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Elementary Preservice Math Teachers' Evolving Dispositions Throughout a Math Methods Course: A Mixed Methods Study

Christine E. Hood
University of Denver

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Results show that a four-credit ten-week elementary math methods course statistically significantly decreased EPSTs’ math anxiety, math teaching anxiety, and math teacher self-efficacy. The results for self-efficacy were more nuanced. 11 EPSTs’ self-efficacy results increased, but not at a statistically significant level. Additionally, the qualitative data enhanced the narratives of the positive evolutions of the EPSTs. Results of the self-study, support the claim that the course was taught through a rehumanizing, ambitious and equitable lens. Within this teaching lens, we created four math teacher educator design principles that can be applied and modified for other teacher educators’ courses. These course design principles had an overwhelmingly positive impact on EPSTs and will begin to break the cycle of dehumanization for students in elementary math classrooms.

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Paul Michalec

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Lilian Chimuma

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Christine E. Hood

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Author: Christine E. Hood
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Chapter 1: Introduction

Personal Opening Vignette

I learned mathematics traditionally, with my teachers serving as disseminators of knowledge. I was expected to memorize procedures and regurgitate them exactly as they were taught. There was never a 'why' attached to math instruction; none of the problems felt relevant to my life. Even if I got the 'right answer,' I could rarely, if ever, explain it. Math always felt disconnected from my life. My teachers pushed me out of honors math and science in high school, which I attribute to gendered expectations and the traditional mode of rote pedagogy. Math tests came back with "Why even try?" written on them. My questions in class went unanswered. I was dehumanized.

I reflected on my math journey through an autobiographical assignment in graduate school, while getting my Masters and student teaching, in 2017. The autobiography was meant to bring past math beliefs, experiences, and attitudes to my consciousness. I realized I had deep-rooted math trauma that I needed to address before becoming a middle-school math teacher. In the autobiography, I described worries about my ability to do the math, which I now recognize as low math self-efficacy. I also expressed concerns about teaching mathematical content to students, which I now recognize as math teaching anxiety. Throughout my autobiography, there were instances of math avoidance and formative experiences that led me to believe that I was 'not a math person'. I recognize these narratives as being fraught with math anxiety. I was worried about my ability to do and teach math. I was also worried about how effective I would be as a math teacher.

Much to my surprise, many of my classmates, also studying to become math teachers, disclosed similarly dehumanizing K-12 experiences, lack of confidence, and concern about teaching math in their autobiographies. These issues surrounding math are widespread, going far beyond my circle of peers (Ball, 1990; Bekdemir, 2010). The mathematical experiences I had, alongside many others, rooted in the dominant culture, must be questioned and not perpetuated.

Dehumanizing K-12 experiences follow students all the way into adulthood. These dehumanizing experiences prime preservice teachers to frame math, math education, and future pedagogy through traditional dominant lenses (Battista, 1994; Hadley & Doward, 2011). When teachers have negative mathematical dispositions and teach in traditional ways, their students are more likely to have negative beliefs about math (Brady & Bowd, 2005; Geist, 2010; Vinson, 2001). This cycle of dehumanization and negative mathematical experiences from teachers to students must end.

Initially, I learned how to teach math through my experiences learning math, or what Lortie (1975) calls the apprenticeship of observation. However, as a mathematics teacher, I worked hard to question how I was teaching and what my teaching communicated that I valued in my classroom. Instead of letting my assumptions and cultural beliefs from my K-12 experience control how I taught math, I challenged every notion I once held. Through constant critical reflection, I realized math is political and heavily shaped by race, gender, and dis/ability (Gutiérrez, 2018; Martin, 2006; Yeh et al., 2020). This understanding was forged through critical reflection, coursework, and conversations with my colleagues, students, and their families. I analyzed all of the narratives I was taught, both explicitly and implicitly, and began to develop my version of a math counter narrative. I know now that mathematical proficiency should no longer hold an unequivocal unearned privilege that continues to preserve masculinity, whiteness, meritocracy, and power.

After years of reflection and reading the work of critical scholars, I can confidently say that: mathematics is a political act, a cultural act; it has both "informal" and deeply contextual situations, as well as "formal" school-based situations. Math is not an "arbiter of truth" or a subject "unrelated to emotions or morals." Math is multifaceted, non-hierarchical, and deeply connected to humans, their cultures, and their lived experiences (Gutiérrez, 2013, p. 9). Math is creative, flexible, and fluid (Gutiérrez, 2013).

Over the past three years, I have co-created an elementary mathematics curriculum for a teacher preparation program with my advisor, Dr. Brette Garner. Dr. Brette Garner, will also be referred to as Dr. Brette because that is how students refer to her. Elementary preservice teachers (EPSTs) attend our course worried about their abilities to do and teach math, just like I did as a preservice teacher.

Some detest math and avoid it together — other EPSTs report enjoying math and feeling excited to learn to teach. Throughout the course, many EPSTs disclose their own dehumanizing experiences with math. Many of their experiences come up through an autobiographical assignment like the one I once did as a middle school math preservice teacher.

My experiences as a K-12 learner, a middle school teacher, and now higher education instructor form my deeply personal connection and desire to study the mathematical dispositions of preservice teachers. EPSTs reflected on their experiences, some of which were negative and dehumanizing. Some of these experiences caused anxieties about doing or teaching math, leading to a lack of self-efficacy or math teacher self-efficacy. On the other hand, some of these experiences have built a solid mathematical foundation where EPSTs feel excited, confident, and comfortable doing and teaching math. Some EPSTs' experiences with math teaching and learning were positive and enriching. EPSTs went through a math methods course taught through a rehumanizing, ambitious and equitable math framework. Over the last two years, by the end of the course, EPSTs report that they had rehumanizing experiences and had the opportunity to become more confident in their math abilities and math teaching abilities. Only our students can indicate whether or not the impact of this iteration of this course was rehumanizing, but as the instructors, that was our intent. The less anxieties around doing and teaching math and the more efficacy EPSTs have with doing and teaching math, the better teachers they will be to their students. I want my EPSTs to have positive mathematical dispositions and hopefully to become rehumanizing, ambitious, and equitable math teachers for their students.

Our goal throughout the course was to broaden mathematics for all using a rehumanizing, ambitious, and equitable framework. As an instructor, I gave my EPSTs opportunities to improve their beliefs, perspectives, and identities about doing and teaching math through this I supported shifts in EPSTs' mathematical dispositions. In my future professional practice, I will continue to encourage EPSTs to see math as a complex embodiment that includes rather than excludes (Yeh et al., 2020). I want these EPSTs and all of my future students to know that dis/ability is an asset within mathematics. Blackness is an asset within mathematics. Queerness is an asset within mathematics. Personal and cultural lived experiences are assets within mathematics. I encourage my teacher education students to seek ways of creating mathematical counter narratives and, if necessary, forms of creative insubordination that negotiate "the politics of school reform, language, racism, and testing" (Gutiérrez, 2013, p. 9).

I called out — and continue to call out — white dominance within mathematics (i.e., meritocracy, producerism, ableism, and lack of representation). The EPSTs I teach will be more likely to try to rehumanize mathematics for their students so that math is no longer a "vehicle for the reproduction of existing social structures needed to maintain capitalism" (Yeh et al., 2020, p. 2). EPSTs who have experienced a rehumanizing, ambitious, and equitable math classroom are more likely to implement these practices in their own classroom. The EPSTs attempt to develop a "socio-political consciousness, a sense of agency, and positive social and cultural identities" through their experiences in mathematics in my classroom (Gutstein, 2003, p. 40). Although math is often thought of as neutral and bias-resistant (Gutstein & Peterson, 2005), we align our course with critical scholars who argue that math is a sociopolitical space embedded within social issues that determine the value of knowledge, power, and identity (Gutiérrez, 2013). Learning should be framed as a continuous and ongoing event attached to students' realities; it should be an act of "becoming" through humanization that divests from the current structure of power and domination. Our goal is that our EPSTs grapple with this rehumanizing, ambitious, and equitable version of doing and teaching math.

Overview of Research Topic

EPSTs enter teacher education programs with already formed systems of beliefs and identities surrounding learning and teaching math (Kagan, 1992; Pajares, 1992). Research has shown that many EPSTs' beliefs about mathematics are negative (Battista, 1986; Brown et al., 2012; Bolyard & Valentine, 2017; Bursal & Paznokas, 2006; Dogan-Dunlap et al., 2007; Hadfield & McNeil, 1994; Philippou & Christou, 1998; Trujillo & Hadfield, 1999; Young-Loveridge et al., 2012). As Kaasila and colleagues (2012) state, "at the beginning of the mathematics education course, many preservice teachers' narratives with negative experiences mainly followed the plot used in tragedies" (p. 990). Lee and Zeppelin (2014) disclose that 85% of elementary EPSTs had negative mathematical reflections when asked to draw their experiences with math. Similarly, Rule and Harrell (2006) found that 63% of elementary EPSTs had negative emotions toward math when EPSTs were asked to draw qualitative images about math. Wilson (2015) also conducted a similar study and found that 52% of EPSTs' drawings revealed negative beliefs. These negative prior learning experiences lead to math anxiety (Cornell, 1999; Finlayson, 2014; Harper & Daane, 1998; Karunakaran, 2020; Kelly & Tomhave, 1985; Sloan, 2010), math teaching anxiety (Bates et al., 2013; Levine, 1993), and decreased levels of efficacy around doing and teaching math (Briley, 2012; Brown et al., 2012; Charalambous et al., 2009; Swars, 2005).

EPSTs are not always aware of the effects of their beliefs on teaching math before entering math methods courses (Stuart & Thurlow, 2000). Many of these beliefs and experiences lie in their subconscious until they are prompted to reflect (D'Emidio-Caston, 1993). In previous studies, once ESPTs grappled with their beliefs, they realized they did not want to pass on their counterproductive beliefs about math to their students (D'Emidio-Caston, 1993; Stuart & Thurlow, 2000). Recognition and awareness of emotional responses to math can make space for self-regulation and re-engaging in mathematics (Swanson, 2013). If EPSTs do not get the chance to bring their beliefs to conscious levels, then they will maintain the status quo, which is problematic for teachers and students alike.

Before EPSTs were EPSTs, they were math learners. Many EPSTs have been dehumanized throughout their experiences as learners. Mathematics was presented to them as a fantasy of pure objectivity through facts and numbers. Some of these dehumanizing experiences come from an emphasis on math as a product rather than a process (Furner & Gonzalez-DeHass, 2011), seeing math as a masculine domain and therefore having a gender bias (Alderton, 2020; Beilock et al., 2010; Bowd & Brady, 2003; Bowd & Brady, 2005; Gunderson et al., 2011), and parental pressure or a lack of parental support (Beilock & Maloney, 2015; Finlayson, 2014; Sloan, 2010; Trujillo & Hadfield, 1999). Gutiérrez (2013) explains how power, race, culture, gender, socioeconomics, and identity deeply affect mathematics; therefore, privilege and status affect math learning and teaching. EPSTs' negative past experiences "include tying instruction to the exact procedures in the textbook, timed tests, hostile teacher behavior, embarrassing students in front of peers, only accepting one method of solving a problem, and lack of differentiation based on student needs" (Burton, 2012, p. 2). In Cornell's (1999) study, graduate students reported that they struggled with obscure vocabulary, incomplete instruction, fast pace, rote memorization, math in isolation, drill and kill, and their teachers acting as if math was self-explanatory. EPSTs report many dehumanizing experiences throughout their past mathematical learning.

EPSTs have spent hundreds and hundreds of hours observing math teaching. EPSTs are more likely to add to their past beliefs about the math learning environment than let go of or unlearn their preconceived beliefs (Phillip, 2007). Even if EPSTs are faced with dissonant information in their teacher preparation, they are still likely to hold onto their old perceptions about math teaching and learning (Schanke, 2023).

EPSTs enter their teacher preparation programs with narrow visions of math based on their prior lived experiences (Swars et al., 2006). Because of EPSTs' previous experiences as learners, they typically describe math concepts as unrelated to each other (Grouws, 1996). They also conceptualize math as objective procedures and memorizable rules (Schoenfeld, 1989). Amato (2004) articulates, "without deeper understanding of mathematics STs [student teachers] will probably teach mathematics as a set of disconnected rules and algorithms and disseminate even more negative attitudes to the subject among primary school children" (p. 2-3). These narrow visions of mathematics do not support the creative, connected, and inquiry-based conceptual version of math that fosters students' love of math.

Amirshokoohi and Wisniewski (2018) point out that EPSTs must relearn math to understand the conceptual, abstract, and complex processes because it was not the sort of learning they were used to in K-12. After years of dehumanizing math instruction, EPSTs develop an instrumental view of math rooted in procedure and memorization. But to support their own understandings as math teachers and students' mathematical knowledge, they need to develop a relational view of math, rooted in mathematical flexibility and connection-making among various topics, which goes beyond memorizing procedures (Van de Walle et al., 2016). Teacher education can begin this conceptual mathematical relearning necessary for successful teaching. Instead of one procedural solution path and disconnected mathematical topics, relational views of math encourage teachers and their students to see the connection and the human nature of mathematics.

Experiences as learners also affect the teaching practices that teachers will employ. If EPSTs were taught traditionally, they are likely to teach their students this way (Lambert, 1990; Lortie, 1975; Stipek et al., 2001). Suppose EPSTs' experiences as learners are not identified and processed. In that case, they are likely to teach mathematics in ways that involve lower cognitive demand, drill and kill rote memorization, and rule-based procedural learning (Ball, 1988; Bursal & Paznokas, 2006; Gresham, 2004; Vinson, 2001). These traditional methods dehumanize students. Civil (1992) explained that, despite EPSTs' negative experiences with math, they are still likely to continue the cycle of teaching in the way they were taught because of conformity, comfortability, and not wanting to deal with unknowns. ESPTs' negative feelings surrounding math and their desire to persevere with a pedagogy that they are comfortable with reinforces negative mathematical dispositions. Negative mathematical dispositions fall into two main categories, efficacy and anxiety. Within anxiety, there are two sub-categories: anxiety about doing math and anxiety about teaching math. Within efficacy, there are also two sub-categories: efficacy around doing math and efficacy around teaching it. Anxiety around doing and teaching math brings up feelings of worry, dread, and avoidance. Efficacy around doing and teaching math is related to one's self-confidence in their ability to successfully do or teach math.

Teachers can pass these negative dispositions surrounding mathematics onto their students in various ways (Bekdemir, 2010; Furner et al., 2005; Hembree, 1990; Sloan et al., 1997; Tobias, 1998; Vinson, 2001). Their past negative experiences form their expectations of math teaching, specifically, that teachers' role is to "tell the children what to do" (Civil, 1992, p. 6). Teachers do not want to see their students struggle, be confused, or be frustrated (Civil, 1992). Teachers who harbor negative mathematical beliefs tend to overprotect their students from their negative experiences as learners (Gellert, 2000). Instead of challenging their students to explore and create with mathematics, teachers with negative experiences rely on step-by-step procedures because they think negative experiences will be less likely. In actuality, this makes negative experiences more likely for their students. EPSTs with negative mathematical beliefs tend to have lower expectations for their students (Mizala et al., 2015). Lower expectations of students are related to lower student performance. Negative mathematical attitudes of teachers are also linked to lower student engagement (Fennema et al., 1996). In short, teachers' mathematical dispositions directly impact students through teachers' expectations and pedagogy.

Key Terms

In this study, “mathematical dispositions” refers to individuals’ math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy.

