore lacked confidence in their ability to teach mathematics. However, as these residents felt safe, built connections, and regulated their emotions, they began identifying themselves as mathematics teachers. They expressed increased confidence in the conceptual underpinnings of the mathematics and their ability to communicate this learning to their future students. Thus, TIC practices aided by motivation and increased mathematical competency also strengthened the individuals' attitudes and beliefs about themselves as teachers. This framework, therefore, may strengthen mathematics teacher identity as a component of an individual's overall mathematics identities.

Interestingly, the three residents with mathematics trauma expressed a desire to build positive mathematics identities within their future students. They explained that they did not want to "traumatize" their students in the way that they felt traumatized in mathematics. Instead, they referenced the TIC practices they desired to bring to their future mathematics classrooms. The residents without mathematics trauma did not mention the potential of creating math trauma within their future students. This may suggest that when pre-service teachers have opportunities to process their own mathematics trauma, they gather awareness and motivation to promote positive

mathematics identities within their future students. This may be an important and powerful practice in breaking the cycle of mathematics trauma and negative mathematics identities.

Summary

The TIC practices embedded within the MET course increased the participants' awareness of and ability to cope with trauma responses and stress within the classroom. This, in turn, increased student engagement in mathematics and subsequently mathematical competency and confidence. Motivation was an important factor in participant engagement in the TIC practices and in building mathematical competency. These "strands" therefore work to strengthen one another over time, contributing to overall strengthened mathematics identities. The results of this study suggest a that TIC practices are effective in mathematics identity development for students with and without mathematics trauma.

Implications

The results of this study hold implications for teacher residency programs as well as several groups of educators who interact with pre-service teachers. This includes mathematics teacher educators, specifically mathematics teacher educators of residents, and mentor teachers.

Residency Programs

Urban Teacher Residency (UTR) programs aim to promote "greater gender and racial diversity" in the teaching workforce and a commitment to increased retention of these teachers (Guha et al., 2016 p. 11). Within this study, there were several themes in which both cases of residents identified similar practices that promoted positive change

within their mathematics identities. These themes may also indicate practices that would promote positive residency experiences and coursework within UTR programs, contributing to better recruitment and retention of their teacher candidates.

Several themes that were similar across both cases described impactful practices pertaining to coursework. These similar themes noted the importance of balance between support, rigor, and relevance in their coursework. The first of these themes were *Meaningful Work/Instructional Trust*. Within these themes, residents identified that the academic focus of the residency coursework was meaningful and connected to their future careers as teachers. Additionally, they expressed that engaging rigor rather than "regurgitation" provided usefulness to the work. Within the themes of *Accessible/Helpful Support*, residents described that academic responsiveness to them as individuals within this coursework was paramount to their academic success. This included responsiveness in the classroom when they were overwhelmed with life circumstances and when they were struggling with the academic content. While the residents were discussing the MET course in these similar themes, these impactful practices are relevant to residency coursework as a whole. Residency programs should provide coursework that has rigor relevant to residents' future careers as teachers. Within this coursework, it is important that this coursework is responsive to students as holistic individuals and acknowledge the need for support inside and outside the classroom.

Other themes that were similar across both groups pertained to their emotions within the academic setting. Residents described the importance of identifying and regulating strong emotions they hold in the academic setting. Under the themes of *Learning Regulation Strategies/"I can control emotions",* residents acknowledged that

strong emotions could have an impact on their learning and their future teaching. They discussed the importance of regulating and processing these emotions before entering the classroom as a teacher. As residents primarily identify as BIPOC, they are more likely to have experienced racial inequity in the classroom grounded in the historic racialized nature of the school setting (Carter Andrews et al., 2019; Grooms et al., 2021; Partee, 2014). As such, teacher residents may be more likely to have negative emotions related to the school setting. It is critical for residency programs to provide space within their program to help residents acknowledge and process these emotions and provide strategies to regulate these emotions and promote healing. Moreover, in the shared themes of *Motivated by Teaching/Motivation as a Teacher,* residents indicated that seeing themselves as future teachers were a catalyst in moving this healing forward. Residency programs should consider helping residents identify personal motivations to begin this healing process including, but not limited to, visualizing themselves as future teachers.

Finally, in three similar themes, *In this together/ "We spoke the same language"/ "We will be together for a year"*, residents discussed the importance of connections within the residency cohort model. Some residents expressed the cohort model as a motivation to collaborate in class, enhancing their learning experience. Others discussed the critical nature of personal connections within the cohort that helped them emotionally and mentally when their personal life or coursework presented challenges. Residents in this study confirmed the current research stating the value of the cohort model to the residency experience (e.g., Guha et al., 2016). However, these residents also highlighted that the personal connections made enhanced their overall wellbeing throughout the

program. As such, residency programs should consider fostering such relationships, providing opportunities for more intentional connections within a cohort.

Mathematics Teacher Educators for Urban Teacher Residency Programs

The implications discussed above outline specific practices that are important for the residency program as a whole. However, these are part of the larger, interconnected pillars of TIC practices. According to the findings in this study, the implementation of all interconnected pillars of TIC in specific coursework may be important for the residents in a UTR program. Specifically, because residents are primarily teachers who identify as BIPOC and are more likely to have experienced mathematics trauma, the use of TIC frameworks in mathematics courses for residents may be especially critical.

Because of the higher potential for mathematics trauma, UTR Mathematics Teacher Educators (MTEs) should participate in TIC trainings to understand the framework and rationale of using the framework with this specific program. As they begin to understand the practices and the importance, MTEs in a UTR should allow time and space in the math classroom to participate in discussions about residents' past math experiences and how these influence their perspectives as a future teacher. These MTEs may consider conducting TIC trainings or mini lessons (like the ones used in this study) for the residents themselves to help them process potential trauma and have the skills to do the same for their future students.

Residents in a cohort model within a UTR are particularly positioned to benefit from TIC practices. Safety and connections are essential components for any TIC setting (Bath, 2008). As seen through the results of this study, residents in a cohort model have the opportunity build personal connections among the other residents in their cohort

throughout the year. They are, therefore, more likely to form connections with one another, creating more emotional and mental safety within the group. This cohort model also provides a foundation for accountability and motivation within the group. A TIC framework, therefore, may be an ideal model for developing mathematics identities with a UTR. MTEs in a UTR can be intentional about practices to support UTRs, including setting supportive norms and modeling support in the mathematics classroom, seeking input from residents about the support they are seeking from the instructor, and ensuring strong connections are developed among the cohort members. Such structures can lead to feelings of safety and connections, allowing for the processing and healing of trauma.

Given that UTRs are specialized in urban school teaching, they are more likely to teach students who are more racially and linguistically diverse (Milner, 2012). Thus, it is especially important for residents to participate in TIC practices that they can then implement in their classrooms to build positive mathematics identities in their students. Thus, MTEs in a UTR need to be explicit in connecting the mathematics and mathematics identity work in which residents are participating with the work they will do in the urban school setting.

Mathematics Teacher Educators

Beyond UTRs, there is a more global implication from this study to all MTEs. There is a body of research that explores how pre-service teachers negotiate their mathematics identities (e.g., Heffernan, 2016; Kaasila et al., 2012; Lutovac, 2020). These studies focus on factors that impact pre-service teachers' mathematics identities such as self-perceptions, beliefs, and attitudes. These studies focus on factors that impact pre-service teachers' mathematics identities such as self-perceptions, beliefs, and attitudes.

Such studies have not acknowledged the impact of mathematics trauma on mathematics identity. In practice, this often takes the form of encouraging positive talk and actions in the math classroom. While it is important to encourage positivity, such practices mask potential math trauma and overlook opportunities to process and heal from this trauma.

As such, a trauma-informed care (TIC) framework within a mathematics course for pre-service teachers could be a critical framework in the development of mathematics identity in all pre-service teachers. A TIC approach does not simply acknowledge factors that may have contributed to negative mathematics identities, but rather embeds processes and practices that allow pre-service teachers to process and cope with mathematics trauma, allowing them to better engage in the mathematics work.

This shift to embedding TIC practices means ensuring that math teacher educators participate in TIC training to learn more about specific practices and dispositions that a TIC framework necessitates. The implementation of the practices that build safety, connections, and help students cope in the math classroom is paramount to their success as both students and future teachers. As opposed to the "positivity" approach, math teacher educators need to provide time and space to process intensely negative math experiences and welcome conversations around potentially negative emotions their students might hold. This approach allows for identity development from the perspective of trauma healing.

Finally, the use of a TIC framework within a mathematics course for pre-service teachers may be an important practice in helping reshape how pre-service teachers promote positive mathematics identities within their future classrooms. The TIC framework provides structures and practices that pre-service teachers can implement in

their future classrooms to promote healing or prevent traumatization of their future students in the mathematics classroom.

Mentor Teachers

In addition to MTEs, mentor teachers play an important role in training and mentoring residents and pre-service teachers (Quartz & IMPACT Research Group, 2014). Mentors may be particularly positioned to help teachers recognize and process academic trauma they may hold. As such, it is important for mentor teachers to promote positive mathematics identities within their mentees. The impactful elements of TIC describe practices that mentor teachers could implement to positively impact their mentees' mathematics identities. For example, the themes under the pillar of *safety* suggest that pre-service teachers (PST's) need to feel safe to make mistakes and ask questions in their mentor classrooms. Additionally, PST's feel safe when they are encouraged, and have accessible and meaningful work. Themes under the pillar of *connections* suggest that non-academic conversations and connections with the mentor teacher and opportunities to collaborate with peers may promote the growth of PSTs' mathematics identities. Finally, the pillar of *managing emotions* suggests that it is important to acknowledge pre-service teachers' emotions within the mathematics classroom and encourage the use of regulation strategies. This study suggests that it may be beneficial for the mentor teacher to both implement and support these practices that might be implemented in PSTs university coursework.

Moreover, by implementing TIC practices, mentor teachers model the use of such practices in the classroom. Such modeling allows the PSTs to observe the implementation of the TIC practices in the classroom, impacting their practice as future mathematics

teachers. This may positively impact the mathematics identities of the K-12 students both within the PST's future classrooms and the students within the mentor teacher's classroom.

Summary

Teacher residency programs are successfully eliminating barriers and recruiting and retaining teachers who identify as BIPOC (e.g., Garza et al., 2018; Reynolds et al., 2016; Zugelder et al., 2020). Meanwhile, the importance of building positive mathematics identities in teachers in supporting student learning is well established. (Graven & Heyd-Metzuyamin, 2019). The implications of this studyprovide new insights into how to support the development of positive mathematics identities within a teacher residency model. Additionally, the implementation of trauma-informed care frameworks within a residency program may provide better holistic support for residents. TIC frameworks provide an approach to building positive mathematics identities of future teachers. As a result, residents and PSTs can be better prepared to teach the next generation of students and break the cycles of academic trauma.

Limitations

This discussion focuses on three limitations to this study.First, it is grounded in the unique context of one UTR program and the experience of these participants. The purpose of this research was to explore the development of mathematics identities through the perspectives and narratives of this unique set of participants. Therefore, this study does not necessarily speak to large-scale generalizations across a wider range of MET courses or UTR programs.