Math anxiety is defined as a context-dependent tension and worry that presents itself when performing mathematical tasks, usually leading to panic and prevention of learning (Morris, 1981; Richardson & Suinn, 1972). People with math anxiety can present the following physical symptoms including sweating, increased heart rate, pale face, nausea, difficulty breathing, and a loss of concentration (Gresham, 2007; Luo et al., 2009). People with math anxiety can also present mental symptoms, including discomfort, low self-esteem, feelings of tension, helplessness, cognitive disorganization, stress, and worry (Hart, 2002). Math teaching anxiety is defined as a context-dependent tension and worry that presents itself when teaching mathematical tasks (Levine, 1993). A teacher who has math teaching anxiety has a fear of their impact on students, including, lesson planning, implementation and student engagement (Bursal & Paznokas, 2006; Gresham, 2009; Levine, 1993; Levine, 1996; Peker, 2009). Math teaching anxiety causes a lack of confidence in pedagogical styles and pedagogical judgements (Bates & colleagues, 2013). In this study, self-efficacy is referred to as a context-dependent belief in one's ability to perform and exercise influence in mathematical problem-solving (Bandura, 1993). Math self-efficacy directly affects behavior, confidence, choices, and performance (Ozben & Kilicoglu, 2021). Math teacher self-efficacy is an individual's belief in their ability to teach math (Enochs et al., 2000; Gresham, 2008, 2017; Swars et al., 2006). Math teacher self-efficacy directly affects behavior, confidence, choices, and performance while teaching (Ozben & Kilicoglu, 2021).

Throughout this study, traditional math is highlighted as a dehumanizing and trauma-laden way to teach math. Dehumanization in this context means that math is taught through ways that limit students' holistic beings in the classroom. Sometimes, this is because certain identities or ways of knowing are privileged. If these identities and ways of knowing are privileged, then they have a position of power within the classroom.

When there are dominant positions, that means that there are positions that are minoritized. Mathematics taught through privileging certain ways of being inherently means that someone is dehumanized.

In traditional pedagogical style, teachers serve as disseminators of knowledge through rote pedagogy (Freire, 1970). The pedagogical method is rooted in memorization and procedural knowledge. In traditional math teaching, math is taught as disconnected answers and has one solution path. In this type of classroom math is seen as falsely 'objective and neutral' (Gutiérrez, 2013). Teachers who teach in this way often have formed negative mathematical dispositions. Teachers 'learn' to teach in traditional ways from informal participation (Gutiérrez, 2013) and the apprenticeship of observation (Lortie, 1975). Since they experienced learning math and watched teachers teach math, they default to their understandings rooted in past experiences. EPSTs naturally begin to teach this way, the way they learned, which perpetuates a cycle of dehumanization, trauma, and negative mathematical dispositions. Traditional math teaching narrows mathematics to 'math people', which limits math to a type of belonging that privileges whiteness and maleness (Gutiérrez, 2013). Math taught through traditional instruction justifies social divisions and borders for access, limiting people who feel othered (e.g., queer people, people of color, and women) (Yeh & Rubel, 2020).

This study will focus on rehumanizing math instruction. This type of instruction flips all of the notions of traditional math on their head and creates a counter narrative to the 'norm'. Instead of the teacher as the disseminator of knowledge, students are the meaning makers and have the 'authority' in the classroom (Gutiérrez, 2018). In this kind of teaching and learning style, math is seen as connected, relational, and creative. Math is also seen as a *deeply* political act that is value-laden, not neutral. Rehumanizing math breaks the cycle of negative mathematical dispositions and creates room for students and teachers to develop a positive disposition towards math. Rehumanizing math broadens math for *all,* especially students who have previously been ‘othered’ by mathematics. It highlights a counter narrative to the traditional notions of privilege, status, and hierarchies that exist in the classroom (Gutiérrez, 2018). Instead of privileging typical ‘math people,’ rehumanizing math privileges students of color, women, and queer folks while building on their funds of knowledge (Gutiérrez, 2018).

Ambitious and equitable math teaching is another pedagogical style that will be employed throughout this study. Ambitious math instruction cultivates both procedural fluency and a deeper conceptual and relational understanding of math (Horn & Garner, 2022). The equitable aspect focuses on the holistic funds of knowledge that students bring to the classroom (Lampert et al., 2011). Ambitious and equitable math is student-centered, so students are a source of authority, legitimacy, power, and knowledge in a classroom. This framework prioritizes mathematical discourse. The discourse should involve authentic, real-world contexts that encourage students to compare their mathematical reasoning with others (Yackel & Cobb, 1996). In ambitious and equitable math, both the students’ and the teachers’ identities directly impact instruction (Boaler, 2002).

Research Problems

To address the problem of negative mathematical dispositions affecting EPSTs' mathematical learning and teaching, which has a direct negative impact on their students, I proposed a study surrounding EPSTs' mathematical disposition in teacher education. I focused on four specific constructs within EPSTs' mathematical dispositions: math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy. All four of these affective pieces make up mathematical disposition. Experiences from K-12 are the antecedent for all constructs within mathematical dispositions. All four of these constructs pose unique problems to EPSTs. Additionally, a fifth problem is the lack of EPSTs content and pedagogical knowledge, which is relevant to all the constructs. EPSTs' responses to math teacher education are shaped by the cumulative effect of prior experiences, which are often but not consistently negative, and include the potential formation of math anxiety (Bekdemir, 2010; Cady & Rearden, 2007), math teaching anxiety (Brown et al., 2012), low self-efficacy (Setra, 2018) or even low teaching self-efficacy (Swars, 2005).

Math anxiety is the construct that sparked this study. I thought math anxiety was the root of my EPSTs' negative mathematical dispositions; I thought the worry and discomfort with doing math made up the bulk of those dispositions.
However, when I began conducting the literature review, I found that math anxiety was only part of the problem: negative dispositions were not just anxiety about doing math

but also about teaching math, which is related to math teaching anxiety. These dispositions were also made up of a lack of confidence in their ability to do and teach math, which are related to math self-efficacy and math teacher self-efficacy. I also thought that self-efficacy was a single construct, but the literature review rebranded efficacy through two lenses: math teacher self-efficacy and math self-efficacy. Math teacher self-efficacy is an EPSTs' report of their perceived ability to teach math. Self-efficacy is an EPSTs' report of their perceived ability to do math. Below, I will summarize what these constructs are and why they are important; I will illuminate the distinctness of these constructs, and I will explain how they are related.

Anxiety

Over the past 65 years, there has been a plethora of research on math anxiety, first coined as "number anxiety" by Dreger and Aiken in 1957. Over a decade later, Richardson and Suinn (1972) created a measurement for math anxiety. They described math anxiety as tension and anxiety that interfere with mathematical problem-solving (Richardson & Suinn, 1972). Fennema and Sherman (1976) expanded this construct to include anger surrounding math. Shelia Tobias (1978) described extreme math anxiety as a feeling that she would never be able to rise above and even equated math anxiety to a sense of sudden death. Morris (1981) continued the research and talked about paralyzation with math and the resulting prevention of learning. Miller and Mitchell (1994) added the idea of panic to the construct. There is no one agreed-upon definition of math anxiety; it is ever-evolving to include new attributes. However, the essence of math anxiety is captured throughout this section.

Math anxiety has also been described as "stable internal attributions of low ability" (Bowd & Brady, 2003, p. 4). These attributions are perceptions of self, not actual decreased ability. Beilock and Maloney (2015) make an important distinction when they say that "math anxiety is not a proxy for low math ability" (p. 5). Though people with low math ability often have anxiety, and vice versa, those with high math ability can also be anxious about the subject. Usually, there are especially intense pressures on students deemed advanced math students because math anxiety in this context can be more closely related to a narrow view of math (e.g., problems having one solution path, math ability conflated with speed and accuracy, etc.). Again, although math ability and math anxiety are related, an EPST having math anxiety does not necessarily mean that they have low mathematical ability.

Math anxiety is a contextual and multi-faceted construct (Brady & Bowd, 2005). As described in the key term section math anxiety can cause physical symptoms, including sweating, increased heart rate, pale face, nausea, difficulty breathing, and a loss of concentration (Gresham, 2007; Luo et al., 2009). Mental symptoms are also a side effect of math anxiety, including discomfort, low self-esteem, feelings of tension, helplessness, cognitive disorganization, stress, and worry (Hart, 2002). Math-anxious students might report some or all of these symptoms depending on the environment that they are in or the task that they are expected to complete; math anxiety is contextual. Taking a standardized test is a different environment than low-stakes practice problems. A classroom that supports students learning from mistakes instead of embarrassing students when they make mistakes are different contexts. The manifestation and level of math anxiety can shift depending on the pedagogical style, stimulus, and level of encouragement. Math anxiety that EPSTs might have experienced in past contexts does not necessarily mean it will manifest in an elementary math methods course. It also does not mean that their level of math anxiety will stay consistent. Throughout the course, there will be different classes covering different topics that might cause EPSTs' math anxiety to manifest differently. Specifically, various topics (e.g., fractions) can cause more anxiety than others.

Math anxiety in EPSTs' can be a cycle. If EPSTs come into teacher education with math anxiety and, therefore, are uncomfortable and unconfident in math, this can negatively affect their ability to learn math and teach math, which negatively affects their students. EPSTs are in a special place to break the cycle of math anxiety and increase student mathematical performance. EPSTs who report more negative mathematical dispositions towards math describe themselves as less prepared to teach math to children (Çaycı, 2011). If math anxiety is left unchecked in EPSTs, then they are likely to teach using traditional methods, which provokes math anxiety in their students (Bursal & Paznokas, 2006; Fennema et al., 1996). Traditional ways of math teaching narrows what math is and who gets dubbed a 'math person' because it is embedded in procedure and memorization instead of inquiry and creativity. An elementary math methods course specifically focused on shifting mathematical dispositions of EPSTs has the potential to break this negative cycle. EPSTs can serve as a source of positive mathematical dispositions where students are more likely to form a positive disposition surrounding math. So, instead of perpetuating a negative cycle of math dispositions, EPSTs can promote a positive cycle.

EPSTs who have anxiety are likely to instill it into their students (Brady & Bowd, 2005; Vinson, 2001). EPSTs with anxiety can develop math avoidance, meaning they spend less time planning and teaching math to their students (Bromme & Brophy, 1986). Pedagogical methods, math anxiety, and decreased time spent on math because of math avoidance directly affect students' attitudes and success in math (Amirshokoohi & Wisniewski, 2018). Math anxiety also intersected with socio-political norms and identity, which have an effect on EPSTs and their future students. Some students don't see themselves as 'math people' because of math's current role in society that perpetuates gendered, racialized, and meritocratic principles. These students who already do not see themselves as 'math people' are more susceptible to forming negative mathematical dispositions (Mizala et al., 2015). The students who are already leaning towards a negative mathematical disposition are more affected by their teachers' dispositions.

Math teaching anxiety is also a part of the larger 'anxiety problem'. It is the least studied of the constructs because it is most recently discovered compared to math anxiety, math self-efficacy, and math teacher self-efficacy. Although Levine initially studied it in 1993, more research by additional authors was not conducted until 13 years later. It is a teacher-specific construct: not everyone teaches, and not all teachers teach math. Math teaching anxiety is different from math anxiety, though they are often closely related. Instead of fear and anxiety about math itself, math teaching anxiety is fear and tension surrounding mathematical instruction (Bursal & Paznokas, 2006; Levine, 1993; Levine, 1996; Peker, 2011). Math teaching anxiety includes anxiety around planning for mathematical lessons and the implementation of the lessons.

When EPSTs have high math teaching anxiety, they are not comfortable teaching math and are often nervous about their teaching abilities. Bates and colleagues (2013) found that 72% of EPSTs reported fears about their negative impact on students in math, which included a lack of confidence in their teaching abilities, a lack of knowledge about teaching methods, and an inability to engage students in math. Similarly, Bosica (2021) found that math teaching anxiety leads EPSTs to believe that they cannot get students to engage in math lessons (Bosica, 2021). Since EPSTs are expected to teach fundamental mathematical principles to students in K-5 mathematics, it is especially consequential to see this effect on students. Math teaching anxiety is especially unique in a preservice setting. Preservice teachers are more likely to have general anxiety around teaching as many of them do not have much experience teaching. This general teaching anxiety increases the likelihood of EPSTs having math teaching anxiety as well.

The discomfort associated with math teaching anxiety often leads to less innovative pedagogical strategies that are not student-centered (Bosica, 2021). Pedagogical strategies informed by teaching anxiety are teacher-centered. When instruction is teacher-centered, it reduces uncertainty, increases step-by-step instruction, and decreases the likelihood that the teacher will have to interpret unexpected student responses or questions. Teacher-centered instruction is cognitively safer, especially for teachers who are anxious about teaching. These types of lessons are often over-planned and leave no room for diversion. Lessons planned through the fraught lens of anxiety are more likely to be scripted down to the sentence. This over-structured environment leads teachers to a sense of control, even if it is a false sense of control. Frequently, these pedagogical styles perpetuate negative mathematical dispositions in students. With more math teaching anxiety and, therefore, more traditional instruction, teachers are unknowingly setting their students up with fewer opportunities to form positive mathematical dispositions and fewer opportunities to be successful math students.

Many EPSTs' math teaching anxiety also develops into math teaching avoidance (Stoehr, 2017a). EPSTs attempt to avoid math by teaching earlier grade levels or subjects that do not contain math (Stoehr, 2017a). Özdemir and Seker (2017) found that third-grade teachers had more math anxiety than fourth-grade teachers, adding to Stoehr's

(2017b) work about math teaching anxiety leading to math avoidance and choosing younger grades. Since some elementary EPSTs choose early elementary education (K-2) to avoid complicated math, it is imperative to see how this affects them and their students (Stoehr, 2017b).

Efficacy

Both mathematics self-efficacy and mathematics teacher self-efficacy are rooted in generalized self-efficacy; therefore, an overview of self-efficacy is essential to understand math teacher self-efficacy entirely. Bandura (1977) conducted foundational research on the topic. Bandura separated self-efficacy into two different factors. The first factor is outcomes, or the belief that behavior will have the intended effect. The second factor is performance or the belief that the individual is confident and capable in their actions. Self-efficacy is an individual's belief in their ability to perform and exercise influence in different aspects of their life (Bandura, 1993). Self-efficacy directly affects behavior, confidence, choices, and performance (Ozben & Kilicoglu, 2021).

Self-efficacy is context-dependent and subject-matter-dependent (Tschannen-Moran & Woolfolk Hoy, 2001). There is a distinction between math self-efficacy, which is an individual's belief in their ability to do or learn math (Briley, 2012; Ünlü & Ertekin, 2013; Zuya et al., 2016), and mathematics teacher self-efficacy, which is an individual's belief in their ability to teach math (Enochs et al., 2000; Gresham, 2008, 2017; Swars et al., 2006). These contexts are different; therefore, EPSTs may have high self-efficacy to do math, but not teach it. Or they may have high self-efficacy to teach math, but not do it. Although efficacy is context and subject-dependent, some scholars found math teacher self-efficacy was positively related to math self-efficacy (Bates et al., 2011; Briley, 2012; Ünlü & Ertekin, 2013).

Anyone can have low math self-efficacy. However, EPSTs with low math self-efficacy can develop low math teacher self-efficacy, directly impacting students. Low math self-efficacy can be the antecedent to math teacher self-efficacy. If EPSTs struggle with math teacher self-efficacy, they are likely to teach using traditional methods, which do not support student success (Sari & Aksoy, 2016; Swars et al., 2006). EPSTs can impose their lower levels of self-efficacy on their students (Chang, 2015; Incikabi, 2013). If EPSTs have low math self-efficacy or low math teacher self-efficacy, it can encourage students to have low efficacy and low confidence surrounding their abilities to do the math. As with math anxiety, EPSTs are in a special place to break the cycle of low self-efficacy in math for their students.

Teacher educators must pay attention to the effects of math teacher self-efficacy, which often has an antecedent of math self-efficacy. How EPSTs feel about their math ability and their math teaching ability impacts how they approach teacher education. It is a teacher educator's responsibility to address all of the efficacy implications.