Second, the data from each participant does not wholly reflect each individual. Rather, the data has been interpreted through my lens of understanding based on the words, stories, and contexts of the participants' narratives. I acknowledge that an individual's identity is complex and multifaceted, influenced by the individual's social and cultural context overtime. As such, the experiences of these individual participants within the MET course represent a small portion of their overall experience the many factors influencing their mathematics identities. Moreover, these experiences represent a small portion of their overall identities. I must also reiterate that the mathematics trauma discussed within this study is one category of trauma that may or may not be impacted by other trauma caused by an individual's life experiences.

Third, the researcher (myself) was both the researcher and instructor (R-I) for the MET course.. While I implemented data collection and analysis practices to help mitigate bias (See Chapter 3), I recognize that I may hold implicit biases towards the impact of the instructional practices within the course. Additionally, while I attempted to mitigate power hierarchies between the participants and myself, I recognize that such hierarchies may still have impacted the study. As the instructor for the course and as a White female, it is possible that participants felt the need to perform in certain ways throughout the course and interview.

Future Directions for Research

The implications and limitations of this research present important directions for future research. As this study is confined to the MET course and participants from one Urban Teacher Residency (UTR) program, future research is needed to study other

mathematics courses for elementary teacher courses across other UTR programs. This may provide more large-scale generalizability among courses and programs.

Additionally, longitudinal research that studies these participants overtime would be informative. As participants graduate from their UTR program and become a teacher of record in their own classroom, their mathematics identities may continue to develop and grow. Research is needed that goes beyond teacher preparation, studying how early career teachers' mathematics identities are influenced during their career as teachers. Such research may document the continued influence (or lack thereof) from their PST experiences and document efforts to infuse TIC frameworks with a focus on positive mathematics identities into mentoring models.

Finally, this study suggests a trauma-informed care (TIC) framework can be useful in promoting positive mathematics identities. It is possible that TIC frameworks can help students process and heal from other forms of academic trauma. Future research should be conducted to test the effects of TIC frameworks in promoting positive identities within other academic areas. Additionally, future research should be conducted to test the effects of TIC frameworks in promoting positive teacher identities in teachers who may have experienced primary or secondary trauma in their personal lives or within the classroom.

Final Thoughts

"A Math Hug"

I entered this study with a passion for trauma-informed care. I have seen the difference that coping skills can make both in a classroom setting and in my personal life. It is exceptionally important to acknowledge the narratives of people-what makes them

individuals. This study highlights the ways that this acknowledgement can have a positive impact on residents who are both shaped by, and shaping, K-12 school experiences. This particular group of residents ignited a further passion for me, in that they were vocal about their desire to empower their K-12 students. Hearing their stories, encouraging them to make sense of their stories, and providing a supportive environment for them to heal from their own trauma was paramount. This created an opportunity for me to empower them, allowing them to develop their own teaching practices.

Being a "math teacher" was not part of the residents' math identities. Part of the empowerment I sought to create for my teachers was to provide them the space and skills to cope with any potential mathematics trauma from past experiences and build their "math teacher" identity and break the cycle. This also gave them space and agency to begin breaking the cycle of math trauma for their K-12 students.

As the researcher for this study and the instructor of this MET course, I have been encouraged by the findings. I have seen first-hand the transformations from fearful and timid mathematics learners and doers to empowered and enthusiastic mathematics teachers. Moreover, I have witnessed dramatic shifts from confident math learners and doers to confident and equipped mathematics teachers. I am excited about the impact of TIC practices within a mathematics setting for participants with and without mathematics trauma. All mathematics classes should be a place of mathematics sanctuary and empowerment. In the words of one participant, the mathematics classroom should be a "math hug" – a hug that provides safety, security, and connection and spurs residents forward to be confident in themselves as mathematics learners and doers.

REFERENCES

Agee, J. (2004). Negotiating a teaching identity: An African American teacher's struggle to teach in test-driven contexts. Teachers College Record, 106(4), 747–774.

Aguirre, J., Mayfield-Ingram, K., & Martin, D. (2013). *The impact of identity in K-8 mathematics: Rethinking equity-based practices.* Reston, VA: NCTM.

Ainsworth, M.D., Bell, S.M. (1970) Attachment, exploration, and separation: Illustrated by the behavior of one-year-olds in a strange situation. *Child Dev*. ;41(1):49-67. doi:10.2307/1127388

Akin, A., & Kurbanoglu, I. N. (2011). The relationships between math anxiety, math attitudes, and self-efficacy: A structural equation model. *Studia Psychologica*, *53*(3), 263.

Alvarez, A. (2017). "Seeing their eyes in the rearview mirror": Identifying and responding to students' challenging experiences. Equity & Excellence in Education, 50(1), 53–67. http://dx.doi.org/10.1080/10665684.2016.1250686

Anderson, J. D. (1988). The education of blacks in the South, 1860-1935. Chapel Hill, N.C.: University of North Carolina Press.

Anfara, V. A., Brown, K. M., & Mangione, T. L. (2002). Qualitative analysis on stage: Making the research process more public. *Educational researcher* 31(7), 28-38.

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic bulletin & review*, *14*, 243-248. https://doi.org/10.3758/BF03194059

Association of Mathematics Teacher Educators. (2017). *Standards for preparing teachers of mathematics.* Available online at amte.net/standards.

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, *59*(5), 389–407. https://doi.org/10.1177/0022487108324554

Bandura, A. (1997). Self-efficacy: The exercise of control. W H Freeman/Times Books/ Henry Holt & Co.

Bartlett, J. D., Barto, B., Griffin, J. L., Fraser, J. G., Hodgdon, H., & Bodian, R. (2016). Trauma-informed care in the Massachusetts child trauma project. Child Maltreatment, 21, 101–112. doi:10.1177/1077559515615700

Bath, H. (2008). The three pillars of trauma-informed care. *Reclaiming children and youth.* 17(3):17-21.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report*, *13*(4), 544-559. doi: 10.46743/2160-3715/2008.1573

Beck J. S. (2016). The complexities of a third-space partnership in an urban teacher residency. *Teacher Education Quarterly*, 43(1), 51–70. https://digitalcommons.odu.edu/teachinglearning_fac_pubs/95

Beijaard, D., Meijer, P. C., & Verloop, N. (2004). Reconsidering research on teachers' professional identity. *Teaching and Teacher Education, 20*(2), 107-128. https://doi.org/10.1016/j.tate.2003.07.001

Berry, B., Montgomery, D., & Snyder, J. (2008). Urban teacher residency models and institutes of higher education: Implications for teacher preparation. *Center for Teaching Quality*.

Bhansali, R., & Trivedi, K. (2008). Is academic anxiety gender specific: A comparative study. *Journal of Social Sciences, 17*(1), 1-3. https://doi.org/10.1080/09718923.2008.11892627

Birkeland, S. E., & Peske, H. G. (2004). Literature review of research on alternative certification. *National Education Association*.

Blanton, H., Buunk, B., Gibbons, F., & Kuyper, H. (1999). When better-than-others compare upward: Choice of comparison and comparative evaluation as independent predictors of academic performance. *Journal of Personality and Social Psychology, 76*, 420–430. doi:10.1037/0022-3514.76.3.420.

Blazar, D., (2021). Teachers of color, culturally responsive teaching and student outcomes: Experimental evidence from the random assignment of teachers to classes. Anneburg Brown University Working paper No. 21-501. Available at https://www.edworkingpapers.com/sites/default/files/ai21-501.pdf.

Bloom, S. L. (1997). Creating sanctuary: Toward the evolution of sane societies. New York: Routledge.

Blumenfeld, P. C., Kempler, T. M., & Krajcik, J. S. (2006). *Motivation and cognitive engagement in learning environments* (pp. 475-488). na.

Bostwick, K. C. P., Martin, A. J., Collie, R. J., & Durksen, T. L. (2022). Motivation in context: A multilevel examination of growth orientation across one year. *Journal*

of Applied Developmental Psychology, *81*, 101435. https://doi.org/10.1016/J.APPDEV.2022.101435

Bowlby, J. (1951) Maternal care and mental health. *Bull World Health Organ*.3(3):355-533.

Breuer, J., & Freud, S. (1957). Studies on hysteria. *Standard Edition of the Complete Psychological Works of Sigmund Freud*. Vol. 2, trans. James Strachey. London: Hogarth Press.

Carter Andrews, D. J., Castro, E., Cho, C. L., Petchauer, E., Richmond, G., & Floden, R. (2019). Changing the narrative on diversifying the teaching workforce: A look at historical and contemporary factors that inform recruitment and retention of teachers of color. *Journal of Teacher Education*, *70*(1), 6-12. https://doi.org/10.1177/0022487118812418

Centers for Disease Control and Prevention. (2016). Violence prevention: *The ACE pyramid* (adapted by RYSE Youth Center). https://www.cdc.gov/violenceprevention/acestudy/about.html.

Centers for Disease Control and Prevention. (2022, April 6). *Adverse childhood experiences resources, violence prevention, injury Center CDC*. Centers for Disease Control and Prevention. Retrieved March 17, 2023, from https://www.cdc.gov/violenceprevention/aces/resources.html

Charmez, K. (2014). *Constructing grounded theory* (2nd ed.). Thousand oaks, CA: Sage.

Chu, Y., & Wang, W. (2022). The Urban Teacher Residency Model to Prepare Teachers: A Review of the Literature. *Urban Education*, 00420859221102976.

Clandinin, D. J., (Ed.). (2007). *Handbook of narrative inquiry: Mapping a methodology*. Thousand Oaks, CA. Sage.

Clandinin, D. J., & Connelly, F. M. (1989). Narrative and story in practice and research.

Cooper, K., & Olson, M. (1996). The multiple I's of teacher identity. In M. Kompf (Ed.), Changing research and practice: Teachers' professionalism, identities, and knowledge (pp. 78-89). London, UK: Falmer Press.

Cole, S. F., O'Brien, J. G., Gadd, M. G., Ristuccia, J., Wallace, D. L., & Gregory, M. (2005). Helping traumatized children learn. Boston: Massachusetts Advocates for Children.

Cole, M., & Stuart, J. S. (2005). "Do you ride on elephants" and "never tell them you're German": The experiences of British Asian and black, and overseas student teachers in South-East England. British Educational Research Journal, 31(3), 349-366.

Colborn, T. (2004). Neurodevelopment and endocrine disruption. Environmental Health Perspectives, 112(9), 944–949. http://dx.doi.org/10.1289/ehp.6601

Corbin J., & Strauss, A. (2015). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (4th ed.) Thousand Oaks, CA: Sage.

Costigan, C. L., Koryzma, C. M., Hua, J. M., & Chance, L. J. (2010). Ethnic identity, achievement, and psychological adjustment: Examining risk and resilience among youth from immigrant chinese families in canada. Cultural Diversity and Ethnic Minority Psychology, 16(2), 264-273. doi:10.1037/a0017275

Creswell, J. W., & Poth (2018). *Qualitative inquiry & research design: Choosing among five approaches* (4th ed.). Thousand Oaks: CA: Sage Publications, Inc.