Subject Matter and Pedagogical Content Knowledge

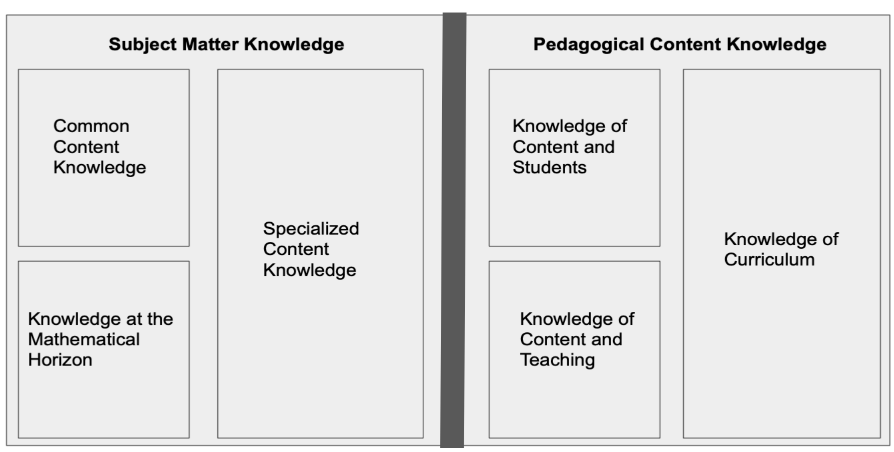
Teacher expertise in pedagogical content knowledge is one of, if not the most, crucial factors in student success (Ball, 1990; Ball et al., 2008; Battista, 1999; Darling-Hammond & Ball, 2004). Teachers need to develop subject matter knowledge to develop a conceptual understanding of all of the mathematics they are expected to teach. This subject matter knowledge is related to math anxiety (Ball, 1990), math self-efficacy (Swars, 2005) math teacher self-efficacy (Liljedahl, 2005), and math teaching anxiety (Bosica, 2021). EPSTs that have deeper subject matter knowledge have lower anxiety and higher efficacy around doing and teaching math.

Math subject matter knowledge affects EPSTs' mathematical dispositions, including math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy. In 1990, Ball found that EPSTs' approaches to the subject of math were shaped by self-confidence. Ball found that one-third of EPSTs reported lacking confidence in math, reported not enjoying math class, and reported thinking that they were bad with math content. ESPTs with low self-confidence were less likely to persist in problem-solving and more likely to approach math tasks procedurally. EPSTs with low self-confidence also had lower levels of efficacy.

Ball (1990) reported fragmented, memorized, and rule-based understandings of subject matter knowledge in both elementary and secondary preservice teachers. These understandings were unattached to any relational or connected understanding of mathematics. Ball (1990) also looked at math specialists who were going to teach secondary math; there was a sharp contrast between elementary and secondary preservice teachers: secondary preservice teachers all reported confidence, enjoyment, and being good at math. EPSTs reported much lower confidence and enjoyment of math. Ball argues that EPSTs' lower self-esteem in math is partially because of their lack of conceptual subject matter knowledge. EPSTs had a more pronounced lack of subject matter knowledge than secondary math preservice teachers.

Just as necessary as subject-matter knowledge to do math is pedagogical content knowledge to teach math (Ball et al., 2008; Gudmundsdottir & Shulman, 1987). Much of this knowledge is not typically used outside of educational settings. In teacher education, we have to build all these types of expertise throughout our courses.

Figure 1
Mathematical Knowledges



Note. The figure above is an adapted diagram from Ball et al., 2008. It shows specific mathematical knowledge divided into subject matter knowledge and pedagogical content knowledge.

Common Content (Math) Knowledge is basic skills adults possess about math, including basic operations (multiplication, division, subtraction, addition), counting, using fractions (e.g., for cooking), and budgeting. Specialized Content (Math) Knowledge is something adults who specialize in math know (e.g., scientists, accountants, etc.). Knowledge at the mathematical horizon is how different mathematical ideas are connected and related (e.g., operations with whole numbers are the foundation for operations with fractions and decimals). This type of knowledge is the end of the diagram's subject matter side (left) (see Figure 1).

Next, we move on to the pedagogical content knowledge (see Figure 1). Knowledge of content (math) and students in understanding how students will interact, understand and misunderstand topics. This includes potential student misconceptions within a particular lesson or topic — like students not understanding a common denominator. This is also relevant to learning progressions and trajectories — especially the developmental sequence and readiness. If a student did not understand something about a previous aspect of mathematics, then they might have certain misconceptions. Knowledge of content (math) and teaching is understanding *why* different procedures work and explaining *how* to do it. Teachers with this knowledge can ask certain questions to get at students' understanding and support their learning. They can choose certain representations and know what they help illustrate and their limitations. This level of knowledge includes timing (e.g., understanding how long activities might take for students to get through). Knowledge of (math) curriculum is flexibility in understanding vertical alignment and scope and sequence. The scope and sequence can be broken into units, including summative assessments and performance tasks. It can be broken down further into lessons, including formative assessment. Lastly, the smallest piece of a scope and sequence would be the components of a lesson, including any tasks, assignments, technologies, or manipulatives. Knowledge of the curriculum is essential to understanding how to plan learning experiences for students.

The knowledge required to teach math is not just about subject matter knowledge or pedagogical knowledge; it is a hybrid of all the above mathematical contexts. All of these mathematical contexts are relevant to EPSTs' mathematical dispositions. Their sense of confidence or anxiety with doing or teaching math can be rooted in any of these types of mathematical knowledge.

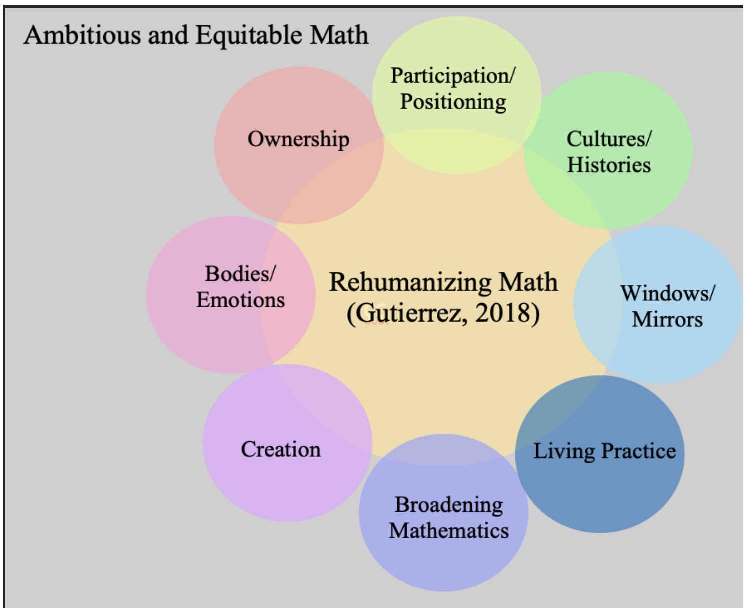
Pedagogical strategies EPSTs employ for elementary and middle school math are directly affected by their content knowledge (Ball, 1990). Some ESPTs report a lack of conceptual understanding of math and rely on procedural methods, such as rote memorization and algorithms, to teach students (Ball et al., 2005; Newton et al., 2012). Math anxiety, low math self- efficacy, low math teacher self-efficacy, math teaching anxiety, and a lack of content knowledge typically result in traditional pedagogical strategies. As previously expressed, these pedagogical strategies negatively affect student performance and student mathematical dispositions.

Ball and colleagues (2008) state that teacher education programs tend to be abstract and disconnected from the authentic practice of teaching. The better understandings that EPSTs can form about the relationship between pedagogy and content, the more effective they will be in their classroom (Amato, 2004). Teacher educators must reflect on the role that both subject matter knowledge and pedagogical content knowledge play in EPSTs' mathematical dispositions. Teacher educators must also bridge the pedagogy, context, theory, and practice of teaching. Furthermore, teacher educators should employ pedagogical strategies to increase these types of knowledge. EPSTs should have the opportunity to explore math through all of these knowledge dimensions by discussing it, developing habits of mind, and building sense-making (Auslander et al., 2016). Addressing the problem of EPSTs' mathematical disposition cannot be done unless the problem of subject matter knowledge and pedagogical content knowledge is also addressed.

Conceptual Framework

In response to the posed problems, teacher education has a responsibility to preservice teachers to increase their subject-matter knowledge, pedagogical content knowledge, and mathematical dispositions. The best way to tend to all of these needs is for teacher educators to attend to both affect and knowledge by teaching through rehumanizing, ambitious, and equitable math teaching frameworks. I approach my dissertation, classroom, and, most importantly, my students through this framework.

Figure 2
Conceptual Framework



Note. This figure illustrates my conceptual framework for this study and the course I will be studying and co-teaching. The gray background is the setting of ambitious and equitable math instruction. Ambitious and equitable math attends to mainly the subject matter and the pedagogical content knowledge with some affective additions. Rehumanizing math attends to the EPSTs' affect (i.e., mathematical dispositions) while attaching the utmost importance to mathematics. Both of these frameworks, in tandem, are stronger than they are alone.

Ambitious and Equitable Math

Ambitious math instruction cultivates both procedural fluency and a deeper conceptual understanding of math (Horn & Garner, 2022). Horn and Garner (2022) specifically emphasize all students' learning, "with a particular attention to those that have been underserved in schools", which is where the focus on equity comes in (p. xii).

Lampert and colleagues (2011) define ambitious teaching as a pedagogical framework that employs authentic problems in the mathematical domain. Ambitious and equitable teaching uses all students' holistic funds of knowledge, unlike traditional teaching, which only uses some students' funds of knowledge, the ones that fit the dominant narrative of success (Horn & Garner, 2022). Ambitious and equitable math teaching vastly differs from traditional math. This framework prioritizes a deep conceptual and relational understanding, while traditional math prioritizes procedural knowledge. Math taught in a traditional way is presented through fragmented concepts and lessons instead of being framed as a tapestry of integrated and comprehensive knowledge. Ambitious and equitable math is supported by the National Council of Teachers of Mathematics (NCTM, 2014).

Ambitious math prioritizes a connection among mathematical knowledge rather than rote memorization of procedures, which increases deeper mathematical understanding. Ambitious and equitable math is student-centered. Focused on equity, students are a source of authority, legitimacy, power, and knowledge in a classroom. Students are encouraged to be creative and develop their ways of doing mathematics. Ambitious and equitable math calls for authentic, real-world contexts. Students should be prompted to participate in genuine discourse with others. This discourse should encourage students to compare their mathematical reasoning with others (Yackel & Cobb, 1996). Ambitious and equitable math encourages students to challenge procedural assumptions of one single solution path through mathematical discourse. Yackel and Cobb (1996) solidified the importance of building mathematical norms in classrooms that support students' learning.

In this conceptual framework, ambitious and equitable instruction is understood through productive struggle, interpreting the relationship between mathematical and real-world contexts (Boaler, 2002). The framework encourages math instruction to move beyond the abstract into more concrete applications of mathematics, which can differ depending on students' lived experiences (Boaler, 2002). So, students who identify with particular social, cultural, gender, or linguistic groups often have different genuine mathematical applications. Ambitious and equitable math framework positions identity as directly impacting math and therefore math instruction (Boaler, 2002). Math is contextualized through lived experience, which promotes deeper learning in comparison to traditional math, which is more surface-level learning relying on the idea that objectivity drives math. Ambitious and equitable math is in many ways the opposite of traditional instruction. Ambitious and equitable math focuses on students' lived experiences and mathematical learning in deeply contextual and relational ways.

Rehumanizing Math

Rochelle Gutiérrez presented rehumanizing math in 2018. Rehumanizing math respects the fact that math has been taught in humanizing ways for eons in some spaces and cultures, which is why the prefix *re-* is included. Gutiérrez points out that rehumanizing is a verb and, therefore, a process. It "requires constant vigilance to maintain and evolve with contexts" (Gutiérrez, 2018, p. 3). No educator can claim that they are implementing rehumanizing mathematics without "obtaining recurring evidence from their students" (Gutiérrez, 2018, p. 4).

Gutiérrez explained a need for math to support all students' cultural and linguistic resources while participating in math. In her previous work, she posited that "knowledge and power are inextricably linked" (Gutiérrez, 2010/2013, as cited in Gutiérrez, 2018, p. 2). She explained that "what counts as knowledge, how we come to 'know' things, and who is privileged in the process are all part and parcel of issues of power" (p. 2). If we attempt to change learning and teaching math without attending to sociopolitical aspects of the subject, we are unlikely to produce any real change in the inequity of lived experiences in math. To bring about lasting change in math, we have to "focus on those who the system had most failed" (p. 2). Rehumanizing math, this framework, and this math methods course takes an ardent and explicit approach to students bringing their embodied selves into mathematics, which in turn attends to the sociopolitical aspects of self in relation to mathematics.

Currently, traditional math in K-12 convinces many students that they are 'not math people' and dehumanizes them. Throughout her experience in education, Gutiérrez asked students and teachers what feels dehumanizing in a math learning environment.

Their answers focused on tracking and standardized evaluation that “do not honor complexity, context, of an individual's own goals, rule following, speed, and the false neutrality and separation of math from morality and ethics" (Gutiérrez, 2018, p. 3). Gutiérrez explains that over 13 years of compulsory math education can create slow violence (Nixon, 2011, as cited in Gutiérrez, 2018). This is akin to the idea of death by a million paper cuts. One paper cut might feel small, inconsequential, or even harmless, but the repeated act of receiving paper cuts creates a wildly harmful and significant impact.

My rationale for embarking on this study is to convince EPSTs' that anyone can be 'a math person.' Instead of permitting math to stay 'objective and neutral' falsely, teacher educators must dispel this myth by exposing the current structure of math for supporting an agenda of white supremacist capitalist patriarchy and settler colonialism (Gutiérrez, 2018; Leyva, 2017; Martin, 2008). Instead of perpetuating a version of math that actively minoritizes students through the dominant narrative in math classrooms, I sought to highlight counternarratives and support all students’ funds of knowledge as they become ‘math people’.

Each person experiences rehumanization differently; it is not a universal experience. These aspects highlight a typical narrative of math and a counternarrative (see Figure 2). EPSTs are *positioned and invited to participate* as meaning makers, decreasing status and hierarchies in the classroom and shifting authority from the instructor onto the EPSTs. *Cultures and histories* encourage students to reconnect with their personal and ancestral histories while privileging students of color, women, and queer folks who are not typically privileged in a math space. This counter narrative builds on all students' unique funds of knowledge. EPSTs should see themselves in the curriculum through *mirrors*. With *windows*, EPSTs foster an appreciation of others through respect and dignity. Rehumanizing math encourages EPSTs to see math as a *living practice* through divergent answers, rule breaking, and debates. Decentering algebra, number sense, symbols, and generalizability *broadens mathematics*. If math is broadened, EPSTs can see math more qualitatively in a deeper conceptual, relational, and connected way. *Creation* encourages EPSTs to seek new forms of math instead of reproducing what has already come before. This counter narrative encourages EPSTs to invent new algorithms and new ways of naming and seeing patterns. In tandem with broadening mathematics, creation fights the myth of math as stagnant and memorizable. In rehumanizing math, *bodies and emotions* are prioritized. This counter narrative highlights all parts of self (e.g., voice, vision, touch, intuition) being involved in math. These aspects of sense are relevant to genuine and authentic real-world problems. EPSTs should take ownership over math as something they do for themselves, not just to play the game of school. An overarching goal of rehumanizing math is to make math useful and joyful.

The idea of rehumanizing math is an ongoing process; it is always partial and in-progress, never completed (Gutiérrez, 2018). As the instructor, I can only try to implement a rehumanizing framework. It will be up to my students to affirm whether they were rehumanized at every step of the way.

Ambitious, Equitable, and Rehumanizing Math in this Context.

I apply ambitious and equitable math teaching and all of the rehumanizing math principles in my classroom. Both of these frameworks could stand alone as powerful tools. They are also both related, but sustain each other in their individuality. Ambitious and equitable math prioritizes the conceptual content and pedagogical knowledge that EPSTs can gain to increase their mathematical dispositions while inspiring sociopolitical-contextualized mathematics. In comparison, rehumanizing math prioritizes dismantling the dominant narrative while inspiring complex math knowledge. Rehumanizing math relates to ambitious and equitable mathematics because it broadens the notion of math and math teaching to include multiple solution paths and values students' cultures and personal histories through a much more conceptual version of math.

I expect the EPSTs to use these frameworks to teach their students in their placements and well into the future. Dr. Brette and I consistently asked the EPSTs to reflect on what was rehumanizing or dehumanizing to ensure that we are implementing rehumanizing pedagogy in tandem with ambitious and equitable math. EPSTs are required to reflect on how they could implement these practices in their classrooms throughout the course. Organizing the course using this framework supports EPSTs' mathematical dispositions in multiple ways. It welcomes vulnerability and prior negative experiences or celebrates positive ones. It creates a safe space to explore and learn mathematics content and pedagogy. As the instructor, I advocate for empathy, community, and growth. Using rehumanizing math challenges how math is traditionally done and learned, which opens up new possibilities.