Cribbs, J. D., Hazari, Z., Sonnert, G., & Sadler, P. M. (2015). Establishing an Explanatory Model for Mathematics Identity. *Child Development*, *86*(4), 1048–1062. https://doi.org/10.1111/CDEV.12363

Cronholm, P. F., Forke, C. M., Wade, R., Bair-Merritt, M. H., Davis, M., Harkins-Schwarz, M., Pachter, L. M., & Fein, J. A. (2015). Adverse childhood experiences: Expanding the concept of adversity. *American Journal of Preventive Medicine, 49*(3), 354–361. doi: 10.1016/j.amepre.2015.02.001

Crocetti, E., Rubini, M., & Meeus, W. (2008). Capturing the dynamics of identity formation in various ethnic groups: Development and validation of a three-dimensional model. *Journal of Adolescence*, *31*(2), 207–222. https://doi.org/10.1016/J.ADOLESCENCE.2007.09.002

Crowe, C., Bay-Williams, J., Morris, S. D. (2021) Math Identity Survey. *Association of Mathematics Teacher Educators. https://amte.net/content/mathematics-identity.*

Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math–gender stereotypes in elementary school children. *Child development*, *82*(3), 766-779. https://doi.org/10.1111/j.1467-8624.2010.01529.x

Cvencek, D., Nasir, N. I. S., O'Connor, K., Wischnia, S., & Meltzoff, A. N. (2015). The development of math–race stereotypes: "They say Chinese people are the best at math". *Journal of Research on Adolescence*, *25*(4), 630-637. doi: 10.1111/jora.12289

Cvencek, D., Brečić, R., Gacesa, D., & Meltzoff, A. N. (2021). Development of math attitudes and math self-concepts: Gender differences, implicit–explicit

dissociations, and relations to math achievement. *Child Development*, *92*(5), e940-e956. https://doi.org/10.1111/cdev.13523

Darling-Hammond, L. (1996). The right to learn and the advancement of teaching: Research, policy, and practice for democratic education. *Educational Researcher*, *25*(6), *5-17*.

Darragh, L. (2016). Identity research in mathematics education. *Educational Studies in Mathematics, 93*(1), 19–33. https://doi. org/10.1007/s10649-016-9696-5.

Darragh, L. (2018). Loving and loathing: Portrayals of school mathematics in young adult fiction. *Journal for Research in Mathematics Education, 49*(2), 178–209. http://www.jstor.org.proxy.mul.missouri.edu/stable/10.5951/jresematheduc.49.2.0178.

DeLay, D., Zhang, L., Hanish, L. D., Miller, C. F., Fabes, R. A., Martin, C. L., ... & Updegraff, K. A. (2016). Peer influence on academic performance: A social network analysis of social-emotional intervention effects. *Prevention Science*, *17*, 903-913. doi: 10.1007/s11121-016-0678-8.

Deo, M. E., (2023). Better than BIPOC. *Law and Inequality: A Journal of Theory and Practice 41*(71) 71-130. https://doi.org/10.24926/ 25730037.655.

Dilworth, M. E., & Brown, A. L. (2008). Teachers of color. In M. Smith, S. Nemser, D. J.McIntyre, & K. E. Demers, Handbook of research on teacher education: Enduring Questions in changing contexts (3rd ed., pp. 424-444). New York, NY: Routledge.

Dixon, A., & Anderson, C. R. (2017). Where are we? Critical race theory in education 20 years later. *Peabody Journal of Education, 98*(1), 121-131. https://doi.org/10.1080/0161956X.2017.1403194

Dorado, J. S., Martinez, M., McArthur, L. E., & Leibovitz, T. (2016). Healthy Environments and Response to Trauma in Schools (HEARTS): A whole-school, multi-level, prevention and intervention program for creating trauma-informed, safe and supportive schools. *School Mental Health, 8,* 163–176. doi:10.1007/s12310-016-9177-0

Downey, L. (2007) Calmer classrooms: A guide to working with traumatised children. Melbourne: Child Safety Commissioner.

Durant, E. L., (2013). Math teachers: their counternarratives and how it influences their math identity. (Publication No. 3573447) [Doctoral dissertation, Purdue University] ProQuest Dissertations Publishing.

Durlak, J., & Mahoney, J. L. (2019). The practical benefits of an sel program. *Collaborative for academic, social, and emotional learning*. Chicago, IL.

Dweck, C. S. (1999). Self-theories: Their role in motivation, personality, and development. Taylor and Francis/Psychology Press.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. Random house.

Dweck, C. S., & Yeager, D. S. (2019). Mindsets: A view from two eras. *Perspectives on Psychological science*, *14*(3), 481-496. https://doi.org/10.1177/1745691618804166

Edmondson (1999). Psychological safety and learning behavior in work teams. *Administrative Science Quarterly,* June 1999.

Endo, R. (2015). How Asian American female teachers experience racial microaggressions from pre-service preparation to their professional careers. Urban Review: *Issues and Ideas in Public Education, 47*(4), 601-625. http://dx.doi.org/10.1007/s11256-015-0326-9

English-Clarke, T.L., Slaughter-Defoe, D.T., Martin, D.B., (2012): Racial Stereotyping and Child Development. Contrib Hum Dev. Basel, Karger. 25, pp 57–79. doi: 10.1159/000336279.

Esaki, N., Benamati, J., Yanosy, S., Middleton, J. S., Hopson, L. M., Hummer, V. L., & Bloom, S. L. (2013). The sanctuary model: Theoretical framework. *Families in society*, *94*(2), 87-95. https://doi.org/10.1606/1044-3894.4287

Every Student Succeeds Act. (2015). https//congress.gov/114/plaws/pub195/PLAW-114pub195.pdf

Erikson, E. H. (1963). Childhood and society (2nd Ed.). New York: Norton.

Erikson, E. H. (1968). Identity, youth and crisis. New York: Norton.

Felitti, V. J., Anda, R. F., Nordenberg, D., Williamson, D. F., Spitz, A. M., Edwards, V., & Marks, J. S. (1998). Relationship of childhood abuse and household dysfunction to many of the leading causes of death in adults: The Adverse Childhood Experiences (ACE) Study. *American journal of preventive medicine*, *14*(4), 245-258.

Fergusson, D. M., & Horwood, L. J. (1997). Gender differences in educational achievement in a New Zealand birth cohort. *New Zealand Journal of Educational Studies, 32*(1) 83–96.

Fisher, W. R. (1984). Narration as a human communication paradigm: The case of public moral argument. *Communications Monographs*, *51*(1), 1-22.

Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The math anxiety-performance link: A global phenomenon. *Current directions in psychological science*, *26*(1), 52-58. https://doi.org/10.1177/0963721416672463

Freud, S. (1923). The Ego and the Id: 1923-1925.

Freud, S. (1955). Beyond the pleasure principle. In *The standard edition of the complete psychological works of Sigmund Freud, Volume XVIII (1920-1922): Beyond the pleasure principle, group psychology and other works* (pp. 1-64).

Gardiner W. (2012). Coaches' and new urban teachers' perceptions of induction coaching: Time, trust, and accelerated learning curves. *The Teacher Educator*, *47*(3), 195–215. https://doi.org/10.1080/08878730.2012.685797

Garofalo, J. (1989). Beliefs and their influence on mathematical performance. *The Mathematics Teacher*, *82*(7), 502-505.

Garza R., Reynosa R., Werner P., Duchaine E. L., Harter R. (2018). Characterizing mentoring capital in a residency program through mentor's voices. *Mentoring & Tutoring: Partnership in Learning*, *26*(2), 226–244. https://doi.org/10.1080/13611267.2018.1472590

Gay, G. (2000). Culturally responsive teaching: Theory, research, and practice. New York: Teachers College Press.

Geary, B., (2007). Calmer classrooms: a guide to working with traumatized children. Melbourne, Australia: Child Safety Commissioner.

Gee, J. P. (2000). Identity as an analytic lens for research in education. Review of Research in Education, 25, 99–125. doi:10.2307/1167322

Geist, E. (2010). The anti-anxiety curriculum: Combating math anxiety in the classroom. *Journal of Instructional Psychology*, *37*(1).

Gellert, U. (2000). Mathematics instruction in safe space: Prospective elementary teachers' views of mathematics education. *Journal of mathematics teacher education, 3*, 251-270.

Gerber, E.B., Loomis, B., Falvey, C., Steinbuchel, P.H., Leland, J., Epstein, K. (2019). Trauma-Informed Pediatrics: Organizational and Clinical Practices for Change, Healing, and Resilience. In: Gerber, M. (eds) Trauma-Informed Healthcare Approaches. Springer, Cham. https://doi.org/10.1007/978-3-030-04342-1_9

Gershenson, S., Hart, C. M. D., Hyman, J., Lindsay, C., Papageorge, N. W. (2021). The long run impacts of same-race teachers. National Bureau of Economic Research Working paper 25254. Available at http://www.nber.org/papers/w25254.

Gibb, S. J., Fergusson, D. M., & Horwood, L. J. (2008). Gender differences in educational achievement to age 25. *Australian Journal of Education*, *52*(1), 63-80. https://doi.org/10.1177/000494410805200105

Ginwright, S. (2018). The future of healing: Shifting form trauma-informed care to healing centered engagement. Retrieved from https://medium.com/@ginwright/the-future-of-healing-shifting-from-trauma-informed-care-to-healing-centered-engagement-634f557ce69c

Glaser, B. G., (1978). *Theoretical sensitivity*. Mill Valley, CA: Sociology Press.

Glesne, C. (2011). *Becoming qualitative researchers: An introduction (*4th edition). New York: Pearson.

Gonzalez, L., Chapman, S., & Battle, J. (2020). Mathematics identity and achievement among Black students. *School Science and Mathematics*, *120*(8), 456-466. doi: 10.1111/ssm.12436

Goldin, G. A. (2000). Affective pathways and representation in mathematical problem solving. *Mathematical thinking and learning, 2*(3), 209–219.

Golden, N. (2020). The Importance of Narrative: Moving Towards Sociocultural Understandings of Trauma-Informed Praxis. Occasional Paper Series, 2020 (43). doi: https://doi.org/10.58295/ 2375-3668.1344

Goodwin A. L., Roegman R., Reagan E. M. (2016). Is experience the best teacher? Extensive clinical practice and mentor teachers' perspectives on effective teaching. *Urban Education*, *51*(10), 1198–1225. https://doi.org/10.1177/0042085915618720

Graven, M., Heyd-Metzuyanim, E. (2019). Mathematics identity research: the state of the art and future directions. *ZDM Mathematics Education* 51, 361–377. https://doi.org/10.1007/s11858-019-01050-y

Gray, L. (2009). Educational Trauma. Plagrave Macmillan Cham.

Green, J., Nelson, G., Martin, A. J., & Marsh, H. (2006). The causal ordering of self-concept and academic motivation and its effect on academic achievement. *International Education Journal*, *7*(4), 534–546. http://iej.com.au

Greenwald, R. (2005). Child trauma handbook: A guide for helping trauma-exposed children and adolescents. New York: The Haworth Maltreatment and Trauma Press.

Griffin, A. (2018). Our stories, our struggles, our strengths: Perspectives and reflections from Latino teachers. The Education Trust. Retrieved from https://edtrust.org/resource /our-stories-our-struggles-our-strengths/

Grooms, A. A., Mahatmya, D., & Johnson, E. T. (2021). The Retention of Educators of Color Amidst Institutionalized Racism. *Educational Policy*, *35*(2), 180–212. https://doi.org/10.1177/0895904820986765

Guha, R., Hyler, M.E., and Darling-Hammond, L. (2016). *The Teacher Residency: An Innovative Model for Preparing Teachers*. Palo Alto, CA: Learning Policy Institute. https://learningpolicyinstitute.org/product/teacher-residency

Harré, R. (2012). Positioning theory: Moral dimensions of social-cultural psychology. In J. Valsiner (Ed.), *The Oxford handbook of culture and psychology* (pp. 191–206). Oxford University Press.

Harré, R., & van Langenhove, L. (1999). The dynamics of social episodes. In R. Harré & L. van Langenhove (Eds.), Positioning theory (pp. 1–13). Oxford, UK: Blackwell.

Harris, J. R. (1995). Where is the child's environment? A group socialization theory of development. *Psychological Review, 102*, 458–489. doi:10.1037/0033-295X.102.3.458.

Heffernan, K. (2016). *Promoting preservice teachers' mathematics identity exploration* (Order No. 10111342). Available from ProQuest Dissertations & Theses Global. (1794166759).

http://echo.louisville.edu/login?url=https://www.proquest.com/dissertations-theses/promoting-preservice-teachers-mathematics/docview/1794166759/se-2

Heffernan, K.A., Newton, K.J. (2019) Exploring mathematics identity: an intervention of early childhood preservice teachers, Journal of Early Childhood Teacher Education, 40:3, 296-324, DOI: 10.1080/10901027.2019.1590484

Hembree, R. (1988). Correlates, causes, effects, and treatment of test anxiety. Review of Educational Research, 58, 47–77.

Herman, J. L. (1992). Complex PTSD: A syndrome in survivors of prolonged and repeated trauma. *Journal of traumatic stress*, *5*(3), 377-391.

Higher Education Opportunity Act, 110-135 § Public Law (2008).

Hinton, E., Keels, M., Williams, S. (2018). Understanding and Responding to the Acting Out Cycle. Practice Brief #6. TREP Project.

Hodges, T. E., & Hodge, L. L. (2017). Unpacking personal identities for teaching mathematics within the context of prospective teacher education. *Journal of Mathematics Teacher Education*, *20*(2), 101–118. https://doi.org/10.1007/S10857-015-9339-2/METRICS

Holland, D., Skinner, D., Lachicotte, W., Jr., & Cain, C. (1998). Identity and agency in cultural worlds. Cambridge, MA: Harvard University Press.

Hollins, E. R. (2012). *Learning to teach in urban schools: The transition from preparation to practice.* Routledge.

Hoover, S. A., Sapere, H., Lang, J. M., Nadeem, E., Dean, K. L., & Vona, P. (2018). Statewide implementation of an evidence-based trauma intervention in

schools. *School Psychology Quarterly, 33*(1), 44–53. https://doi.org/10.1037/spq0000248

Hussar, W. J. (1999). *Predicting the need for newly hired teachers in the United States to 2008-09*. National Center for Education Statistics, US Department of Education, Office of Educational Research and Improvement.

Ijadi-Maghsoodi, R., Marlotte, L., Garcia, E., Aralis, H., Lester, P., Escudero, P., & Kataoka, S. (2017). Adapting and implementing a school-based resilience-building curriculum among low-income racial and ethnic minority students. Contemporary School Psychology, 21, 223–239. doi: 10.1007/s40688-017-0134-1

Ishak, Z., Low, S.F. & Lau, P.L. (2012). Parenting Style as a Moderator for Students' Academic Achievement. *J Sci Educ Technol* 21: 487–493. https://doi.org/10.1007/s10956-011-9340-1

Jameson, M. M., & Fusco, B. R. (2014). Math anxiety, math self-concept, and math self-efficacy in adult learners compared to traditional undergraduate students. *Adult Education Quarterly*, *64*(4), 306-322. https://doi.org/10.1177/0741713614541461

Jankowski, M. K., Schifferdecker, K. E., Butcher, R. L., Foster-Johnson, L., & Barnett, E. R. (2019). Effectiveness of a trauma-informed care initiative in a state child welfare system: A randomized study. *Child maltreatment*, *24*(1), 86-97. Doi: 10.1177/1077559518796336

Jeynes, W. H. (2003). A meta-analysis: The effects of parental involvement on minority children's academic achievement. *Education and urban society*, *35*(2), 202-218.

Johnson, B. (2018). *Math teachers who don't like math: A narrative inquiry into the mathematics experience of early childhood and elementary educators who dislike*

mathematics. (Publication No. 10837489) [Doctoral dissertation, Ball State University]. ProQuest Dissertations Publishing.

Kawasaki, J., Hunter Quartz, K., & Francois, A. (2014). *Multiple measures of mentoring quality: Early lessons from an urban teacher residency program*. UCLA Center X. https://doi.org/10.14507/epaa.28.5001

Karge, B. D., & McCabe, M. (2014). Quality Alternative Certification Programs in Special Education Ensure High Retention. *Journal of the National Association for Alternative Certification*, *9*(2), 24-43.

Kenner, C., & Weinerman, J. (2011). Adult Learning Theory: Applications to Non-Traditional College Students. Journal of College Reading and Learning, 41(2)

Klein, A. (2018, July 16). Does ESSA require teachers to be highly qualified? Education Week. https://www.edweek.org/policy-politics/does-essa-require-teachers-to-be-highly-qualified/2018/07

Kolman J. S., Roegman R., Goodwin A. L. (2016). Context as mediator: Teaching residents' opportunity and learning in high-need urban schools. *Teaching Education*, 27(2), 173–193. https://doi.org/10.1080/10476210.2015.1062979

Ladson-Billings, G. (1996). Silences as weapons: Challenges of a Black professor teaching White students. Theory Into Practice, 35, 79–85.

Ladson-Billings, G. & Tate, W., (1995). Towards a critical race theory of education. Teachers College Record; 97(1): 47-68

Lake, V. E. & Kelly, L. (2014) Female Preservice Teachers and Mathematics: Anxiety, Beliefs, and Stereotype., *Journal of Early Childhood Teacher Education*, *35*(3) 262-275, DOI: 10.1080/10901027.2014.936071

Lankford, H., Loeb, S., & Wyckoff, J. (2002). Teacher sorting and the plight of urban schools: A descriptive analysis. *Educational evaluation and policy analysis*, *24*(1), 37-62.

Larabee. D. F. (2008). An uneasy relationship: The history of teacher education in the university. In M. Cochran-Smith, S. Feiman Nemser, & D. J. McIntyre (Eds.), *Handbook of research on teacher education: Enduring issues in changing contexts* (3rd ed., pp. 290-306). Association of Teacher Educators.

Leatham, K. & Hill, D.S. (2010). Exploring our math. *Mathematics Teaching in the Middle School, 16*(4), 224-231. **doi:** 10.5951/MTMS.16.4.0224

Lesko, A. C., & Corpus, J. (2006). Discounting the difficult: How high math-identified women respond to stereotype threat. *Sex Roles, 54*(1), 113-125. doi: 10.1007/s11199-005-8873-2

Lochmiller. C., Huggins. K... & Acker-Hocevar. M. (2012). Preparing leaders for math and science: Three alternatives to traditional preparation. Planning & Changing. 45(1/2). 198-220. http://education.illinoisstate.edu/planning/articles/vol43.php

Lutovac, S. (2020). How failure shapes teacher identities: Pre-service elementary school and mathematics teachers' narrated possible selves. https://doi.org/10.1016/j.tate.2020.103120

Lutovac, S., & Kaasila, R. (2011). Beginning a pre-service teacher's mathematical identity work through narrative rehabilitation and bibliotherapy. *Teaching in Higher Education*, *16*(2), 225–236. https://doi.org/10.1080/13562517.2010.515025

Lutovac, S., & Kaasila, R. (2014). Pre-service teachers' future-oriented mathematical identity work. *Educational Studies in Mathematics, 85*(1), 129–142. https://doi.org/10.1007/s10649-013-9500-8.

Lynn, M., Parker, L. (2006). Critical Race Studies in Education: Examining a Decade of Research on U.S. Schools. *Urban Rev* 38, 257–290 https://doi.org/10.1007/s11256-006-0035-5

Mambrol, N. (2018, July 15). *Trauma studies*. Literary Theory and Criticism. Retrieved March 15, 2023, from https://literariness.org/2018/12/19/trauma-studies/.

Mapolelo, D.C.Akinsola, M.K. (2015). Preparation of mathematics teachers: lessons from review of literature on teachers' knowledge, beliefs, and teacher education. *American journal of educational research*, *3*(4), 505-513. doi: 10.12691/education-3-4-18.

Martin, D. B. (2006). Mathematics Learning and Participation as Racialized Forms of Experience: African American Parents Speak on the Struggle for Mathematics Literacy. *Mathematical Thinking and Learning, 8*(3), 197-229. doi:10.1207/s15327833mtl0803_2

Martin, A. J., Colmar, S. H., Davey, L. A., & Marsh, H. W. (2011). *Longitudinal modelling of academic buoyancy and motivation: Do the "5Cs" hold up over time?* https://doi.org/10.1348/000709910X486376

Martin, A. J., & Marsh, H. W. (2008). Academic Resilience and Academic Buoyancy: Multidimensional and Hierarchical Conceptual Framing of Causes, Correlates, and Cognate Constructs. https://doi.org/10.1080/03054980902934639

Martin, A. J., Marsh, H. W., & Debus, R. L. (2003). Self-handicapping and defensive pessimism: A model of self-protection from a longitudinal perspective. *Contemporary educational psychology*, *28*(1), 1-36.

Maxwell, J. A. (2005). Qualitative research design: An interactive approach. Thousand Oaks, CA: Sage.

Mayes, C., (2009). The psychoanalytic view of teaching and learning, 1922–2002, *Journal of Curriculum Studies, 41*(4), 539-567, doi: 10.1080/00220270802056674.

McKinney, S. E., Berry, R. Q., Dickerson, D. L., & Campbell-Whately, G. (2007). Addressing Urban High-Poverty School Teacher Attrition by Addressing Urban High Poverty School Teacher Retention: Why Effective Teachers Perservere. *Educational Research and Reviews*, *3*(1).

McCrory, E., De Brito, S. A., & Viding, E. (2011). The impact of childhood maltreatment: Areview of neurobiological and genetic factors. Frontiers in Psychiatry, 2, 48. doi: 10.3389/fpsyt.2011.00048

Mead, G. J. (1934). Mind, self and society. Chicago: University of Chicago Press.

Metzler, M., Merrick, M. T., Klevens, J., Ports, K. A., & Ford, D. C. (2017). Adverse childhood experiences and life opportunities: Shifting the narrative. *Children and youth services review*, *72*, 141-149. https://doi.org/10.1016/j.childyouth.2016.10.021

Merriam, S. B. (2009). Qualitative research: A guide to design and implementation. San Francisco, CA: Jossey-Bass.

Mezirow, J. (1997). *Transformative learning: Theory to practice*. New directions for adult and continuing education, 1997(74), 5-12

Middleton, J. A., & Toluk, Z. (1999). First steps in the development of an adaptive, decision-making theory of motivation. *Educational Psychologist, 34*(2), 99–112.