Purpose of Study

In this study, I analyzed EPSTs' mathematical dispositions surrounding math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy before and after a graduate-level elementary math methods course taught using a rehumanizing framework.

To address this, my research questions are:

Research Question 1(RQ1): What are EPSTs mathematical dispositions before taking their math methods course taught through a rehumanizing, ambitious and equitable framework?

Research Question 2 (RQ2): How do EPSTs mathematical dispositions evolve throughout their math methods course taught through a rehumanizing, ambitious and equitable framework?

Research Question 3 (RQ3): Through a self-study lens, how do the instructors iterate their practice from weeks 1-10 to implement ambitious and equitable and rehumanizing mathematics?

Research Design and Methodology Overview

I conducted this study in my classroom with elementary teacher education students. I fulfilled the role of co-instructor and led as a co-researcher. This study's main lens is phenomenology and self-study of teacher education. The phenomenon I looked at is EPSTs' lived experiences and mathematical dispositions throughout a graduate elementary math methods course. My dissertation is primarily qualitative, with supplemental pre/post quantitative analyses. Integrating qualitative and quantitative data for triangulation tells a more powerful story than either of them could tell on their own. I collected data through a mixed methods, researcher-as-practitioner approach. These data were analyzed using emergent thematic analysis with the additional quantitative paired samples t-test.

Chapter 2: Review of the Literature

Review of Literature Purpose

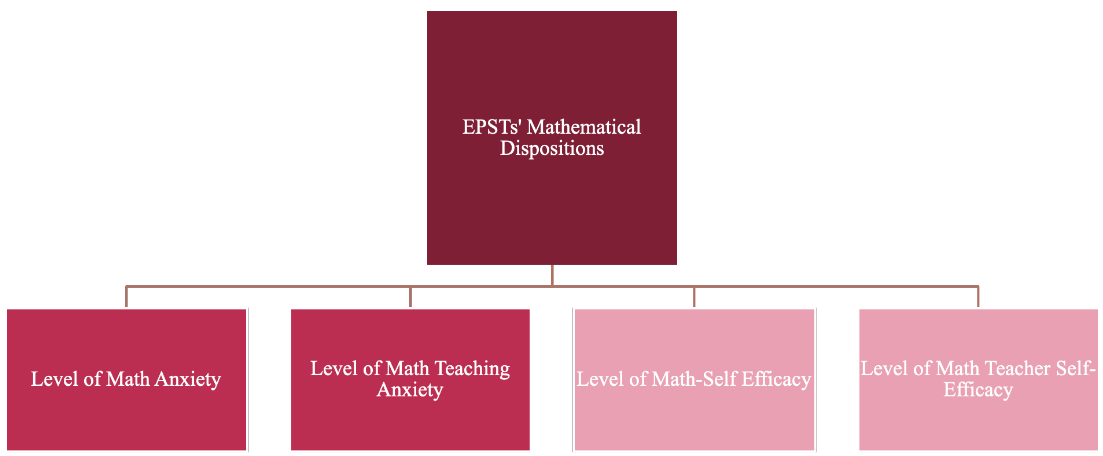
This literature review aimed to understand math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy related to EPSTs. Specifically, I wanted to see how scholars operationalize these constructs. The literature review also helped me iterate my research questions for my study. Lastly, the literature review helped me understand the gap in current research. Below, I detail my literature review method. Then, I identify the results within the literature. In conclusion, I create practical design principles for math teacher educators to pose solutions to the problems.

Literature Review Conceptual Framework

I created a conceptual framework that guided the subsequent literature review. This framework is called mathematical dispositions (see Figure 3 below). This framework includes the aspects of EPSTs' mathematical dispositions in this literature review: math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy. The overarching idea is that mathematical disposition is affected by EPSTs' level of anxiety around doing math, anxiety around teaching math, how confident they feel about their ability to do math, and how confident they feel about their teaching abilities.

This conceptual framework does not denote the direction or magnitude of impact that any aspects have on each other or the overarching concept of mathematical disposition because the relationships between these constructs are complex. There is not one definitive relationship, directionality, or power that creates mathematical disposition. It is context-dependent and EPST-dependent. The all-encompassing 'mathematical disposition' includes math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy.

Figure 3
Literature Review Conceptual Framework



Literature Review Search Procedures

I included sources if they met the following criteria:

1. The author(s) wrote the study in English.
2. The author(s) examined elementary preservice teachers in any country and year.

3. The author(s) examined generalists, not mathematics specialists. Generalists are seeking K-6 certifications across all subject areas. Specialists are only certified in math.
4. The author(s) included teacher attitudes, beliefs, efficacy, self-concept, identity, math anxiety, math teaching anxiety, confidence, or math avoidance.
5. The author(s) used systematic review, quantitative, mixed, or qualitative methodologies.

I excluded sources if they met the following criteria:

1. The author(s) looked at in-service teachers. I am only focused on EPSTs.
2. The author(s) studied secondary preservice teachers or programs that trained teachers to be math specialists. I am only focused on elementary generalists.
3. The author(s) included science or STEM in the study; I am not focused on science or STEM.
4. The author(s) focused only on fieldwork with EPSTs. I am interested in coursework; if the study had fieldwork as a component, it was accepted, but if it was the sole focus, it was excluded.
5. The author(s) focused exclusively on EPSTs' content knowledge. Again, this can be a component of math disposition, but not the sole focus of the study.
6. The author(s) focused only on special education preservice teachers, as those are specialists.

Electronic Database Search

I originally searched both PsycINFO and ERIC on 2/16/22. I searched both of these databases again on 2/28/23. The following were my search terms: ("teacher" OR "educator") AND ("elementary" OR "middle school" OR "K-8" OR "K-6" OR "primary school" OR "junior high") AND ("Math" or "Mathematics") AND ("anxiety" OR "teaching anxiety" OR "teacher efficacy" OR "self-efficacy" OR "efficacy" OR "self-esteem" OR "self esteem" OR "math avoidance" OR "teacher attitudes" OR "attitude change") AND ("preservice teacher education" OR "teacher education" OR "teacher preparation" OR "teacher educator" OR "higher education" OR "methods" OR "methods courses" OR "methods instruction").

I used Zotero to facilitate organization. When searching these terms in PsycInfo, I got 744 results. I read the abstracts and titles for all 744. After combing through these results with my inclusion and exclusion criteria, I paired it down to 122 articles. When searching these terms in ERIC, I got 2,860 results. Again, I read the abstracts and the titles for all 2,860. Once I narrowed ERIC down using my inclusion and exclusion criteria, I pared it down to 437. Next, I combined the PsycInfo and ERIC sources; during this step, I deleted duplicate entries and had the list down to 519. I checked the abstracts and titles to double-check that the papers were relevant. After thoroughly reading all 203 articles, 133 were relevant to my study. For a graphic representation, see Appendix B. In the additional search a little over a year later, I found one peer reviewed article and two dissertations that were relevant. All three of these sources provided up-to-date information on the field of mathematical disposition and were added to this study.

Hand Search

I looked at all the originally pulled sources from the systematic review and I looked at who they were citing. I looked at where those citations were published. I made a list of what journals the citations from the original database (ERIC and PsycInfo) came from. I totaled how many relevant readings came from each journal. I then picked the top three journals with the most sources (see Appendix A). *School Science and Mathematics* had eight sources and had the highest sources among the journals. Issues in the *Undergraduate Mathematics Preparation of School Teachers* was second with six. *Journal of Mathematics Teacher Education* was third with three. A fourth journal was tied for third but focused on Australia, so Mathematics Teacher Education won the tie. In *School Science and Mathematics*, I reviewed 95 entries from the past three years; none fit my inclusion criteria. I reviewed 137 from issues in the *Undergraduate Mathematics Preparation of School Teachers* in the last three years. I decided to look at a single article from this additional hand search. It was a review of research in mathematical content courses. Although I am not explicitly studying a content course, my course includes content. So, I wanted to ensure that there was no additional information I might have missed in Hart and colleagues' (2018) review. Lastly, I looked at the *Journal of Mathematics Teacher Education*. I reviewed 20 results. Only one was relevant; it was a duplicate.

Ancestral Search

My literature review pulled four systematic analyses on math anxiety. I reviewed them and found ten additional readings. Since only one of the five systematic reviews included efficacy, not teacher efficacy, and none included math teaching anxiety, I focused on the dissertations relevant to all three constructs. I conducted a backwards search by scanning who they cited in their reference lists and read those abstracts. Once I narrowed those citations down to what was pertinent to my study, I read 53 additional articles in this process. This entire process brought an additional 53 relevant readings to my attention. From all three search methods, I thoroughly read 190 readings (133 from database, one from hand, 53 from ancestral, and three from the additional search a year later).

Results of the Literature Review

In this section, I will describe the results of my systematic literature review. I will discuss anxiety, both math anxiety and math teaching anxiety. I will also examine efficacy, both self-efficacy and math teacher self-efficacy. Also, I will explain the literature surrounding how to reduce anxieties and how to increase efficacies.

Anxiety

I discuss both math anxiety and math teaching anxiety throughout this section. Scholars have conducted much more research on math anxiety than on math teaching anxiety. I hypothesize that this is because math teaching anxiety is a construct that Levine (1993) developed more recently than Dreiger and Aiken (1957). First, I will explain the difference between math anxiety and math teaching anxiety. Then, I will discuss the potential causes of anxiety, mainly rooted in math anxiety literature but likely relevant to math teaching anxiety. Third, I will elaborate on the effect both types of anxiety have on instruction. Lastly, I will note strategies to reduce anxiety, rooted in mainly math anxiety literature but also likely highly relevant to math teaching anxiety.

Levine (1993) found math teaching anxiety to be a separate construct from math anxiety. He studied 28 EPSTs before and after a math methods course and found a reduction in math teaching anxiety. Levine's study was quantitative, which could have been more robust with a qualitative component. EPSTs' past experiences were the most significant predictor of their anticipated future pedagogical style. EPSTs’ anxiety about teaching was a distinct construct from math anxiety (about doing and learning math) and made EPSTs more likely to teach in a traditional procedural style. ESPTs who were anxious about teaching math felt safer with a step-by-step process and therefore were more comfortable teaching step-by-step. Those anxious EPSTs equated procedure with control. They tried to avoid questions or confusion in the classroom. This illustrates how math teaching anxiety leads math teachers to be more teacher-centered and less exploratory, which is not supportive for students.

EPSTs felt that some of the causes of their math anxiety were a lack of self-confidence, fear of failure, past experienced pedagogical styles, their own ineffective learning practices, and past teachers' non-engagement of students (Finlayson, 2014). These EPSTs noted their symptoms of math anxiety were both physical and mental. Physically, they experienced a racing heart, irregular breathing, sweatiness, shakiness, and nausea. Mentally, they noted a feeling of helplessness, lack of confidence, and nervousness, which manifested in frustration, confusion, shutting down, and stopping listening. When EPSTs understand where their anxiety comes from and what symptoms they display because of their math anxiety, it empowers them to reflect and potentially change their disposition.

According to Bates and colleagues (2013), math teaching anxiety is rooted in limited content knowledge and a lack of higher-order conceptual understanding. Vinson (2001) studied the content knowledge of EPSTs and found that they had moderate procedural knowledge and very low conceptual knowledge, which affected their beliefs in their ability to teach math. EPSTs who had low conceptual knowledge were more anxious about teaching and explaining mathematical concepts to students. Since content knowledge is related to math teaching anxiety, it is vital to consider how teacher education plays a role in increasing access to content knowledge. However, I believe that math teaching anxiety is more complex than just a lack of content knowledge. Math teaching anxiety is also rooted in personality type, experience teaching, and comfortability with teaching math, etc. An EPST can still have math teaching anxiety, even if they have a strong mathematical content background.

An additional potential cause of math teaching anxiety was pedagogical strategies; if EPSTs were taught one way and expected to teach differently, it caused tension and cognitive dissonance (Althauser, 2018; Bosica, 2021). ESPTs must leave the comfort of how they were taught to relearn a new, more complex way of doing and teaching mathematics. There is an additional layer of tension between how EPSTs are encouraged to teach in their preparation programs, usually rooted in a constructivist view of learning, and how they observe teaching in their school placements, which often promote a more traditional view of learning (Cochran-Smith et al., 2015). Beyond mere observation, many of their placement schools expect teachers to follow the curriculum, which often does not allow for mathematical exploration. For EPSTs, both the tension of teaching differently than they learned and reconciling the differences between their teacher education programs' conceptual approach and the practical application at their placements generates additional math teaching anxiety.

Bosica (2021), who studied math teaching anxiety, claimed that it was an overlooked construct. He also explained that we, as teacher educators, get a much clearer picture of mathematical dispositions when math teaching anxiety is included as a separate construct. To better understand EPSTs' math teaching anxiety and the sources of that anxiety, teacher educators need to present EPSTs with the opportunity to reflect on why they are anxious about teaching, where it might come from, and how they might reduce this type of anxiety.

Math anxiety affects EPSTs' mathematical performance on all levels of mathematical tasks (e.g., tests, projects, practice problems, and group work) (Ashcraft, 2002; Bosica, 2021). Ashcraft (2002) analyzed the connection between working memory and math anxiety. Intrusive anxious thoughts — e.g., *I can't do this*, *I am not fast enough*, or *I don't know where to start* — diminish one's working memory, which leads to less available working memory to apply to mathematics, then leading to more anxiety and poor results on mathematical tasks; this creates a negative loop. The connections between math anxiety and working memory are often directly linked to math test anxiety, a smaller sub-construct within the larger construct of math anxiety (Hembree, 1990).

Math avoidance is another potential reason math anxiety affects performance (Ashcraft, 2002). People avoid continuing to take mathematical courses because of their math anxiety and therefore have fewer opportunities to learn the content. EPSTs who have math anxiety are likely to have lower mathematical performance in math classes. Many math anxiety scholars expect EPSTs to struggle on standardized mathematical tests. These things are relevant to teacher education programs because ESPTs must take math courses and standardized licensing exams. Teacher educators must recognize the impact of math anxiety on EPSTs' mathematical performances in their teacher education programs.

Past experiences rooted in a contextualized environment, including mathematical societal norms, are a primary factor in math anxiety among EPSTs (Karunakaran, 2020; Trujillo & Hadfield, 1999). Experiences with either their teacher or their teacher's pedagogical style can promote anxiety, from fast-paced content coverage and emphasis on procedural skills or rote memorization (Cornell, 1999; Finlayson, 2014), emphasizing right answers (Harper & Daane, 1998; Kelly & Tomhave, 1985), a lack of clarity on conceptual aspects of math or vocabulary (Cornell, 1999; Sloan, 2010), authority rested with the teacher (Finlayson, 2014), teachers were dismissive or rude (Cornell, 1999), cold calling (Finlayson, 2014; Kelly & Tomhave, 1985), competition (Finlayson, 2014), timed tests (Finlayson, 2014; Harper & Daane, 1998), only accepting one solution path (Kelly & Tomhave, 1985) and little to no connection between math and real life (Cornell, 1999). Negative experiences rooted in race (e.g. model minority myth), gender (e.g. math as a masculine space), multilingual backgrounds (e.g. devaluing different linguistic funds of knowledge in the classroom), and socioeconomic status (e.g. students who are not in the middle or upper middle class not being as good at math as their higher-class counterparts) impact society, the view of mathematics, and students' experiences in the math classroom. Such adverse experiences lead EPSTs to have a negative disposition towards math. The more of these negative environmental experiences that elementary EPSTs have had, the more likely they have a higher level of anxiety (Bekdemir, 2010). The higher level of anxiety, the more repair needs to be done in teacher education with EPSTs. A teacher education course taught through a rehumanizing and ambitious math framework would present EPSTs with a version of math teaching and learning that is vastly different from the version that they experienced in school (i.e., an emphasis on conceptual understanding, a shared authority, a teacher who encourages mistakes, an equitable learning environment, and deep connections to real-life).

Math anxiety is common for EPSTs; indeed, it is more common compared to other college students and other grade levels of preservice teachers (Bursal & Paznokas, 2006; Cady & Rearden, 2007; Gresham, 2007; Gresham, 2010; Harper & Daane, 1998; Hembree, 1990; Kelly & Tomhave, 1985; Liljedahl, 2005; Vinson, 2001). Through EPSTs' reflective writing about math, Cady and Reardon (2007) found an overwhelming theme of a deep-rooted fear and perceived inadequacy in most EPSTs, pointing to pervasive math anxiety. While Cady and Reardon found that most EPSTs have worries about math, other authors found fewer math anxious EPSTs. Bursal and Paznokas (2006) found about 30% of the EPSTs in their study had high, 30% had moderate, and 30% had low math anxiety — math anxiety was evenly distributed across all levels. Even if only termed moderate, 60% of EPSTs had math anxiety. Gonzalez-DeHass and colleagues (2017) argued that EPSTs are particularly at risk for math anxiety compared to other college majors because EPSTs are forced to face mathematics. To be an elementary educator EPSTs have to learn math and how to teach it; it's required. In contrast, other majors in college have the option to avoid math. Often, EPSTs will spend less time on math than secondary preservice teachers might.

High math anxiety among EPSTs is a cause for concern because math anxiety in teachers fosters math anxiety in students. If students are more math-anxious, they are more likely to perform poorly on mathematical tasks. EPSTs want their students to perform up to their abilities and form positive mathematical dispositions, which is harder to do with disproportionately high math anxiety.

Effects on Instruction.

Math anxiety affects EPSTs' pedagogical styles. Hadley and Dorward (2011) and Sari and Aksoy (2016) found an inverse relationship between math anxiety and pedagogical style. This means that EPSTs will tend to use more traditional pedagogical styles if they have higher math anxiety and if they have low math anxiety, they are more willing to innovate with student-centered approaches such as inquiry and problem-based pedagogical strategies. Schmidt and Buchmann (1983) found that confident math teachers, or math teachers without math anxiety, spend 50% *more* time on math lessons than teachers with math anxiety. With traditional pedagogical styles and less time spent on math, teachers are even more likely to unintentionally foster the math anxiety that they have in their students (Bekdemir, 2010; Brady & Bowd, 2005).

Additionally, EPSTs avoid planning and teaching math because of negative prior experiences in the classroom (Bromme & Brophy, 1986). Math avoidance is the desire to spend less time on math (Ashcraft & Krause, 2007). When medical professionals present EPSTs with a mathematical task, brain imaging shows that EPSTs initiate a part of the brain associated with pain (Lyons & Beilock, 2012). To evade that feeling of pain, people with math anxiety avoid math. EPSTs who have math anxiety and wish to avoid math cannot because they must teach it as one of the core subjects of K-5. Since they cannot avoid it, they spend as little time on it as possible, which is problematic for students.

The most crucial impact of EPSTs having math anxiety is how wildly detrimental these beliefs are to students (Ball et al., 2008; Jackson & Leffingwell, 1999). These beliefs limit the EPSTs' scope of what mathematics is and who is good at mathematics. EPSTs with math anxiety set a dichotomy that reinforces a false binary of 'math people' and 'not math people'. This boundary preserves a fixed mindset around math for both teacher and learner. In conjunction with math anxiety, this fixed mindset about learning math carries into teaching math. A narrow scope of math, the dichotomy of math people and not math people, and a fixed mindset contribute to dehumanizing practices for students in the classroom.

Mizala and colleagues (2015) discovered that math anxiety could affect teachers' ability to cultivate inclusive environments in their classrooms. EPSTs' expectations of students' future performance differed by gender. EPSTs in this study thought boys would have more math achievement when compared to girls in their class. Essentially, teachers who had higher levels of math anxiety had lower expectations of their future students. Moreover, these EPSTs were more likely to recommend additional special education math support to students from lower socioeconomic backgrounds. These findings are especially troubling. In math education, many students do not feel that they fit the narrow description of who is good at math; this description is rooted in sociocultural -isms, including racism, ableism, and sexism (Gutiérrez, 2018). Math anxiety further perpetuates the dominant false narratives of math through a classroom that is not inclusive, making this problem more significant than initially anticipated.

Olson and Stoehr (2019) point out an additional dimension to math anxiety: teachers' anxiety on behalf of their students. Teachers reported feeling anxious about lessons they thought students would find challenging. They were not worried about teaching it; instead, they were worried about the students' perspectives. They did not want to see students struggling. To save students from negative math feelings, teachers tend to decrease the cognitive demand of a task. Reduced cognitive demand can reduce a conceptual math task to step-by-step procedures or give students hints that take away productive struggle. Step-by-step procedures and less student struggle can decrease the tension, worry, and anxiety a teacher might face while teaching because it makes math much more black-and-white. Although this might make the teacher feel at ease, this dramatically limits students' learning opportunities. Procedural learning limits students' productive struggle, sense-making, and deeper conceptual understanding of math.

Math anxiety can continue with teachers throughout their in-service years (Gresham, 2017; 2018). The higher levels of EPSTs' anxiety, the more likely they will extend those feelings into their in-service years. The more anxiety in-service teachers have, the more likely their students will develop math anxiety (Bekdemir, 2010; Brady & Bowd, 2005; Maloney & Beilock, 2012). Reducing math anxiety in EPSTs will reduce math anxiety in in-service teachers and, therefore, in their students (Geist, 2015).

To summarize, math anxiety is disproportionately high in EPSTs compared to other college students. Math anxiety affects mathematics performance in all different scenarios. Societal norms contribute to math anxiety. Past K-12 environmental experiences are often where math anxiety begins. Math anxiety leads to math avoidance.

Math avoidance leads to less time spent planning and teaching math, which is directly related to more traditional pedagogical styles. Unfortunately, math anxiety can be passed from teacher to student through these traditional pedagogical styles and other environmental experiences. Math anxiety is a barrier to providing an inclusive math classroom. Through a rehumanizing, ambitious and equitable math framework, teacher education can help EPSTs process their prior math experiences, which can decrease avoidance and exclusivity within the classroom and increase teaching and learning rooted in conceptual and relational ways. When EPSTs experience a course that focuses on broadening mathematical content, including real-world math application, and having a sense of ownership in the classroom, their dispositions toward math will likely shift. This shift to becoming less anxious can, in turn, promote ambitious and equitable mathematical instruction in their classrooms.

Reducing Anxiety.

Reducing math teaching anxiety will help EPSTs and their students in the future. Much of the research around math teaching anxiety is quantitatively focused, emphasizing the use of psychometrics to prove that it is a distinct construct from math anxiety. Additional research on math teaching anxiety focused on the correlations between math teaching anxiety and math anxiety and past experiences or future pedagogical styles. From the literature review I conducted, I found much less research on techniques for reducing math teaching anxiety. I assert that some reduction tactics for math anxiety might also have similar effects on math teaching anxiety.

Haciomeroglu (2013) found that field experiences between Turkish undergraduates' third and fourth years, a math methods course, and observations on teaching math decreased math teaching anxiety. He also argued that teacher educators should provide opportunities for EPSTs to become aware of this math teaching anxiety through reflection. I would argue that the ways to reduce math teaching anxiety are much like math anxiety but more focused on teaching than doing mathematics.

Throughout this literature review, many scholars supported empirical methods to reduce anxiety. Reflective writing, increased content knowledge, individual coping mechanisms, and teacher education courses have shown to decrease anxiety. The first one that I will expand on is reflective writing, which reduces math anxiety through increasing humanization (Boylard & Valentine, 2017; Dowker et al., 2016; Karunakaran, 2020; Looney et al., 2017; Maloney & Beilock, 2012; Ramirez & Beilock, 2011; Quinn, 1998). Wilson and Thornton (2008) said the following about EPSTs who had reflected on prior experiences " [they] developed enhanced self-images as learners of mathematics, and changed their assessment of their capacity to learn and teach mathematics" (p. 32). Di Martino and Zan (2010) caution researchers against labeling mathematics attitudes before letting EPSTs explain their experiences in narrative form. Teacher educators should never assume mathematical dispositions; instead, they should let their EPSTs expand on their mathematical dispositions through reflective writing.

Conceptual knowledge about mathematics can reduce math anxiety (Bosica, 2021). The more conceptual knowledge EPSTs have in math, the less likely they are to be anxious (Bosica, 2021). Teacher educators should prioritize building their EPSTs' conceptual math knowledge. Conrad and Tracy (1992) and Harper and Daane (1998) claim that awareness of math anxiety and cultivating a welcoming classroom environment in teacher education are vital to decreasing EPSTs' anxieties and their students'. Building an environment that brings attention to math anxiety and creates a community of practice in teacher education is integral to EPSTs' success. Conceptual instruction decreases math anxiety. Some of these methods are: using hands-on, concrete manipulatives (Dunkle, 2010; Sherman & Christian, 1999), direct vocabulary instruction (Carbonneau et al.; Dunkle, 2010; Furner et al., 2005; Rethlefsen & Park, 2011), and unpacking curriculum standards (Dunkle, 2010). Although manipulatives can decrease anxiety, they can also increase anxiety if EPSTs are unfamiliar with them. In order to effectively decrease anxiety, ESPTs should learn math with manipulatives and learn to teach math with them (Sloan, 2010; Karunakaran, 2020; Jao, 2017). Most EPSTs' K-12 teachers did not teach with manipulatives, so EPSTs may be resistant and nervous to learn or teach with them. This resistance can cause anxiety. To ensure that EPSTs derive confidence from manipulatives, teacher educators need to provide ample opportunities to practice with them. The newness and anxiety surrounding manipulatives will decrease as time goes on, with intentional practice built in by the teacher educator.

Coping mechanisms around math anxiety can be helpful and simultaneously harmful to the EPSTs. Stoehr (2017a) found that some coping mechanisms were "a sort of double-edged sword" (Stoehr, 2017a, p. 137). The EPST in this study separated herself from math as a coping mechanism, which enabled her to continue becoming an elementary teacher. Yet, it stopped her from engaging in some of the math tasks. This EPST did not gain the necessary conceptual understandings because when she was in the classroom, she built up a "mathematics wall" to protect herself from embarrassment and shame (p.128). The EPSTs in Finlayson's (2014) study noted other, more productive individual coping mechanisms, including relaxing, building self-confidence, practicing, and getting help from an instructor.

As teacher educators, it is crucial to attempt to make transparent the coping mechanisms EPSTs have around math anxiety. It is also vital that teacher educators talk about tweaking coping mechanisms to make them more productive. Instead of building the "mathematics wall" firmly planted in mathematics avoidance, teacher educators need to encourage EPSTs to break those walls down. Teacher educators need to allow EPSTs to engage in continual critical self-reflection on how they feel related to their math anxiety and how they cope with those feelings.

EPSTs in the Finlayson (2014) study also noted strategies they intended to use as future teachers to stop or reduce math anxiety in their students; some of those strategies were to encourage risk-taking, give additional practice, employ diverse teaching strategies, and thoughtfully engage students. Teacher educators who teach through rehumanizing and ambitious math teaching frameworks will use these strategies in their practice. Risk-taking is encouraged by setting up an environment where students can make mistakes without embarrassment, directly related to math as a living practice, which is a tenet of rehumanizing math (Gutiérrez, 2018). Giving EPSTs opportunities to practice is supported by ambitious math teachings' goal of understanding math as interconnected, conceptual, and flexible. Diverse teaching strategies are connected to thoughtfully engaging students through broadening mathematics, another rehumanizing math tenet (Gutiérrez, 2018).

EPSTs' anxiety can be reduced throughout math methods courses (Gresham, 2007; Harper & Daane, 1998, Sloan, 2010; Vinson et al., 1997; Tooke & Lindstrom, 1998; Vinson, 2001). In teacher education, math methods courses prepare students to be instructors of mathematics. EPSTs generally study learning theories through the lens of students' mathematical thinking, mathematical content, and research-based pedagogical practices throughout the course. EPSTs also practice giving math lessons and engage in continuous activities to improve their mathematical instruction. These courses increase multiple kinds of mathematical knowledge. The increase in EPSTs' knowledge often results in a decrease in anxiety in both math and teaching. Not all researchers found a change after methods courses; for instance, Esterly (2003) found that mathematical beliefs did not change. These conflicting results point to a need for more research, specifically on teacher education, curricular planning, and pedagogical decisions because of the different ways teacher educators teach methods courses, causing varying experiences for EPSTs.

The most effective anxiety reduction comes from long-term solutions. Specifically, Gresham (2017) found that two math education courses for the same undergraduate teacher education cohort resulted in a significant and stable reduction in math anxiety. EPSTs in this study took one math content course at the beginning of their coursework and one math methods course at the end of a four-year program. Without looking at math anxiety longitudinally, studies might capture temporary reductions in math anxiety, which could come back when EPSTs become in-service teachers (Gresham, 2017). Ideally, teacher education programs would require multiple math education courses to make this level of an impact. The Association of Mathematics Teacher Educators (AMTE) recommends that EPSTs take at least 12 credits of elementary mathematics content coursework and at least six credits of elementary mathematics methods, though most teacher education programs require far less than that

(Garner et al., in press). Buck (2022) even recommends that EPSTs take a course that focuses specifically on mathematical dispositions in tandem with math methods courses.

Understanding the multiple ways to reduce anxiety will allow me to empirically support the curricular aspects of a rehumanizing, ambitious and equitable math teaching framework in a math methods course. I knew that some of my pedagogical choices reduced EPSTs' anxiety in previous iterations of this course, but now I have peer-reviewed studies to support those choices. Teacher education has shown to reduce anxieties around math. Some of the design principles for teacher education are supported by the literature and my conceptual framework of rehumanizing and ambitious math (reflective writing, increased content knowledge, both subject matter and pedagogical, and coping mechanisms).

Self-Efficacy

I will discuss both math self-efficacy and math teacher self-efficacy throughout this section. First, I will explain the difference between math self-efficacy and math teacher self-efficacy. Then, I will discuss the internal versus external attributions of efficacy. Third, I will elaborate on the effect both types of efficacy have on instruction. Lastly, I will note strategies to increase efficacy.

Math self-efficacy is often a precursor for math teacher self-efficacy. Math self-efficacy is a self-evaluation of how successful someone believes they can be when presented with mathematical tasks (e.g., "I can successfully solve higher-level conceptual math tasks surrounding fractions”). Math teacher self-efficacy is a self-evaluation of how successful one believes they can be as a *teacher* of the math content (e.g., “I can be successful with helping students' misconceptions when it comes to fractions”). Although these two types of efficacy are related, they are distinct constructs. EPSTs’ understandings of their dispositions surrounding both doing math and teaching math should be understood separately. EPSTs could have positive understandings of themselves as *doers* of math, but that does not mean that they have a positive understanding of themselves as *teachers* of math.

Esterly (2003) found that mathematical beliefs affected math teacher self-efficacy but not math efficacy. In other words, what people believed about math affected their belief in their ability to teach it, but not their perception of their ability to do it. EPSTs who saw math as traditional — rooted in procedural knowledge and memorization — typically had lower math teacher self-efficacy because they thought getting better at math was outside their locus of control. These teachers who taught traditionally also were less willing to take risks, like using more student-centered instruction. On the other hand, EPSTs who saw math through more conceptual lenses were more likely to believe that students’ success in math was inside their locus of control and that they could affect student achievement. A rehumanizing, ambitious and equitable math teaching framework can bring ESPTs to shift from procedural understandings of math to more conceptual understandings. A rehumanizing, ambitious and equitable math course can also shift the locus of control from external to internal. EPSTs will gain deeper understandings from new conceptual mathematical understandings, which positively affects student outcomes. Sherman and Christian (1999) also found that a problem-based approach with manipulatives and cooperative learning courses changed EPSTs' understandings of math teaching, but not math self-efficacy.