Miles, H., & Huberman, A. M. Saldana. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Thousand Oaks, CA: Sage.

Miles, H., & Huberman, A. M. Saldana. (2020). *Qualitative data analysis: A methods sourcebook* (4th ed.). Thousand Oaks, CA: Sage

Milner, R. H. (2007). Race, culture, and researcher positionality: Working through dangers seen, unseen, and unforeseen. *Educational Researcher, 36(7), 388-400.* https://doi.org/10.3102/0013189X07309471

Milner H. R. (2012). But what is urban education? *Urban Education*, *47*(3), 556–561. https://doi.org/10.1177/0042085912447516

Mok, S. Y., & Staub, F. C. (2021). Does coaching, mentoring, and supervision matter for pre-service teachers' planning skills and clarity of instruction? A meta-analysis of (quasi-) experimental studies. *Teaching & Teacher Education, 107, N.PAG,* https://doi-org.echo.louisville.edu/10.1016/j.tate.2021.103484

Morgan, A., Pendergast, D., Brown, R., & Heck, D. (2015). Relational ways of being an educator: Trauma-informed practice supporting disenfranchised young people. *International Journal of Inclusive Education*, *19*(10), 1037-1051. http://dx.doi.org/10.1080/13603116.2015.1035344

Murayama, K., Pekrun, R., Lichtenfeld, S., & Vom Hofe, R. (2013). Predicting long-term growth in students' mathematics achievement: The unique contributions of

motivation and cognitive strategies. *Child Development, 84*(4), 1475–1490. https://doi.org/10.1111/cdev.12036

Murnane, R. J., Singer, J. D., Willett, J. B., Kemple, J. J., & Olsen, R. J. (1991). Who will teach? Policies that matter. Cambridge, MA: Harvard University.

National Commission on Excellence in Education. (1983). A nation at risk: The imperative for educational reform. https://edreform.com/wp-content/uploads/2013/02/A_Nation_At_Risk_1983.pdf

National Council of Teachers of Mathematics (NCTM) (2020). *Catalyzing change in early childhood and elementary mathematics: Initiating critical conversations.* Reston, VA: NCTM.

National Child Traumatic Stress Network, Schools Committee. (2017). Creating, supporting, and sustaining trauma-informed schools: A system framework. Los Angeles, CA: National Center for Child Traumatic Stress.

Natriello, G., & Zumwalt, K. (1993). New teachers for urban schools? The contribution of the provisional teacher program in New Jersey. *Education and Urban Society*, *26*(1), 49-62.

Ng B. (2018) The Neuroscience of Growth Mindset and Intrinsic Motivation. Brain Sci. Jan 26;8(2):20. doi: 10.3390/brainsci8020020. PMID: 29373496; PMCID: PMC5836039.

No Child Left Behind Act, 20 U.S.C. 6310 *et seq*. (2001).

Nunez-Pena, M. I., Suarez-Pellicioni, M., & Bono, R. (2016). Gender differences in test anxiety and their impact on higher education students' academic achievement.

Procedia-Social and Behavioral Sciences, 228, 154-160. https://doi.org/10.1016/j.sbspro.2016.07.023

Okeke, N. A., Howard, L. C., Kurtz-Costes, B., & Rowley, S. J. (2009). Academic race stereotypes, academic self-concept, and racial centrality in African American youth. *Journal of Black Psychology*, *35*(3), 366-387. doi: 10.1177/0095798409333615

Olson, K., (2009). Wounded by school: recapturing the joy in learning and standing up to old school culture. Teachers College Press. New York, NY.

Papay, J. P., West, M. R., Fullerton, J. B., & Kane, T. J. (2012). Does an urban teacher residency increase student achievement? Early evidence from Boston. *Educational Evaluation and Policy Analysis*, *34*(4), 413-434. http://dx.doi.org/10.3102/0162373712454328

Park, H., (2015). "Learning Identity A Sociocultural Perspective," Adult Education Research Conference. https://newprairiepress.org/aerc/2015/papers/41

Parker, P. D., Marsh, H. W., Ciarrochi, J., Marshall, S., & Abduljabbar, A. S. (2014). Juxtaposing math self-efficacy and self-concept as predictors of long-term achievement outcomes. *Educational Psychology*, *34*(1), 29-48. https://doi.org/10.1080/01443410.2013.797339

Partee, G. L. (2014). Retaining Teachers of Color in Our Public Schools: A Critical Need for Action. *Center for American Progress.* https://cdn.americanprogress.org/wp-content/uploads/2014/06/Partee-TeachersOfColor-report2.pdf

Patton, M. Q. (1985). Quality in qualitative research: Methodological principles and recent developments. Invited address to Division J of the American Educational Research Association, Chicago, April 1985.

Pekrun, R., Goetz, T., Frenzel, A. C., Barchfeld, P., & Perry, R. P. (2011). Measuring emotions in students' learning and performance: The Achievement Emotions Questionnaire (AEQ). *Contemporary Educational Psychology*, *36*(1), 36–48. https://doi.org/10.1016/j.cedpsych.2010.10.002

Perry, A. B. (2004). Decreasing math anxiety in college students. *College student journal*, *38*(2), 321-325.

Perry, B. (2006). Applying principles of neurodevelopment to clinical work with maltreated and traumatized children. In N. Webb (Ed.), Working with traumatized youth in child welfare (pp. 27-52). New York: The Guilford Press.

Peshkin, A. (1988). In search of subjectivity-one's own. *Educational researcher*, *17*(7), 17-22.

Pigott, R. L., & Cowen, E. L. (2000). Teacher race, child race, racial congruence, and teacher ratings of children's school adjustment. *Journal of School Psychology*, *38*(2), 177-195.

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of educational Psychology*, *95*(4), 667.

Praat, A. (1999). Gender differences in student achievement and in rates of participation in the school sector, 1986–1997: a summary report. The Research Bulletin, 10, 1–11.

Quartz, H. K., & IMPACT Research Group. (2014). *Learning in residence: Mixed-methods research on an urban teacher residency program*. UCLA Center X.

Ravitch, D. (2013). *Reign of error: The hoax of the privatization movement and the danger at America's public schools.* Alfred A. Knopf.

Reid, K. W. (2013). Understanding the Relationships among Racial Identity, Self-Efficacy, Institutional Integration and Academic Achievement of Black Males Attending Research Universities. Journal Of Negro Education, 82(1), 75-93. https://doi.org/10.7709/jnegroeducation.82.1.0075

Reynolds H. M., Wagle A. T., Mahar D., Yannuzzi L., Tramonte B., King J. (2016). Changes in residents' self-efficacy beliefs in a clinically rich graduate teacher education program. *Action in Teacher Education*, 38(2), 137–155. https://doi.org/10.1080/01626620.2016.1155096

Rivard, J. C., Bloom, S. L., Abramovitz, R., Pasquale, L. E., Duncan, M., Mccorkle, D. W., & Gelman, A. (2003). Assessing the implementation and effects of a trauma-focused intervention for youths in residential treatment. In *Psychiatric Quarterly* 74(2).

Roach, V., & Cohen, B. A. (2002). Moving Past the Politics: How Alternative Certification Can Promote Comprehensive Teacher Development Reforms.

Rounds Jr, J. B., & Hendel, D. D. (1980). Mathematics anxiety and attitudes toward mathematics. *Measurement and Evaluation in Guidance*, *13*(2), 83-89.

Roth, T. L., Lubin, F. D., Funk, A. J., & Sweatt, J. D. (2009). Lasting epigenetic influence of early-life adversity on the BDNF gene. *Biological Psychiatry, 65*(9), 760–769. http://dx.doi.org/10.1016/j.biopsych.2008.11.028.

Rouland, K. (2017). Exploring Equity Issues: Racial Identity, Academic Identity, and Academic Outcomes for Students of Color. *Center for Education Equity, Mid-Atlantic Equity Consortium*.

Rounds Jr, J. B., & Hendel, D. D. (1980). Mathematics anxiety and attitudes toward mathematics. *Measurement and Evaluation in Guidance*, *13*(2), 83-89.

Rutledge, J., Sommers, S., Miller, S. F., Katka, A., Moore, C., Neginsky, K. C., Soricone, L., Stoesz, K., & Woodland, G. (2023). Teaching Skills That Matter: Instructional Coaching That Works. *COABE Journal: The Resource for Adult Education, 12*(2). 66-74.

Saldaña, J. (2016). The coding manual for qualitative researchers. *The coding manual for qualitative researchers*. Thousand Oaks, CA: Sage

Seymour, E., & Hewitt, N. (1997). Talking about leaving: Why undergraduates leave the sciences. Boulder, CO: Westview.

Siegel, D. J., & Bryson, T. P. (2012). *The whole-brain child*. Robinson.

Silva T., McKie A., Knechtel V., Gleason P., Makowsky L. (2014). *Teaching residency programs: A multisite look at a new model to prepare teachers for high-need schools* (NCEE 2015 400). https://ies.ed.gov/ncee/pubs/20154002/pdf/20154002.pdf.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42*(1), 70. https://doi.org/10.1037/0012-1649.42.1.70

Singer, J. M., & Stake, J. E. (1986). Mathematics and self-esteem: Implications for women's career choices. Psychology Of Women Quarterly, 10(A), 339-52.

Sloan, K., Allen, A., Blazevski, J., Carson, F., Rockman, S. (2018). A different, more durable model: hunter college urban teacher residency project. New Visions for Public Schools.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage

Stake, R. E. (2005). Qualitative Case Studies. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (pp. 443–466). Sage Publications Ltd.

Stake, R. E. (2013). *Multiple case study analysis*. Guilford press.

Starkey-Perret, R., Deledalle, A., Jeoffrion., C., Rowe, C., (2017) Measuring the impact of teaching approaches on achievement related emotions: the use of achievement emotions questionnaire. *British journal of educational Psychology. 88*(3), 446-464. https://doi.org/10.1111/bjep.12193

Stoehr, K. (2017). Mathematics anxiety: One size does not fit all. *Journal of Teacher Education, 68*(1), 69–84. DOI: 10.1177/0022487116676316.

Substance Abuse and Mental Health Services Administration, National Center for Trauma-Informed Care. (2015). Trauma-informed approach. http://www.samhsa .gov/nctic/trauma-interventions.

Suell, J. L., & Piotrowski, C. (2007). Alternative teacher education programs: A review of the literature and outcome studies. *Journal of Instructional Psychology*, *34*(1), 54.

Swain, G., Schmertzing, L., & Schmertzing, R. (2011). A qualitative investigation of the impact of early-career experience on teachers with alternative certification. *Delta Kappa Gamma Bulletin*, *77*(4), 59.

Thomas, M. S., Crosby, S., & Vanderhaar, J. (2019). Trauma-Informed Practices in Schools Across Two Decades: An Interdisciplinary Review of Research. In *Review of Research in Education* (Vol. 43, Issue 1, pp. 422–452). SAGE Publications Inc. https://doi.org/10.3102/0091732X18821123

Thomas, M. S., Howell, P. B., Crosby, S., Brkic, E., & Clemons, K. (2019). Teacher Candidates' Emerging Perspectives on Trauma-informed Teaching. In *Kentucky Teacher Education Journal: The Journal of the Teacher Education Division of the Kentucky Council for Exceptional Children* (Vol. 6). https://doi.org/10.61611/2995-5904.1022

Tiedemann, J. (2000). Parents' gender stereotypes and teachers' beliefs as predictors of children's concept of their mathematical ability in elementary school. Journal Of Educational Society, 9 2 ,144-151.