From this research, it seems that it is easier to shift EPSTs' views around math and their ability to teach it rather than their opinions about themselves within math. Changing ESPTs' beliefs about the subject and their ability to affect students might be easier than trying to change their perception of their self-confidence around math. Internal attributions of efficacy — or their perception of their math abilities — seem harder to change than external attributions of efficacy. Internal attributions consist of things that EPSTs feel in solely in control over (e.g. their own mathematical abilities), whereas external attributions are things that EPSTs do not feel solely responsible for or in control of (e.g. their students' mathematical abilities). Further research is needed to examine this relationship. If EPSTs do not have high math self-efficacy, even after attempting belief change, this could eventually impact students. Based on Sherman and Christian (1999), if internal attribution of efficacy is indeed harder to change, math self-efficacy would be more challenging to change versus the more external attribution of math teacher self-efficacy.

Effects on Instruction.

Math teacher performance, commitment to the work, promotion of student learning, and persistence with students are all connected to math self-efficacy and math teacher self-efficacy (Althauser, 2018). Math self-efficacy is related to EPSTs' behavior and motivation (Brown et al., 2012; Henson, 2002; Tschannen-Moran & Woolfolk Hoy, 2001). EPSTs are more likely to remain in teaching and have a higher professional commitment when they have higher levels of efficacy for teaching in general (Henson, 2002). Teachers with higher self-efficacy are more effective than teachers with a lower sense of self-efficacy (Swars, 2005). When effective teachers remain in the field, this positively affects students.

EPSTs' math teacher self-efficacy influences their math teaching (Newton et al., 2012; Uusimaki & Nason, 2004). When in a math classroom, math teacher self-efficacy is directly tied to pedagogical strategies (Althauser, 2018). EPSTs frequently report being incredibly nervous and having low teacher self-efficacy around answering questions from students that they might not know the answer to (Wenta, 2000). In response, they employ traditional pedagogical frameworks to avoid questions that they do not know the answers to. EPSTs' worries surrounding effectively answering questions from their students is a product of low math teacher self-efficacy.

Teachers with high math teacher self-efficacy also have higher persistence rates with struggling students (Henson, 2002). Swars and colleagues (2006) explain that EPSTs are less willing to use innovative learning plans when they have less efficacy. However, EPSTs with higher math teacher self-efficacy are more likely to teach in inquiry-based, student-centered ways (Swars et al., 2008). High math teaching efficacy had a strong positive relationship with non-traditional and more sophisticated mathematical beliefs, fostering more robust teaching strategies (Briley, 2012). EPSTs' willingness to engage students in innovative pedagogical frameworks and help them when they are struggling are based on levels of efficacy.

If their teacher has a higher level of efficacy, students greatly benefit. Math teacher self-efficacy is positively related to student motivation, student achievement, and students' self-efficacy (Bosica, 2021). Incikabi (2013) and Chang (2015) found that students' attitudes and abilities correlate to their teachers' self-efficacy. Innovative pedagogical strategies, like rehumanizing, ambitious and equitable math frameworks, can create an inquiry-based, student-centered classroom, which is better for math learning.

In review of the efficacy section, both math self-efficacy and math teacher self-efficacy are related to past learning experiences. Content knowledge affects both forms of efficacy. If EPSTs have low efficacies, then they are more likely to teach with a more traditional pedagogical framework, which hurts their students. Internal attributions of efficacy are more challenging to change than external attributions of efficacy. Lastly, less self-efficacious teachers produce less self-efficacious students.

Increasing Self-Efficacy.

One way to elevate EPSTs' self-efficacy is to provide a supportive environment through a rehumanizing, ambitious and equitable framework (Vinson, 2001). Vinson (2001) increased EPSTs' positive feelings towards math by centering the teacher candidates in teacher education. They centered EPSTs as learners by teaching with manipulatives, games, and problem-solving activities that supported positive shifts in EPSTs' mathematical dispositions. Ambitious and equitable and rehumanizing pedagogical frameworks promote self-efficacy and teacher self-efficacy by positioning EPSTs t as active creators of knowledge.

Teacher educators can increase EPSTs' math teacher self-efficacy through pedagogical frameworks and course design. Teacher education is a potent way to shift EPSTs confidence and attitude toward math, which can also shift their math teacher self-efficacy (Burton, 2012). Burton found that EPSTs had higher teaching self-efficacy when doing mathematics involving real-world contexts, which is similar to findings in previous studies (Bekdemir, 2010; Furner & Gonzalez-DeHass, 2011; Geist, 2010). EPSTs' math teacher self-efficacy significantly increased after math content courses (Alsup, 2004).

Math methods courses taught with innovative strategies also increased EPSTs' math teacher self-efficacy (Cakiroglu, 2000; Huinker & Madison, 1997; Wenta, 2000). The increases in self-efficacy came from grappling with math in new ways. EPSTs engaged in problem-solving through low floor and high ceiling mathematical tasks that felt authentic to their learning. EPSTs also gained a better understanding of the *why* behind much of the math that was taught to them in procedural ways, which supported higher levels of self-efficacy. Teacher education has the power to increase both math self-efficacy and math teacher self-efficacy, which has a positive impact on students.

Intersections

Mathematics self-efficacy, math teacher self-efficacy, mathematics anxiety, and mathematics teaching anxiety are all separate constructs that interact (Bosica, 2021). EPSTs can come into teacher education with various combinations of anxiety and efficacy. Some EPSTs are confident in their ability to do traditional math because it mirrors how they were taught. Other students are not confident in their ability to do math, yet find they have an asset in teaching: They can put themselves in their struggling students' shoes more easily, so they are more confident in their teaching abilities. EPSTs who approach math instruction through this compassionate lens humanize their students by prioritizing students’ experiences before focusing on content.

Intersections Among Math Anxiety and Math Self-Efficacy.

Math anxiety and self-efficacy are negatively correlated; when someone has high levels of math anxiety or anxiety about doing math, they tend to lack confidence in their ability to perform mathematically — which is to say, they have low math self-efficacy. Similarly, mathematics anxiety and mathematics self-efficacy negatively correlate (Bosica, 2021; Bursal & Paznokas, 2006; Gresham, 2008; Peker, 2018; Swars et al., 2006; Ünlü et al., 2017; Ural, 2014). When EPSTs have high self-efficacy – a positive belief in their ability to teach math – their anxiety is usually relatively low (Peker, 2008). Conversely, a lack of self-efficacy and a lack of confidence correlate with high math anxiety (Beilock & Maloney, 2015; Finlayson, 2014; Gonzalez-DeHass et al., 2017; Mizala et al., 2015; Swars et al., 2006).

EPSTs who have low self-efficacy and high math anxiety tend to reproduce their negative dispositions in their students' through their pedagogy, teacher presence and instructional materials. EPSTs who fit into the highly anxious and low self-efficacy category tend to implement more rote teaching practices rooted in memorization, dehumanizing students. EPSTs who fit into this category tend to dismiss struggling students or even embarrass students when they do not get the correct answers. Also, EPSTs in this category tend to implement multiple-choice assessments, give single-solution math tasks, and often grade by right or wrong. They rely on multiple choice tests and textbook homework that mirrors standardized tests. Teachers in this category can cultivate a very narrow way of success in math that can negatively affect students' mathematical dispositions.

Some findings added nuance to the previously researched correlation between math anxiety and math self-efficacy. For instance, Ozben and Kilicoglu (2021) found EPSTs' self-efficacy and beliefs about mathematics were much higher than other studies, and their anxiety was lower than past findings. Brown and colleagues (2011) and Adeyemi (2015) add more nuance to the relationship between math anxiety and math self-efficacy; they argue that not all preservice math teachers who have high anxiety have low self-efficacy, and not all EPSTs who have low math teacher self-efficacy have high math anxiety. Moreover, this influence is not always negative; EPSTs who are worried about their ability to do math might view their struggle as productive, making them feel more efficacious or proud of overcoming the challenge. These studies show that EPSTs' mathematical dispositions are complex and can manifest in all different ways.

Intersections Among Math Teaching Anxiety and Math Teacher Self-Efficacy.

There are also intersections among math teacher self-efficacy and math teaching anxiety. EPSTs' math teacher self-efficacy often predicts if they will have math teaching anxiety or not. In general, math teacher efficacy and mathematics teaching anxiety negatively correlate (Bursal & Paznokas, 2006; Gresham, 2008; Peker & Ertekin, 2011; Swars et al., 2006). Math anxiety influences teachers' self-efficacy and attitudes towards math (Swars et al., 2006). People who are anxious about their ability to teach math tend to be less confident in their abilities to teach it. The negative correlation means a high level of math teacher self-efficacy is associated with low math teaching anxiety, and vice versa. Teaching attitude predicts teaching anxiety and teaching efficacy beliefs, so EPSTs' attitudes toward math predicts teaching anxiety and math teacher self-efficacy (Al-Mehrzi et al., 2011). Ural (2014) found that math teacher self-efficacy accounted for 35% of the variance in math teaching anxiety. Clearly, math teacher self-efficacy and math teaching anxiety have a relationship.

Although prior research has solidified a connection between math teaching anxiety and efficacy, recent research has painted a more nuanced relationship. Bosica (2021) found that some EPSTs have high teaching anxiety but also have high efficacy, although this was not the majority. EPSTs with high teaching anxiety and high efficacy often relied on resources and over-planning to ease their anxieties around teaching (e.g., lesson plans, textbooks, and worksheets). These teachers went out of their way to make sure they were prepared by attempting to plan each lesson as much as possible (e.g., scripted directions, scripted questions, and answer sheets that contained single solution paths as the only accepted way to solve the problem). They took more time planning and were vigilant about their selected resources, which helped them ease their teaching anxieties (Bosica, 2021). Some EPSTs cope with their anxieties successfully (e.g. by preparing), which adds nuance to prior research that touted teaching anxiety as always having a negative impact. Coping mechanisms can be powerful tools in decreasing anxiety around teaching math.

Intersections Among Math Anxiety and Math Teaching Anxiety.

Math anxiety and math teaching anxiety also have a relationship that affects teaching and students. Math anxiety and math teaching anxiety are positively correlated (Adeyemi, 2015; Bosica, 2021; Haciomeroglu, 2014; Peker & Ertekin, 2011; Ünlü et al., 2017). If someone is worried about their ability to do the math, they are often concerned with their ability to teach it. Bursal and Paznokas (2006) found that the 30% of EPSTs who had high math anxiety also had high math teaching anxiety. Although previous research showed that math teaching anxiety and math anxiety were correlated and affected students, Hadley and Doward (2011) found that student performance correlated to math teaching anxiety, but *not* math anxiety. This finding indicates that student success in math is positively related to EPSTs' confidence in teaching math but not in doing it. The authors found that math teaching anxiety was a better predictor of student performance. EPSTs' confidence in their ability to *teach* math might be more critical to their students' success than their confidence in *doing* math. As teacher educators, it is essential to prioritize math teaching anxiety and math teacher self-efficacy because of their direct impact on students.

According to Bosica (2021), deep content knowledge is related to low teaching anxiety and low math anxiety. If EPSTs felt that they had a command of the content, they were less anxious about math and math teaching (Bosica, 2021). Content knowledge here refers to both subject matter knowledge and pedagogical content knowledge. Deepening both of these knowledges is a way to address anxiety. Bosica (2021) found that if EPSTs gained a deep conceptual understanding of the math then they were empowered to explain the *why* behind the math to others, including their peers. EPSTs who gained new mathematical understandings prioritized productive mathematical discourse. Their recently developed content knowledge and their peer communities helped them demystify math and math teaching. This demystification decreased both their math teaching anxiety and their math anxiety (Bosica, 2021).

Internal versus external control is one possibility for understanding divergent anxieties. Math anxiety is more *internally* focused on self-confidence, whereas math teaching anxiety is *externally* focused on confidence to engage students in mathematics learning (Brown et al., 2011). Depending on the EPST, the internal versus external locus of control might negatively correlate with math anxiety and math teaching anxiety, or not. Some EPSTs might be more anxious about self (internal) or more anxious about their effect on students (external). Some EPSTs have confidence in their ability to do the math (internal) but are not confident in teaching it (external) (Brown et al., 2012). This difference between math anxiety and math teaching anxiety suggests a potentially more complicated relationship than previously thought. Math anxiety and math teaching anxiety do not always seem to be linked. Brown and colleagues (2011) found that 39.6% of EPSTs had no prior math anxiety and no prior math teaching anxiety. They found that 17% had no prior math anxiety, yet had math teaching anxiety. They revealed that 18.9% of their participants had math anxiety but no math teaching anxiety. Lastly, they found that 20.8% had math anxiety and math teaching anxiety. Their work challenged the prior assumption and research that math anxiety leads to math teaching anxiety. Though Brown and colleagues (2011) found math teaching anxiety and math anxiety unrelated, many studies have shown a relationship between the two constructs. Since math teaching anxiety is understudied, we need further research to understand the relationship between these constructs.

Review of Literature Conclusions

This section will uncover how elementary math teacher educators can improve their EPSTs' mathematical dispositions (math anxiety, self-efficacy, math teaching anxiety, and math teacher self-efficacy). I start by arguing why teacher education can make a difference in mathematical dispositions. Then, I will describe my design principles for how I plan to improve mathematical disposition through an elementary math methods course using rehumanizing, ambitious and equitable math teaching — providing for both content and affect in teacher education. The next section will be the action steps I will take from the literature review conclusions that teacher education can improve mathematical dispositions.

Teacher Education Can Improve EPSTs' Math Dispositions

Teacher education that attends to mathematical disposition can decrease math anxiety and math teaching anxiety, and increase both math self-efficacy and math teacher self-efficacy. The external attributions of math teaching anxiety and math teacher self-efficacy are easier to shift than the internal attributions of math anxiety and mat self-efficacy. EPSTs will have more positive dispositions if programs attend to mathematical dispositions. These positive dispositions will lead to students experiencing a more confident and effective teacher in the classroom, which benefits their students greatly. Negative emotions, beliefs, identities, and attitudes can be detrimental to EPSTs as they complete teacher education (Dogan & Yaylı, 2012; Liljedahl, 2005; Rule and Harrell, 2010). Negative mathematical dispositions can directly affect teacher engagement in teaching, learning, and curriculum (Scott, 2005). I believe that teacher education must attend to EPSTs' mathematical dispositions; as D'Emidio-Caston (1993) stated, "Any attempt to change the way mathematics is taught and learned must also confront the ghosts of negative experiences for each individual" (p. 4). Pajeres (1992) outlined the importance of teacher education by claiming, “Understanding the belief structures of teachers and teacher candidates is essential to improving their professional preparation and teaching practices” (p. 307). EPSTs have to reflect on their prior dehumanizing and miseducative experiences and as they begin to heal their mathematical dispositions. It is important to note that these beliefs are resistant to change because EPSTs have developed them over 13 years of K-12 education. Many EPSTs have formed unproductive habits, schemas, and understandings about doing, learning, and teaching math (Ambrose, 2004). The longer EPSTs have their beliefs, the harder they are to change (Beswick, 2006).

Historically, teacher education has not challenged EPSTs’ mathematical dispositions (Leaman & Flanagan, 2013) or asked them to reflect on their own experiences as learners. Unfortunately, many teacher educators woefully underestimate the effect prior experiences have on EPSTs (Jong & Hodges, 2015). Teacher education preparation programs' responsibility is to disrupt EPSTs' dispositions surrounding math (Amirshokoohi & Wisniewski, 2018). EPSTs need to reflect on their experiences as learners, and teacher educators need to give them opportunities to reconstruct their math dispositions through rehumanizing, ambitious and equitable math teaching (Dogan & Yaylı, 2012). Beliefs, emotions, personal histories, and understanding of cognition through competence and performance form mathematical dispositions. Teacher education should focus on those aspects and the intersections (Grootenboer & Zevenbergern, 2008).

Furthermore, teacher education should support EPSTs to create mathematical dispositions concerning self-understanding, equity, and socio-political landscapes rooted in context-specific environments (Crockett & Buckley, 2009). Many mathematical dispositions are also rooted in larger master narratives. DePiper (2011) calls for critical self-examination and deconstruction of current mathematical dispositions to make room for reformation. Teacher educators need to challenge EPSTs' beliefs so that they can critically reflect and potentially reformulate them. Hopefully, my course will achieve mathematical disposition reformation through a rehumanizing, ambitious and equitable math teaching framework.

Teacher education can change EPSTs' beliefs about math (Beswick, 2006; Gill et al., 2004; Swars et al., 2008; Wilkins & Brand, 2004). Teacher education should include changes in EPSTs' beliefs as a specific and measurable learning outcome for the program (Benbow, 1993). Beswick (2006) argues that there will never be successful reform in mathematics without shifting teacher beliefs. Lee and Zeppelin (2014) note that teacher educators must bridge teachers' prior experiences as students in math with their future experiences with teaching math. With my experience in teacher education, I agree with all of these scholars. I believe that teacher education is robust and can shift mathematical dispositions. Teacher educators have to intentionally plan to challenge EPSTs' mathematical beliefs and support discussing prior experiences. Furthermore, challenging beliefs and discussing previous experiences are important, but teacher educators need to prepare for their EPSTs to solidify new beliefs. The following section includes design principles for how teacher educators can take action to improve EPSTs' mathematical dispositions.

Design Principles for Improving EPSTs' Math Dispositions

These four design principles are all employed in my math methods course. They support the pedagogical and curriculum decisions. The design principles also support the framework (rehumanizing, ambitious and equitable math teaching) I used while co-building and co-iterating this course. Woven throughout these design principles is my conceptual framework of rehumanizing (Gutiérrez, 2018) and ambitious and equitable math teaching (Boaler, 2002; Horn & Garner, 2022; Lampert et al., 2011; NCTM, 2014). In the following sections, I explain how I employ each design principle.

1. Teacher educators must model the kinds of classroom environments they hope EPSTs use in their classrooms (Conrad & Tracy, 1992; Firestone et al., 2005; Gonzalez-DeHass et al., 2017; Gresham, 2007; Harper & Daane, 1998; Leavy, 2015; Karunakaran, 2020; Putney & Cass, 1998; Schanke, 2023).

2. Teacher educators must give EPSTs the opportunity to reflect on their prior negative experiences, bringing awareness to their dispositions, and then work with ESPTs to combat them (Beilock & Maloney, 2015; Harper & Daane, 1998; Johnson & VanderSandt, 2011; Karunakaran, 2020; Kelly & Tomhave, 1985; Sloan, 2010; Wilson, 2015). Specifically, teacher educators must challenge EPSTs' preconceived dispositions and empower EPSTs to have productive mathematical dispositions (Ewart, 2022; Shilling, 2010).
3. Teacher educators must build communities of practice that will foster shifts in disposition (Gonzalez-DeHass et al., 2017; Gresham, 2007; Harper & Daane, 1998; Karunakaran, 2020; Schanke, 2023; Shilling, 2010; Uusimaki & Nason, 2004).
4. Teacher educators need to provide EPSTs with the opportunities to do and explore mathematics as learners and as teachers (Althauser, 2018; D'Emidio-Caston, 1993; Hill et al., 2008; Karunakaran, 2020; Schanke, 2023; Stuart & Thurlow, 2000). Specifically, teacher educators need to bridge theory and practice (Shilling, 2010).

Classroom Environment.

This design principle calls for teacher educators to create an environment that supports all EPSTs' learning. Not all environments are created equal. Traditional math environments are often limited to a type of belonging that privileges whiteness and maleness (Gutiérrez, 2018). In those spaces, math focuses on traditionally masculine traits of objectivism and rationalism (Gutiérrez, 2018). In traditional math environments, math justifies social divisions and borders for access, limiting people who feel othered (e.g., queer people, people of color, and women) (Yeh & Rubel, 2020). Rehumanizing math turns those traditional notions on their head. Rehumanizing math broadens math for *all,* especially students who have previously been 'othered' by mathematics. A rehumanizing and welcoming environment can significantly impact EPSTs' mathematical dispositions and, in turn, support a broadened range of EPSTs' learning (Conrad & Tracy, 1992; Harper & Daane, 1998).

A rehumanizing environment highlights a counter narrative to the traditional notions of privilege, status, and hierarchies in the classroom (Gutiérrez, 2018). Instead of the teacher as the disseminator of knowledge, students are the meaning makers (Gutiérrez, 2018). Instead of privileging white middle-class norms, rehumanizing math privileges students of color, women, and queer folks while building on their funds of knowledge (Gutiérrez, 2018). Though, just because someone's identity is privileged in math does not mean they do not experience dehumanization. Dehumanization in math affects most people, but especially marginalized peoples. Rehumanizing math characterizes math in motion instead of a static set of truths (Gutiérrez, 2018). A math classroom focused on rehumanizing math generates a new environment where EPSTs can learn and grow.

Through the rehumanizing, ambitious and equitable math teaching framework, I hope to create a welcoming environment where EPSTs see themselves as capable learners. I know that as a co-instructor, I have a considerable impact on the environment and what EPSTs take away from the course (Gonzalez-DeHass et al., 2017; Gresham, 2007). I plan that both Dr. Brette and I generate a welcoming environment by building trust, encouraging transparency, and amplifying EPSTs' voices. I aim to decenter myself as the instructor and recenter ESPTs' ownership while empowering them to give me feedback. I genuinely support the EPSTs in my classroom, bringing their whole selves, including their informal math experiences, culture, creativity, and body and emotion, as will Dr. Brette. Throughout the course, we consistently affirm their whole selves. We want to create a mathematical environment where EPSTs are inspired to be vulnerable and make mistakes. We want EPSTs to face challenges with resilience. We treat students with respect and encourage them to be the best teachers they can be.

The most important thing that EPSTs should take away from teacher education is to become a reflective mathematics educator who meets all learners' needs in the classroom environment through a vision of content knowledge, learning orientation, and pedagogies. Theoretically, EPSTs can transfer positive dispositions, too. Dr. Brette and I both hope my EPSTs find the framework rehumanizing and transfer their new positive mathematical dispositions onto their students.

We make explicit to the EPSTs how they can implement this environment in their own classrooms. We want them to learn how to implement rehumanizing, ambitious and equitable math frameworks by experiencing a classroom built on those principles — though experience is not enough. We consistently prompt EPSTs to make practical connections to the theory. We will make sure they can apply the practices that we are implementing in our classroom in their classrooms. We will provide EPSTs with the opportunities to apply the theory of math teaching and learning to real life and encourage them to spend more time with the content (Ellsworth & Buss, 2000).

Reflecting on Prior Experiences.

This design principle includes opportunities for EPSTs to reflect on their prior learning experiences. Instead of a method of teaching focused solely on content knowledge, teacher educators must begin challenging EPSTs' existing mathematical dispositions through critically reflective practices (Looney et al., 2017). Teacher educators must consider how to scaffold and model their productive struggles as they consider EPSTs' dispositions (Bolyard & Valentine, 2017). They must be vulnerable about their mathematical disposition formation. Teacher educators need to metacognitively reflect on their mathematical dispositions and their math teacher identities to help support EPSTs through their own journey of mathematical disposition reformation (Alderton, 2020). Teacher educators must find a way to weave content knowledge and disposition reformation into their courses so that EPSTs can leave their teacher education programs with positive mathematical dispositions. Teacher educators can assign their EPSTs to engage in reflective writing on mathematical dispositions (Gresham, 2007; Harper & Daane, 1998; Wilson, 2015).

In our course, EPSTs engage in an autobiographical writing assignment. This assignment is just the beginning of the conversation on prior experiences. Many conversations come up that contain stories of EPSTs' K-12 experiences throughout the course. I see these conversations as powerful ways for EPSTs' to evolve their mathematical dispositions. Every course session, we provide an opportunity to weave content knowledge and reflections on mathematical dispositions into the curriculum.

Small Group Collaboration.

This design principle is rooted in collaboration, community, and socialization (Richardson, 1996). As teacher educators, we must create opportunities for small group collaboration within our math courses to reshape EPSTs identities through experiences and relationships (Kaasila, 2007). Alderton's (2020) study pointed to the need for a trusted community of EPSTs to discuss strategies, understandings, and mistakes. Through communities of practice, EPSTs develop and evolve their mathematical dispositions through an internally persuasive discourse. EPSTs need to evolve their internally persuasive discourse around their mathematical dispositions by extending, discarding, or keeping their discourses.

ESPTs' communities of practice in math methods courses will provide opportunities for EPSTs to reform their math dispositions (Boaler et al., 2000). These newly reformed mathematical dispositions lead to EPSTs' empowerment (Hart, 2002; Steele, 1994). In our classroom, small groups provide EPSTs' with the opportunities to reform their math dispositions through argumentation, narratives, discussion, morality, and critical reflection in relation to others, self, and the socio-mathematical context (Lutovac & Kaasila, 2011). These new dispositions are context-dependent and can shift, so someone might have a clear sense of math disposition that varies when talking to their small group versus one of their instructors (Kaasila et al., 2012). Dispositions are also fragile, especially at the beginning of the reflection and reformation process (Pavlovich, 2019). If reformation begins to happen or happens, it is easy to revert to old patterns, which is why support from their small group is so important. Forming a mathematical disposition is "full of turning points that shape who they are, who they are not, and who they intend to become" (Pavlovich, 2019, p. 134).

In our classroom, EPSTs work in small collaborative groups every session. They have the opportunity to reflect on how activities made them think differently about themselves, learning, or teaching concerning math**.** There are small group activities that support the pedagogical, practical, and mathematical learning targets that we want our EPSTs to learn.

Do and Explore Mathematics.

Teacher educators have a complex responsibility to focus on content and psychological shifts in EPSTs (Battista, 1986; Bailey, 2014). Problem-based teaching, group work, and productive discourse encourage EPSTs to make changes in their dispositions. These three findings, problem-based teaching, group work, and discourse, are also highlighted in ambitious math courses (Hart et al., 2018). Ewart (2022) emphasizes the importance of creativity in math. Additionally, they emphasize the need to “model, practice, discuss, and reflect " on doing and teaching math (p. 70). Teacher educators need to provide EPSTs with the opportunities to do, explore, reflect upon, and apply their mathematical understandings to student sense-making (Althauser, 2018).

In our course, EPSTs grapple with mathematical problem-solving, including making mistakes and productive struggle (Stuart & Thurlow, 2000). Mathematical problem-solving includes the conceptual nature of the problems, a higher level of critical thinking, and the interconnectedness of mathematical content (Hill et al., 2008). Productive struggle includes persevering through a task to learn more than just the steps to find the answer, but the why to the procedure. Many of the actual tasks that they solve are contextualized into authentic real-life scenarios (Gonzalez- DeHass et al., 2017; Gresham, 2007).

We teach through a student-centered lens, where students are meaning-makers and are seen as a source of deep knowledge. Both Dr. Brette and I encourage our EPSTs' mathematical thinking by connecting math to past learnings, current understandings, and reorganization of knowledge into new schema or systems. We emphasize the connectedness of topics in the course and ensure that topics are not isolated (e.g., how operations with fractions or decimals build off of operations with whole numbers).

EPSTs in our course get the opportunity to view mathematical tasks from students' perspectives. Past research shows that taking this perspective challenges elementary EPSTs to see math as more conceptual than procedural (Steele, 1994). To encourage thinking through a mathematical task from a student's perspective, we have our EPSTs use manipulatives. Yet we are also mindful of the learning curve attached to manipulatives. Concrete manipulatives can decrease negative mathematical dispositions (Gresham, 2007; Harper & Daane, 1998; Sloan, 2010; Vinson, 2001), but for some students, they increase anxiety because they are unfamiliar (Gresham, 2007; Sloan, 2010; Vinson, 2001). I hope that encouraging EPSTs to practice using manipulatives in every one of our class sessions will decrease the initial anxiety and increase their familiarity, which will support positive shifts in disposition.

Dr. Brette and I see math as a living practice rooted in creativity (Gutiérrez, 2018). We teach math in a way that allows students to see math more qualitatively, which encourages new patterns or solution paths in mathematics (Gutiérrez, 2018). I support breaking the 'rules' of math and the invention of new algorithms, not just the reproduction of those that existed before (Gutiérrez, 2018). We consistently challenge the idea that math is just for school and instead see math as a way to express oneself and as something personally relevant (Gutiérrez, 2018). Last but not least, like Gutiérrez (2018), we highlight joy as a critical element in the classroom. Joy in doing and teaching mathematics is the end goal.

The Gap in the Literature

I researched our graduate EPSTs' mathematical dispositions. I defined mathematical dispositions as math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy. The literature motivated the choice to include math teaching anxiety because there is a lack of research on math teaching anxiety. Only twelve readings out of 183 used the construct of math teaching anxiety. I will focus on this separate, yet related, topic in addition to math anxiety, self-efficacy, and math teacher self-efficacy.

The choice to include all four components of mathematical disposition is also driven by the literature. There was no single source that included all four aspects of mathematical dispositions. Moreover, only one study focused on math anxiety, math teaching anxiety, and math teacher self-efficacy: Bosica (2021). His study did not include math self-efficacy, which is a separate yet related topic to math teacher self-efficacy. I plan to replicate some aspects of Boscia's study (2021) and some parts I will extend. He did not focus on a particular teacher education course, and instead looked across multiple universities across multiple points in the teacher education programs. By focusing on one math methods course I extend Bosica's (2021) study by concentrating on teacher educators and the specific curriculum that we implemented, promoting a direct practical application. I will build on this study by adding math self-efficacy and my framework of rehumanizing, ambitious and equitable math teaching. I will also add to this study by conducting a self-study of the instructors' experiences throughout the course to make the findings more practically applicable. These additions will shift the focus to teacher educators and their curriculum.

Much of the prior work authors have conducted on undergraduates. Only five of the 183 articles I read for this dissertation had graduate participants, which is a glaring gap. My work will be on masters-level EPSTs. Masters-level programs often have fewer math course requirements for EPSTs compared to undergraduate programs (Garner et al., in press). The age difference is also significant because mature-aged EPSTs experience math anxiety and mathematical contexts differently (Wilson, 2012; 2013).Older students experience more math anxiety (Hadfield & McNeil, 1994). Ashun and Renink (2009) found that adult learners had less confidence in teaching elementary math, and their beliefs were harder to change. My population might be more susceptible to math anxiety and their beliefs might be harder to change because they have had them longer. My setting and participants will add to the current literature surrounding EPSTs' mathematical dispositions.

My study, with a focus on rehumanizing, ambitious and equitable math teaching in elementary teacher education at the graduate level, will contribute to the field of teacher education. In my systematic literature review, no studies were implementing this framework in teacher education.

Chapter 3: Methodology

Introduction

This study aimed to understand graduate-level EPSTs' mathematical dispositions before, during, and after an elementary math methods course taught through a rehumanizing, ambitious and equitable math teaching framework. To fully understand the nuance and complexity of teacher education, I looked at both the EPSTs' and the instructors' perspectives. I investigated this through a multi-methods, sequential, phenomenological, and self-study approach. One research question was entirely qualitative: the instructor-focused self-study. Two other research questions were mixed methods and will employ concurrent data collection. The qualitative data is the driving force for the data analysis with the additional nuance of the quantitative data. I sequentially analyzed the two mixed-method questions through pre- and post- qualitative and quantitative data integration.

I studied the EPSTs' perspectives through a phenomenological lens. The phenomenon of this study is EPSTs' first-person points of view throughout a graduate math methods course taught with a rehumanizing, ambitious and equitable math teaching framework. Salient collective experiences are discussed in the results chapter. This study distilled the essence of the EPSTs' experiences in tandem with the instructors' practice. The self-study portion was focused on how Dr. Brette Garner and I reiterated our practice with rehumanizing, ambitious and equitable math teaching in mind.

Research Questions

The study answered the following questions:

RQ1: What are EPSTs' mathematical dispositions before taking their math methods course taught through an ambitious and equitable, and rehumanizing framework?

RQ2: How do EPSTs' mathematical dispositions evolve throughout the math methods course taught through an ambitious and equitable, and rehumanizing framework?

RQ3: Through a self-study lens, how do the instructors iterate their practice to implement a rehumanizing, ambitious and equitable math framework for EPSTs?