Tobias, S. (1993). *Overcoming math anxiety*. WW Norton & Company.

Tobias, S. (1987). Math anxiety. *Science*, *237*(4822), 1556-1556.

Tillman, L. C. (2004). The impact of the Brown v. Board of education decision on the employment status of Black educators. Education and Urban Society, 36, 280-303.

Tracy, S. J. (2010). Qualitative quality: Eight "big tent" criteria for excellent qualitative research. *Qualitative Inquiry*, *16*(10), 837-851. https://doi.org/10.1177/1077800410383121

Urdan, T., Munoz, C. (2012). Multiple contexts, multiple methods: a study of academic and cultural identity among children of immigrant parents. *Eur J Psychol Educ* 27: 247–265. https://doi.org/10.1007/s10212-011-0085-2

Usher, E. L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. *American Educational Research Journal, 46*(1), 275–314. https://doi.org/10.3102/0002831208324517

Van der Kolk, B. A. (2015). *The body keeps the score: brain, mind, and body in the healing of trauma.* New York, New York, Penguin Books.

Varelas, M., Martin, D. B., & Kane, J. M. (2013). Content learning and identity construction: A framework to strengthen African American Students' mathematics and science learning in Urban Elementary Schools. *Human Development*, *55*(5–6), 319–339. https://doi.org/10.1159/000345324

Vygotsky, L. S., & Cole, M. (1978). *Mind in society: Development of higher psychological processes*. Harvard university press.

Yun, C. (2022). Preparing Transitional Kindergarten to 3rd Grade Educators through Teacher Residencies. In *Learning Policy Institute*. Learning Policy Institute. https://learningpolicyinstitute.org/product/ca-transitional-kindergarten-teacher-residencies-brief

Wade, R., Cronholm, P.F., Fein, J. A., Forke, C. M., Davis, M. B., Harkins-Schwartz, M., Pachter, L. M., Bair-Merritt, M. H., (2016) Household and community-level Adverse Childhood Experiences and adult health outcomes in a diverse urban population. Child Abuse & Neglect. 52, 135-145. https://doi.org/10.1016/j.chiabu.2015.11.021.

Weaver-Hightower, M. (2003). The 'boy turn' in research on gender and education. *Review of Educational Research, 73*(4), 471–498.

Webster's Third International Dictionary (1986). Springfield, MA: Merriam-Webster.

Wolcott, H. F. (1994) *Transforming qualitative data: Description, analysis, and interpretation.* Thousand Oaks, CA: Sage.

Wolpow, R., Johnson, M. M., Hertel, R., & Kincaid, S. O. (2009). The heart of learning and teaching: Compassion, resiliency, and academic success. Olympia: Washington State Office of Superintendent of Public Instruction Compassionate Schools.

Woods, J. R. (2016*). Mitigating teacher shortages: Alternative teacher certification*. Education Commission of the States. https://www.ecs.org/wp-content/uploads/Mitigating-Teacher-Shortages-Alternative-Certification.pdf.

Yeager, D. S., & Dweck, C. S. (2020). What can be learned from growth mindset controversies? *American psychologist*, *75*(9), 1269. doi: 10.1037/amp0000794.

Young ES, Simpson JA, Griskevicius V, Huelsnitz CO, Fleck C. (2019) Childhood attachment and adult personality: A life history perspective. *Self and Identity*. 18:1:22-38. doi:10.1080/15298868.2017.1353540

Yin, R. K. (2003). Designing case studies. *Qualitative research methods*, *5*(14), 359-386.

Zeidner, M. (1998). Test anxiety: The state of the art. New York: Plenum.

Zimmerman, B. J. (2000). Self-efficacy: An essential motive to learn. *Contemporary educational psychology*, *25*(1), 82-91.

Zugelder, B. S., L'Esperance, M., Anderson, P. J., Everett, P., & Grandy, L. (2021). Teacher Residency as Alternative Pathway to Licensure. *Journal of Educational Issues*, *7*(1), 14–33. https://doi.org/10.5296/jei.v7i1.17922.

Appendix A: Math Identity Survey

Mathematics Identity Survey

Created by Johnson, Bay-Williams, & Morris (2021) with activities from Leatham & Hill (2010); Silver, Thomas, & Perini (2000)

Part I - About You

Tell about yourself. Include things that are important to you, things that are important for others to know about you, what you like to do, what you value, etc.

Part II - About Math

Place each of the words in the space below according to how well you think the word describes someone who is good at math (5 being very, very good and 0 being not good)

Arrogant	Brave	Brilliant	Careful
Creative	Curious	Diligent	Focused
Humble	Imaginative	Independent	Interested
Introverted	Motivated	Confident	Gifted
Lighthearted	Obedient	Open-minded	Organized
Passionate	Patient	Persistent	Resourceful
Teachable	Verbal	Social	

5	
4	
3	
2	
1	
0	

Part III - About You and Math

Place yourself on these continua according to how you feel about math. Use an "X" to indicate your position (Leatham & Hill, 2010).

Enjoyment Pain

Not Confident Confident

Not Good at Math Good at Math

Anxiety Peace (No Anxiety)

Part IV - About You and Learning Math

What type of math learner are you? Circle the type of student that best describes you (Silver, Thomas, & Perini, 2000).

Mastery Math Student

- Want to learn practical information and set procedures
- Like math problems that are like problems they have solved before and that use algorithms to produce a single solution
- Approach problem solving in a step-by-step manner
- Experience difficulty when math becomes too abstract or when faced with non-routine problems
- Want a math teacher who models new skills, allows time for practice, and builds in feedback and coaching sessions

Interpersonal Math Student

- Want to learn math through dialogue, collaboration, and cooperative learning
- Like math problems that focus on real-world applications and on how math helps people
- Approach problem solving as an open discussion among a community of problem solvers
- Experience difficulty when instruction focuses on independent seatwork or when what they are learning seems to lack real world application
- Want a math teacher who pays attentions to their successes and struggles in math

Understanding Math Student

- Want to understand why the math they learn works
- Like math problems that ask them to explain, provide, or take a position
- Approach problem solving by looking for patterns and identifying hidden questions
- Experience difficulty when there is a focus on the social environment of the classroom (e.g. collaboration and cooperative problem solving)

- Want a math teacher who challenges them to think and who lets them explain their thinking

Self-Expressive Math Student

- Want to use their imagination to explore mathematical ideas
- Like math problems that are non-routine, project-like nature, and that allows them to think "outside the box"
- Approach problem solving by visualizing the problem, generating possible solutions, and exploring among alternatives
- Want a math teacher who invites imagination and creative problem solving into the math classroom.

Part V - Your Math Identity

Tell about yourself as a learner and doer of math. Include things that are important to you about math and/or doing math, things that are important for others to know about you, what math you like to do, what you value about math, etc. Consider experiences in your past have influenced your math identity.

Complete each sentence.

1. One of my best memories of learning math in grades K-12 was…
2. One of my worst memories of learning math in grades K-12 was…
3. A math topic or concept that really made sense to me was…
4. A math topic that was hard for me to understand was…

Appendix B: Interview Protocol

Question	Probing Question(s)
A. Tell me about your mathematics identity before entering the Mathematics for Elementary Teacher course.	1. What experiences influenced your mathematics identity?
B. Tell me about your experiences in the Mathematics for Elementary Teacher course.	2. How did you feel as a learner and doer of mathematics during the course? 3. What experiences in the course influenced your mathematics identity? 4. Were these experiences different than your previous mathematics experiences? Why or why not?
C. Has your mathematics identity changed since the beginning of the course? If so, how?	5. Reflect on your Math Identity Survey from the beginning of the course. How do you feel about the questions now? 6. How did the activities we did in class help you think about your mathematics identity in a different way than before? 7. How did others in the class (myself as the instructor or other residents/students in the class) impact your mathematics identity? 8. How did thinking about yourself as a teacher impact your mathematics identity?

Appendix C: Journal Prompts

Directions:

- Create a Google Doc under your Google account. Label the document *Your Name: Math Journal.*
- In the top right corner of the Google Doc, hit the blue "share" button. Type in my email address _____ and hit "done". This will share your document with me for the whole semester.
- Each week, you will be given one journal prompt to respond to before the next week of class. You will right all journal prompt responses on this same document. Mark a new journal entry with the date.
- I will review your responses weekly and provide feedback. You will be given time at the beginning of each class to review the feedback and respond if you need/want.

****Note: These prompts will be added weekly based on our classroom discussions so check back each week for your new prompt****

Journal Prompts:

Week 1:

\+ *What is one thing you need added to your math experience to grow this semester?*

\- *What is one thing that would make a difference in your math experience this semester?*

x *What is one way we as a group can support you?*

÷ *Is there anything else you would like to share with the group?*

Week 2:

Review Section IV of your Math Identity Survey (Crowe et al., 2021).

Mastery Math Student

- Want to learn practical information and set procedures
- Like math problems that are like problems they have solved before and that use algorithms to produce a single solution
- Approach problem solving in a step-by-step manner
- Experience difficulty when math becomes too abstract or when faced with non-routine problems
- Want a math teacher who models new skills, allows time for practice, and builds in feedback and coaching sessions

Interpersonal Math Student

- Want to learn math through dialogue, collaboration, and cooperative learning
- Like math problems that focus on real-world applications and on how math helps people
- Approach problem solving as an open discussion among a community of problem solvers
- Experience difficulty when instruction focuses on independent seatwork or when what they are learning seems to lack real world application
- Want a math teacher who pays attentions to their successes and struggles in math

Understanding Math Student

- Want to understand why the math they learn works
- Like math problems that ask them to explain, provide, or take a position
- Approach problem solving by looking for patterns and identifying hidden questions
- Experience difficulty when there is a focus on the social environment of the classroom (e.g. collaboration and cooperative problem solving)
- Want a math teacher who challenges them to think and who lets them explain their thinking

Self-Expressive Math Student

- Want to use their imagination to explore mathematical ideas
- Like math problems that are non-routine, project-like nature, and that allows them to think "outside the box"
- Approach problem solving by visualizing the problem, generating possible solutions, and exploring among alternatives

1. *After discussing these learning styles in class and participating in our work, has this changed from what you previously identified? If yes, how or why? If no, what has solidified your original decision?*
2. *How does your learning style inform your learning in this course?*

Week 3:

You have done a lot of work this week! Sometimes it can be difficult to maintain motivation to keep going. Set some goals for **this week**:

1. *What are your goals for yourself as a math learner/doer?*
2. *What are your goals for yourself as a collaborator?*
3. *What are your goals for me as the instructor?*

Week 4:

1. *What specifically about your learning so far in this class has been different from your previous math learning experiences? What has been the same? How has this impacted your learning?*
2. *When you think about the work you have done in class so far, what are you proud of? What has been the most difficult? Why?*

Week 5:

On your Math Identity Survey (Crowe et al., 2021), you identified adjectives that describe someone who is "good at math" and we discussed how these look in the mathematics setting. Review those words again and answer the questions below.

Arrogant	Brave	Brilliant	Careful
Creative	Curious	Diligent	Focused
Humble	Imaginative	Independent	Interested
Introverted	Motivated	Confident	Gifted
Lighthearted	Obedient	Open-minded	Organized
Passionate	Patient	Persistent	Resourceful
Teachable	Verbal	Social	

1. *Select 3 adjectives that best describe you as you were working on math this week.*
2. *Select 2 adjectives that you want to grow in this week.*
3. *Select 1 adjective that you feel is the most difficult for you.*

Be sure to add a few sentences explaining each

Week 6:

This week we talked about "flipping our lids" in. math. This can happen in math when we are stressed or have negative experiences.

1. *Describe a time in which you remember "flipping your lid" in a current or past math experience.*
    a. *How did you react?*
    b. *How did that make you feel as a math learner and doer?*
2. *Describe a time that you were able to calm yourself and put your "lid" back on in a math experience.*
    a. *How did you handle this?*
    b. *How did that make you feel as a math learner and doer?*

Week 7

We have done so much work and learned a great deal together so far this semester? This is a good time to complete a general reflection about how you are doing. Please reflect on the semester so far using the following questions as a guide:

1. *What is going well for you?*
2. *What is a challenge for you right now?*
3. *What have you learned about math?*
4. *What have you learned about yourself as a math doer this semester?*
5. *How do you feel about yourself as a math teacher right now?*
6. *What do you need before the end of the semester?*

Week 8

What makes a good math teacher?

1. *There are many skills, abilities, and dispositions that make a teacher a strong teacher. What skills, abilities, and dispositions are specifically necessary for a strong math teacher? Be sure to* ***explain why*** *these are necessary.*

2. *Which of these characteristics do you feel you have grown in the most this summer? Why/How? Give specific examples when possible. What characteristics would you like to continue growing in as you enter into the school year?*

Week 9

Review your Math Identity Survey

1. *Look at sections 2, 3, and 4. Is there anything that has changed or shifted? How/why has that shift occurred?*
2. *Look at section 5. What would you add to your response after this course?*
3. *Describe your math identity (how you feel as a learner and doer of math) now after this course. What are the most significant changes (if any) you have experienced as a math learner and doer? What contributed to these changes?*
4. *Based on our "good math teacher description" what do you want to grow in more?*

Appendix D: Informed Consent

INFORMED CONSENT
TITLE OF RESEARCH STUDY: Exploring Mathematics Identities through Trauma Informed Care

Introduction and Background Information
You are invited to take part in a research study because you are an Urban Teacher Resident enrolled in the Mathematics for Elementary Teachers course. The study is being conducted under the direction of Samantha Morris at the University of Louisville**.**

Taking part in this study is completely voluntary, and you do not have to participate. Take your time to decide.

Why is this study being done?
The purpose of this study is to explore how the mathematics identities of Urban Teacher Residents develop throughout the Mathematics for Elementary Teachers course.

What will happen if I take part in the study?
If you consent to participate, you allow me, the instructor, to use of the documents and assignments including the weekly journal prompts and the Mathematics Identity Investigation completed as part of the Mathematics for Elementary Teachers course. Additionally, you allow me, the instructor, to use of research notes taken throughout the discussions that took place during the course and any additional observations made by the instructor. As part of the study, you may be invited to participate in one 90-minute interview following the completion of the course. This interview will take place either in your school classroom after school hours or on campus in a confidential location. Throughout the course, you were given the opportunity to share to the existent you were comfortable. This will be the same in the interview. If there are any questions you do not wish to answer you may decline the question.

What are the possible risks or discomforts from being in this research study?
Because this study is mostly part of your Mathematics for Teacher Education course, this study has minimal risks. However, the information collected from the course may be personal and could lead to personal or social stressors. Please share only what you are comfortable sharing. Additionally, all information shared will remain confidential throughout the study. If you choose not to participate, your course documents, assignments and discussions will not be used in the data analysis process for this study.

There may be unforeseen risks.

What are the benefits of taking part in the study?

You may or may not benefit personally by participating in this study. The information collected may not benefit you directly; however, the information may be helpful to others.

The possible benefits of this study include enhancing your mathematics identity and informing the instructional practices of the Mathematics for Elementary Teachers course to enhance the experiences of future urban teacher residents. Your participation will not affect your course grade or future grades in the Urban Teacher Residency Program.

Will I be paid?
You will not be paid for your time, inconvenience, or expenses while you are in this study.

How will my information be protected?
The data collected about you will be kept private and secure. Your data will be collected and stored using a pseudonym using a password protected computer. Additionally, your information will be kept anonymous and will not be discussed with other members of the Urban Teacher Residency program, the Urban school district, or the University.

Will my information be used for future research?
Your data will be stored and shared for future research without additional informed consent if identifiable private information, such as your name are removed. If identifying information is removed from your data, the data may be used for future research studies or given to another investigator for future research studies without additional consent from you.

Can I stop participating in the study at any time?
Taking part in this study is completely voluntary. You may choose not to take part at all. If you decide to be in this study, you may change your mind and stop taking part at any time. You will not be penalized or lose any benefits for which you qualify. You will be told about any new information learned during the study that could affect your decision to continue in the study.

Who can I contact for questions, concerns and complaints?
If you have any questions about the research study, please contact Samantha Morris 502-592-6212

If you have concerns or complaints about the research or research staff and you do not wish to give your name, you may call this toll free number: 1-877-852-1167. This is a 24 hour hot line answered by people who do not work at the University of Louisville.

If you have any questions about your rights as a research participant, you may call the Human Subjects Protection Program Office at (502) 852-5188. You may discuss any

questions about your rights as a research participant, in private, with a member of the Institutional Review Board (IRB).

Acknowledgment and Signatures

This document tells you what will happen during the study if you choose to take part. Your signature and date indicate that this study has been explained to you, that your questions have been answered, and that you agree to take part in the study. You are not giving up any legal rights to which you are entitled by signing this informed consent document. You will be given a copy of this consent form to keep for your records.

_____	_____	_____
Printed Name of Participant	Signature of Participant	Date Signed
_____	_____	_____
Printed Name of Person Explaining Consent (PEC)	Signature of PEC (if not an investigator)	Date Signed
_____	_____	_____
Printed Name of Investigator (PI, Sub-I, or Co-I)	Signature of Investigator (PI, Sub-I, or Co-I)	Date Signed

---

Samantha Morris, M.Ed.
1905 S. 1st street Louisville, KY, 40208
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502-592-6212
Site(s) where study is to be conducted: College of Education and Human Development
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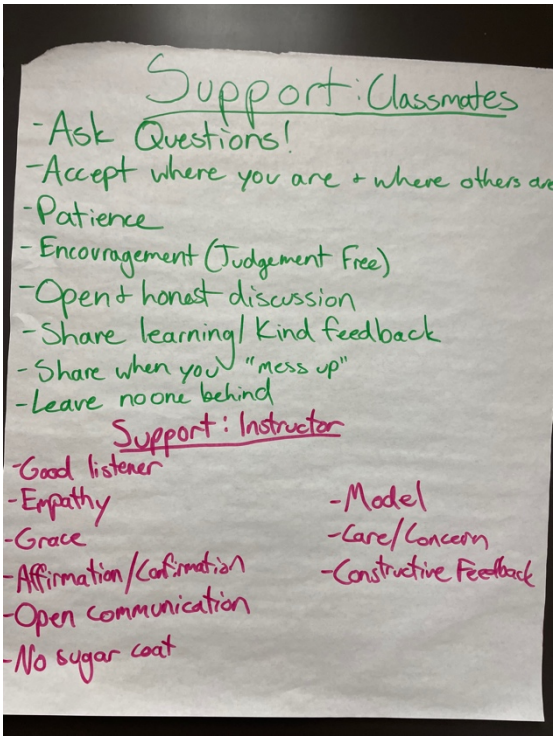
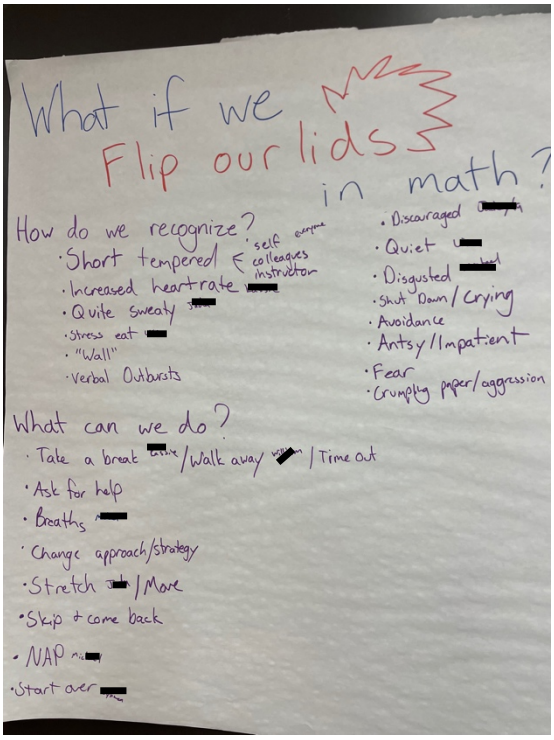
Appendix E: Classroom Posters (Support Poster, "When I Flip my Lid in the Math Classroom")





Appendix F: TIC Practices, Theme, and Data Source Alignment Chart: Participants With Math Trauma

TIC Pillar	Embedded Practices	Theme alignment: Participants With Math Trauma	Data Source Alignment
9. Safety	1. Acknowledging and validating feelings around mathematics (Alvarez, 2017)	*Psychologically Safe Accessible*	e. Research Memos (1-9) f. Math Identity Survey Part III, IV, & V (1) g. Journal Prompts (1, 2, 3, 4, 5, 6, 9) h. Interview (1-8)
	2. Supportive classroom norms (Cole et al., 2005)	*Encouragement, Accessible*	
	3. Table work and professional learning communities (PLCs) (Wolpow et al., 2009)	*Psychologically Safe*	
	4. "Unconditional Positive Regard" (Wolpow et al., 2009)	*Psychologically Safe, Encouragement*	
	5. Multiple ways to present information (Cole et al., 2005)	*Accessible*	
	6. "Islands of Competence" (Cole et al., 2005)	*Accessible*	
	7. Formative feedback on math assignments (Wolpow et al., 2009)	*Psychologically Safe, Encouragement*	
	8. Consistent routine and expectations (Cole et al., 2005)	*Meaningful work, Psychologically Safe, Accessible*	
	9. Relevant and meaningful work (Cole et al., 2005)	*Meaningful Work*	
10. Managing Emotions	1. Identifying traumatic experiences and impacts (Alvarez, 2017)	*Emotional Responses Impact Math Learning*	e. Research Memos (1-7) f. Math Identity Survey Parts I, II, III, & V (1, 2) g. Journal Prompts (1, 2, 3, 6, 7) h. Interview (1-7)
	2. Identifying emotions in the math setting and impacts (Cole et al., 2005)	*Emotional Responses Impact Math Learning, Regulation Strategies*	
	3. Empower students to understand and create their own narrative (Alvarez, 2017)	*Regulation Strategies, Empowered, Motivated by Teaching*	
	4. "Upstairs and Downstairs Brain" lesson (Siegel & Bryson, 2012).	*Regulation Strategies*	
	5. "Flip your Lid" Poster (Siegel & Bryson, 2012)	*Regulation Strategies*	
	6. Help self-regulation when responses are triggered (Alvarez, 2017)	*Regulation Strategies, Empowered*	
	7. Validating responses to journal prompts (Wolpow et al., 2009)	*Empowered*	
11. Connections	1. Recognize the holistic individual shaped by social and cultural experiences (Alvarez, 2017)	*"Instructor knows my story", In This Together*	d. Research memos (1-5) e. Journal Prompts (1-5) f. Interview (1-8)
	2. Build nonacademic relationships (Cole et al., 2005)	*"Instructor knows my story"*	
	3. "Unconditional Positive Regard" (Wolpow et al., 2009)	*"Instructor knows my story"*	
	4. Supportive classroom norms (Cole et al., 2005)	*In This Together,*	

	5. Table work and professional learning communities (PLCs) (Wolpow et al., 2009)	*In This Together, Perspectives for Teaching*	

Appendix G: TIC Practices, Theme, and Data Source Alignment Chart: Participants Without Math Trauma

TIC Pillar	Embedded Practices	Theme alignment: Participants Without Math Trauma	Data Source Alignment
A. Safety	1. Acknowledging and validating feelings around mathematics (Alvarez, 2017)		e. Research Memos (1-9) f. Math Identity Survey Part III, IV, & V (1) g. Journal Prompts (1, 2, 3, 4, 5, 6, 9) h. Interview (1-8)
	2. Supportive classroom norms (Cole et al., 2005)	*Helpful Support*	
	3. Table work and professional learning communities (PLCs) (Wolpow et al., 2009)	*Helpful Support, Built Confidence*	
	4. "Unconditional Positive Regard" (Wolpow et al., 2009)	*Positive Class Environment*	
	5. Multiple ways to present information (Cole et al., 2005)	*Helpful Support*	
	6. "Islands of Competence" (Cole et al. 2005)	*Built Confidence*	
	7. Formative feedback on math assignments (Wolpow et al., 2009)	*Helpful Support, Instructional Trust*	
	8. Consistent routine and expectations (Cole et al., 2005)	*Instructional Trust*	
	9. Relevant and meaningful work (Cole et al., 2005)	*Instructional Trust*	
B. Managing Emotions	1. Identifying traumatic experiences (Alvarez, 2017)		i. Research Memos (1-7) j. Math Identity Survey Parts I, II, III, & V (1, 2) k. Journal Prompts (1, 2, 3, 6, 7) l. Interview (1-7)
	2. Identifying emotions in the math setting and impacts (Cole et al., 2005)	*"My brain can get overwhelmed", Motivation as a Teacher*	
	3. Empower students to understand and create their own narrative (Alvarez, 2017)		
	4. Upstairs and Downstairs Brain lesson (Siegel & Bryson, 2012).	*"I can control my emotions"*	
	5. "Flip your Lid" Poster (Siegel & Bryson, 2012)	*"I can control my emotions"*	
	6. Help self-regulation when responses are triggered (Alvarez, 2017)	*"I can control my emotions"*	
	7. Validating responses to journal prompts (Wolpow et al., 2009)		
C. Connections	1. Recognize the holistic individual shaped by social and cultural experiences (Alvarez, 2017)		6. Research memos (1-5) 7. Journal Prompts (1-5) 8. Interview (1-8)
	2. Build nonacademic relationships (Cole et al., 2005)	*Personalized Instruction, "We spoke the same language"*	
	3. "Unconditional Positive Regard" (Wolpow et al., 2009)	*Personalized Instruction*	

	4. Supportive classroom norms (Cole et al., 2005)	*"We spoke the same language", "We will be together for a year"*	
	5. Table work and professional learning communities (PLCs) (Wolpow et al., 2009)	*"We spoke the same language"*	

Appendix H: Code Book

Participants With Math Trauma

TIC Pillar	Theme	Definition
Safety		Feeling of physical, emotional, and mental, well-being. (Downey, 2007; Morgan et al., 2015)
	Work is Meaningful	Meaningfulness of the work for the purposes of the class and beyond the class.
	Psychologically Safe Environment	Refers to "the belief that you won't be punished or humiliated for speaking up with ideas, questions, concerns, or mistakes". In a classroom, psychological safety can be valued through learning opportunities rather than execution (Edmondson, 1999).
	Encouragement	Encouragement from the instructor and other students with the goal to assure and empower learners in the math classroom.
	Accessible	Allowing and creating access to all students through the work itself. Refers to the course instructor and the class itself acknowledging and responding to the felt needs of students.
Connection		Shared personal connection, empathy, and emotional support of the instructor and peers (Bath, 2008; Cole et al., 2005).
	Perspectives for Teaching	Seeing math content perspectives and personal perspectives of students in the math classroom, valuing these perspectives for future teaching. Refers to helping others and subsequently building confidence/feelings of efficacy.
	In this together	Shared experience and systems of support among residents.
	"Instructor knows my story"	Refers to the instructor getting to know the student personally and being responsive to student math stories.
Managing Emotions		The ability of an individual to identify and regulate their emotions. This includes understanding how their brain reacts to these emotions, and how to begin managing emotions and reactions (Bath, 2008; Siegel & Bryson, 2012).
	Emotional responses impact math learning	Positive and negative emotions can surface while doing math. These emotions impact behavior and learning in math contexts.
	Learning calming strategies	Learning calming strategies can help calm emotions in the math context to reenter the mathematics work.
	Empowered	Positive outcomes when residents became aware of overwhelming math emotions and used calming strategies.
	Motivated by Teaching	Thinking about being a teacher motivated residents to calm down and pursue learning in the math context.

Participants Without Math Trauma

TIC Pillar	Theme	Definition
Safety		Feeling of physical, emotional, and mental, well-being. (Downey, 2007; Morgan et al., 2015)
	Positive Classroom Environment	Meaningfulness of the work for the purposes of the class and beyond the class.
	Instructional Trust	Trust that what was learned was valuable, meaningful, and relevant to the needs of the participants.
	Helpful Support	Support from the instructor and peers that was helpful to address the question or need and move learning forward.
	Built Confidence	Helping and assisting others as well as new math understanding built confidence for current and future work.
Connection		Shared personal connection, empathy, and emotional support of the instructor and peers (Bath, 2008; Cole et al., 2005).
	Personalized Instruction	Instruction built on personal connection, helpful for the specific individual.
	"We spoke the same language"	Shared experience and systems of support among residents.
	"We will be together for a year"	Shared understanding that cohort of residents will be together for the entirety of the program. This prompts connection in and out of the classroom.
Managing Emotions		The ability of an individual to identify and regulate their emotions. This includes understanding how their brain reacts to these emotions, and how to begin managing emotions and reactions (Bath, 2008; Siegel & Bryson, 2012).
	"My brain can get overwhelmed"	Recognition that positive and negative emotions can surface while doing math. These emotions impact behavior and learning in math contexts.
	"I can control my emotions"	Learning calming strategies can help calm emotions in the math context to reenter the mathematics work.
	Motivation as a Teacher	Positive outcomes when residents became aware of overwhelming math emotions and used calming strategies. Thinking about being a teacher motivated residents to calm down and pursue learning in the math context.

CURRICULUM VITAE

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EDUCATION

University of Louisville, Louisville, KY
Ph.D. in Curriculum and Instruction, Mathematics Education 2024
Dissertation: "*Exploring the Mathematics Identities of Urban Teacher Residents Using a Trauma-Informed Care Framework"*
Committee: Dr. Jennifer Bay-Williams (chair), Dr. Katherine Marin (co-chair), Dr. Stefanie Wooten-Burnett, Dr. Maggie McGatha

University of Louisville 2017
M. Ed. in Teacher Leadership with endorsement as Elementary Math Specialist

University of Louisville 2017
Endorsement in English as a Second Language

Georgetown College 2014
B.S. in Elementary Education

TEACHING EXPERIENCE

University of Louisville
Department of Elementary, Middle, and Secondary Teacher Education
Instructor Present
Courses Taught
Elementary Math Methods
Elementary Science and Math Methods (*residency program*)
Mathematics for Elementary Teachers (*residency program)*
Fraction Concepts K-5 (*M. Ed. program*)
Geometry, Measurement, and Data concepts (*M. Ed. program*)
Integrated Teaching and Learning (*alternative certification program)*

Building the Learning Community
Foundations of Instruction
First-Year Experience
Introduction to the Teaching Profession

Jefferson County Public Schools, Kentucky
Elementary Teacher 2014-2019

PUBLICATIONS

Johnson, C. C., **Morris, S**., Bay-Williams, J. M. (2021). Mathematics Identity: Supplemental materials for AMTE Standards for the Preparation of Teachers of Mathematics (SPTM). AMTE. Access at https://amte.net/content/mathematics-identity.

PRESENTATIONS

Woods, D., Johnson, C., Bay-Williams, J**.**, Rupe, K., Cutler, C., & **Morris, S.** (2024, February). *Engaging in inter-institutional research to cultivate positive mathematics identities: Current analysis and next steps* [Conference presentation]. Association Mathematics Teacher Educators (AMTE) Annual Conference, Orlando, FL.

Bay-Williams, J., Johnson, C. C., **Morris, S.**, & Waddell, G. (2022, February). *Focusing teachers on cultivating positive mathematical identities working group.* [Conference presentation]. Association Mathematics Teacher Educators (AMTE) Annual Conference, Las Vegas, NV.

Bay-Williams, J., Johnson, C., & **Morris, S.** (2021, February). *Exploring mathematical identities of emerging and practicing teachers.* [Conference presentation]. Association Mathematics Teacher Educators (AMTE) Annual Conference, Virtual.

Morris, S. D. &Bay-Williams, J. (March 2020). *Finding the Intersection between Trauma-Informed Care and the Math Practices.* [Conference presentation] Kentucky Council of Mathematics. Lexington, KY.

Bay-Williams, J., **Morris, S. D.,** Bennet, S., Barkley, A., **(**March 2020). *Strategic use of games to support basic fact fluency*. [Conference presentation] Kentucky Council of Mathematics. Lexington, KY.

Morris, S. D., (January 2019). *Technology Tools in the Mathematics Classroom.* [Presentation] Greater Louisville Council of Teachers of Mathematics. Louisville, KY.

Morris, S. D., Fellows, G. (June 2018). *Effective feedback in the elementary classroom.* [Conference presentation]. Deeper Learning Symposium. Louisville, KY.

GRANTS & AWARDS

Elementary and Secondary School Emergency Relief Fund Grant 2022
Grant to support first-year teachers

College of Education and Human Development Outstanding Graduate Student 2017

PROFESSIONAL SERVICE (UNIVERSITY OF LOUISVILLE)

Elementary Program Coordinator Present

Urban Teacher Residency/Alternative Certification Present
Instructor, Supervisor, Transcript Reviewer

B. S. Program Advisor Present

Honors and Scholarship Committee Present
Secretary

Community-Engaged Partnership Committee Present

Teaching and Learning Curriculum Committee Present