Methodological Rationale

Phenomenological Rationale

This phenomenological study centered the voices of the people experiencing the phenomenon (Moustakas, 1994). The drive of this research is to understand how our participants experienced the course and their subsequent shifts in disposition. I will employ descriptive language from my participants' perspectives. The salient experiences that I discussed relied heavily on direct quotes from my participants because they are the ones that are explaining the essence of their shared experience. For the phenomenological research approach, I will focus on an entire elementary math methods course to observe the "very nature" of the topic (Creswell & Poth, 2017, p. 76). I will gain insight into my participants' experiences through multiple data collection modalities:. Autobiographies, quantitative pre/post questionnaires, semi-structured open-ended interview questions about their experiences, and my pre-planning and post-debrief analytic memos. This phenomenological study pursues common understandings of EPSTs' mathematical dispositions and their particular lived experiences in a rehumanizing math methods course (Creswell & Poth, 2017).

Mixed Methods Rationale

This rationale is for RQ1 and RQ2, which are mixed- methods questions. The types of research questions that I asked called for the use of both quantitative and qualitative data collection. I conducted mixed methods research in this study because throughout my systematic literature review, methodologies were evenly split (21 quantitative, 32 qualitative, and 34 mixed- methods); the more robust studies employed data collection and analysis from both methods. Quantitative data was both validated and expanded on with qualitative data. Neither of these data sources was as powerful by themselves as they are together. The thrust of my research is a qualitative design supplemented by quantitative to gain insight into students' firsthand experiences with their mathematical dispositions and lived experience in a methods teacher education course taught through a rehumanizing, ambitious and equitable math teaching framework. the EPSTs' voices were centered within my research. Using a mixed-method design allowed me to provide multiple sources of data surrounding the lived experiences of EPSTs in a math course taught through a rehumanizing, ambitious and equitable math teaching framework in addition to their mathematical dispositions. Mixed methods encouraged me to tell a richer story than either could alone.

Qualitative Rationale

This rationale is for RQ3, which is entirely qualitative. There is no one true perspective of a lived experience. All knowledge is co-created and co-interpreted in trustworthiness (Kirkhart, 1995). Within qualitative research, reality and knowledge are subjective and deeply rooted in context (Wilding & Whiteford, 2005). Furthermore, qualitative inquiry compromises multiple forms of data to analyze a topic in-depth (Creswell & Poth, 2017). Research in qualitative design allows for the interpretation of circumstances in a way that quantitative design does not. Qualitative researchers do not believe that effects can be controlled and instead understand that conditions vacillate (Rossman & Rallis, 2011). I also selected a self-study design to seriously study our practice as teacher educators.

Self-Study Rationale

The self-study aspect of this dissertation allowed the co-researchers — Dr. Brette and me — to look at our teacher education program, our instruction, and our students' experiences and suggest changes holistically. This level of intricacy was vital for our study and progressed teacher education scholarship on the individual, institutional, and collective levels (Loughran, 2005). Self-study methodology is "respectful of the complexity of the activity of teacher education" (Zeichner, 1999, p. 8). Zeichner states that self-study was "the single most significant development ever in the field of teacher education research" (Zeichner, 1999, p. 8). Self-study emboldened both co-instructors to take a critical lens to their practices. Both of our perspectives, alongside our EPSTs' perspectives, encouraged us "to challenge our assumptions and biases, reveal our inconsistencies, expand our potential interpretations, and triangulate our findings' (LaBoskey, 2004, p. 849)" (as cited in Vanassche & Kelchertmans, 2015). This self-study advances teacher educator accountability and generates practical knowledge that is useful to other teacher educators, promoting educational reform (Lunenberg & Samaras, 2011).

Scholars foundational in self-study methodology recognize the personal and emotional aspects of conducting research as practitioners. Courageously capturing, unpacking, and portraying the nuances of teaching teachers can be draining (Loughran, 2005). Dr. Brette, my trusted partner in this study validated our experiences and made our self-study a lighter load. The partnership that we have forged through this study and beyond makes explicit the lasting contributions that we will have on teacher education.

Setting

Dr. Brette and I taught an elementary math methods course in the fall quarter of 2023. In this course and throughout this study Dr. Brette and I served in multiple roles. Dr. Brette was my advisor, mentoring me through my dissertation process. Dr. Brette and I were also co-instructors for the course, so we had a joint responsibility as teacher educators. Additionally, we served as co-researchers in this setting. I led the research, but in partnership we studied our practice as co-instructors.

Christine in this Context

Every aspect of the research process was subjective. Since I am one of the instruments in this mainly qualitative research, it is especially integral to consider my identities and how they created subjectivity. My identity as a past middle school math teacher who had anxiety around doing and teaching math and negative past mathematical experiences made me especially close to this study. I can sympathize with the EPSTs with negative mathematical dispositions. I employed critical self-reflection on my positionality, or bracketing, both before the research process begins (see personal opening vignette, p. 1-5) and throughout the process. My version of bracketing is from LeVasseur (2003) and van Manen (1990). Neither LeVasseur nor van Manen believes that there is a way to bracket out all subjectivity. Instead, they know personal understandings and experiences will shape the entire research process. LeVasseur (2003) and van Manen (1990) prioritize consistent and critical reflection that generates curiosity. I continuously and systematically searched for my subjectivity "like a garment that cannot be removed" (Peshkin, 1988, p. 17). I made sure to consider which role I was prioritizing and when. There were multiple instances when I had to prioritize my researcher role and other times where I had to prioritize my instructor role. For example, in the beginning of class I was often busy setting up technology to record and that made EPSTs less likely to come to me with questions or conversation during that time. Another example is when EPSTs engaged me in off topic conversation, I prioritized being their instructor and building relationships by engaging in those conversations even if it might not have made for better data. A final example is in Week 10, I prioritized the research side of my role when I needed EPSTs to fill out the post-questionnaire. I sought my most authentic sense of self as a researcher through consistent, authentic self-reflection partially documented in the debrief meetings, and subsequent memos.

I cannot be separated from my research (Yeh & Inman, 2007). I struck a balance between the insider/outsider perspective. I knew Dr. Brette and the EPSTs that I conducted this study with very well. As the course went on, we all developed stronger bonds. With that in mind, I was careful not to over-identify with my participants (Kumar & Cavallaro, 2018). I made sure to set a research boundary for myself. There were many occasions during class that I would actually forget that I was even carrying out research. I also reminded myself that "familiarity breeds inattention," so it was critical that I stayed aware and reflected on my positionality through conversations with my co-instructor (Barclay-McLaughlin, 2005, p. 226).

Reflecting on this teacher-as-researcher experience, the hardest part for me was not to change the purpose of the course or of specific lessons. So, there were times as a teacher that I would hear things pertaining to mathematical dispositions, like negative self-talk, or examples of anxieties and I could not address them from my researcher perspective. I wanted to go down tangents talking about mathematical dispositions, but that was not the main idea for our elementary math methods course. At times, it was challenging to keep the teacher hat on and shelf the researcher hat, despite desperately wanting to go down a rabbit hole.

Christine-as-Researcher.

I tried to make the power relations between myself, an instructor and researcher, and my participants visible, both with my advisor and the EPSTs. The power dynamic between instructor and student at the higher education level contains ethical and methodological struggles (Alderton, 2020). The power dynamic between my advisor and me is best described as a trusted mentor and beloved colleague, which was supportive throughout the entire study, and the self-study especially. Conducting this study as a student-researcher with my advisor as a co-instructor and dissertation chair created an environment where Dr. Brette was more intertwined in my work than other advisors. She was there at every step of the data collection, teaching, and debrief processes.

Technically, as the EPSTs' instructor and the lead researcher, I was in a position of power. I reflected and sought feedback on the participation/positioning within my classroom every chance I got (Gutiérrez , 2018). I focused on our teaching framework of rehumanizing, ambitious and equitable math throughout the course. I questioned status (e.g. who was participating and how often) and hierarchies (e.g. who was positioned as meaningful contributors) within the classroom. I positioned students as meaning-makers and legitimate participants by validating their emotions and supporting them as whole people. In this study, I was doing research *with* my participants, not *on* them, what Peshkin calls "research reciprocity" (1988). Although I aimed to provide a rehumanizing space for my students, the asymmetrical power dynamic was still at play no matter how much bracketing or reflection I did. As Alderton (2020) says, "my subjectivities should be read into the account I offer" (p. 10). A reflective account and consistent questioning mediated power and privilege problems, but it did not mediate them entirely; power dynamics will always be present (Skeggs, 2002).

Throughout data collection and analysis, I conducted self-reflection and encouraged my participants' reflections and feedback (Rager, 2005). Participants were part of the research process at every step. They had time to reflect on their pre-course dispositions, their dispositions throughout the course, and their dispositions after. They were also given feedback after most lessons. Additionally, EPSTs had the opportunity to check every single aspect of their data in the member checking process. I ensured that participants could disagree, want to add more, or agree with how I was portraying them.

This positionality enabled me to better understand the preservice teacher context (Alderton, 2020). The instructor and researcher role allowed for in-depth and firsthand knowledge over an extended period (Hourigan et al., 2016). The reciprocal relationships built on trust, transparency, mutual respect, and rehumanizing, ambitious and equitable math helped the researcher-practitioner and the participants, or EPSTs to feel a sense of care (Gutiérrez, 2018). I weighed the potential risk of exploitation when I conducted research positioned within the same community as those being researched. There were many moments of ethical and pedagogical decision-making that are reflected in my analysis memos and debrief conversations. An example of this is when Dr. Brette and I understood the context of EPSTs' week ten energy levels, when we found out that they had taken a standardized test earlier that day we approached that course session with a new frame of reference and did not push mathematical thinking in the same way we would have if the context was different. In general, Dr. Brette and I viewed teaching as deeply situational.

Christine-as-Co-Instructor.

Since part of this study has a self-study component, it is vital that, as one of the EPSTs' instructors, I explain my deep-rooted beliefs as an educator. I believe that all of my EPSTs are mathematically capable. They all can explain their prior understandings, connections, and deep insights about mathematics. When they are provided the opportunity to engage, reflect, and bring their holistic selves to math, they obtain high-level conceptual mathematical understandings. This is especially powerful in a small group collaborative setting where discourse is prioritized. I believe in building on EPSTs' strengths, encouraging them to see themselves as mathematical sensemakers. I value each of the EPSTs' contributions to our course, mathematical and otherwise. I am always looking for ways to improve my practices and prioritize the EPSTs' experiences through feedback. I created a classroom space where I was learning alongside the EPSTs' and co-creating meaning at every turn. I approach all of my work through rehumanizing, ambitious and equitable pedagogies. This rehumanizing framework emphasized mathematical disposition and conceptual mathematical understanding through ambitious and equitable math. It simultaneously focused on affect and content seamlessly.

I taught a section of this course for two years before conducting this research (Fall 2020 and Fall 2021). My co-instructor, Dr. Brette Garner, has taught this course for five years, since 2018. Dr. Brette planned the curriculum by herself in 2018 and was already implementing the rehumanizing, ambitious and equitable math teaching framework when I was asked to teach a section in 2020. I was asked to teach a section because of room capacity requirements during strict COVID-19 regulations. Like when Dr. Brette planned the course, we continued to use Van de Walle and colleagues' (2018) textbook, supplemented with additional readings. This book is "a leading K-8 math methods text that has the most coverage of the *NCTM Standards*, the strongest coverage of middle school mathematics, and the highest student approval of any text currently available" (Setra, 2018, p. 52). Throughout the past two versions of this course, we co-planned, co-debriefed it, and continued reiterating it year after year. We have used EPSTs' feedback

— and dialogue with each other — to formatively assess the course week by week, consistently noting aspects that need to be tweaked or changed. We continued this practice for the duration of this study. In this iteration of the course Dr. Brette and I are teaching the same section, in the same room, together.

My experiences as an instructor in this course drove my passion for designing this study. Throughout my teaching, I noticed that some EPSTs started the course with negative dispositions – and some of those dispositions improved. However, some EPSTs' dispositions did not change and they were still uncomfortable with math content and teaching. Teaching this course for two years led me to question what mathematical dispositions ESPTs were bringing into our teacher education program and how our course may or may not have the ability to evolve those dispositions.

Co-Researchers-as-Co-Instructors

Dr. Brette Garner was a co-researcher in this study. As my co-researcher, Dr. Brette was actively involved in the pre-planning and the post-debrief sessions. She and I jointly made decisions about both the research and the instructional aspects of this course through authentic dialogue. We both acted as co-researchers-as-co-instructors. Dr. Brette was deeply involved in teaching, planning, debriefing, and reiterating the course. She was a trusted mentor and member-check throughout the process. Additionally, Dr. Brette had the power as the instructor of record in the course as well as the chair of my dissertation committee, which could have negatively affected the results. However, we did not allow this power dynamic to drive our interactions with each other, our students, or this research. We were truly collaborators, giving and receiving feedback and supported each other throughout the co-research and co-instruction. The pedagogical and research decisions were jointly made.

Additional Research Lenses and Ethical Considerations.

Ontologically, I believe that reality is multi-faceted, and there is no one true reality (Creswell & Poth, 2017). Epistemologically, I prioritized student knowledge through collaboration and co-creation. As a researcher, I know I "must situate their stories in relation to our stories, lives, and research project in humanizing ways" (San Pedro & Kinloch, 2017, p. 374S). Axiologically, I believe that research is never objective. My interpretations and our participants' interpretations are biased, based on our perceptions of reality and our lived experiences (Creswell & Poth, 2017). I want this level of *bias* in my qualitative research as it strengthens individuals' qualitative analyses.

Quantitative measures are especially not free of bias. At multiple levels of data collection, there is an opportunity for bias in numerous ways, including historical representation, measurement, evaluation, or aggregation bias (Suresh & Guttag, 2021). Campbell's law states, "The more any quantitative indicator is used for social decision-making, the more subject it will be to corruption pressures and the more apt it will be to distort and corrupt the social processes it is intended to monitor" (Campbell, 1974). Campbell's Law is one of the many reasons that quantitative studies should have an additional qualitative interpretation, one numerical source of biased data is not enough to understand a phenomenon. The single quantitative component was robustly corroborated with multiple qualitative components in this study. I did everything in my power to mitigate bias as a researcher through the self-study portion, personal reflection, and soliciting student feedback but was still there.

Ethically, I used proportional ethics, which weighed the costs and benefits of research. I did not cause more harm than is necessary, and I was dedicated to ensuring that there is no other less harmful way (Angrosino & Mays de Perez, 2000). I considered micro-ethics and ethically important moments as well as the traditional procedural IRB ethics (Guillemin & Gillam, 2004). For example, in Week ten the EPSTs did not have the cognitive bandwidth to take the survey in class like I planned for them to. An EPST asked if they could fill it out later when they did have more bandwidth and I decided that was the right thing to do. The data was also better since I allowed them to do it on their own time. Another example of micro-ethics was during the interview stage. I had some of my EPSTs' phone numbers and decided that when there were a few EPSTs that were late to their interviews to reach out to their friends to try to get her in contact with me. This choice was helpful because it allowed me to reschedule one of the interviews and the other EPSTs just needed a reminder. Rossman and Rallis (2011) state, "We posit that every decision about data collection, analysis, interpretation, and presentation has moral dimensions" (p. 379). I continued to hone my praxis so that every decision weighed both reasoning and action to best support ethical choices.

Current Course

Dr. Brette and I co-taught the fall quarter of 2022 elementary math methods course. We separated the math methods class sessions into segments of teaching that each of us would lead; in some sessions, Dr. Brette would have longer sections, and other times I would. We discussed and agreed upon co-teaching during the debrief meetings while we were planning for the next session. As the course went on, the cadence of co-teaching felt more and more natural. The course began in September and ran for 10 weeks, ending in mid-November. The course was 4 credit-hours on Mondays from 4:00-7:20pm. In our teacher education program, EPSTs take classes all day on Mondays, beginning at 9 or 10am; the math methods course is the last class of the day. I mention this because a main aspect of feedback over the years — this year being no different — is related to the timing and sequencing of the course, which are not directly in the instructors' control. This is important context because the students do not like the schedule and it has an impact on how they showed up to our course sessions.

This course served graduate students enrolled in the teacher education program seeking their elementary education licensure. These EPSTs are also pursuing their master's in education. The course was at a private, medium-sized university in the western United States. The program included field experience (840 hours) three times per week, total graduate coursework of 52 credits, and K-6 generalist elementary licensure. Most EPSTs conducted their field experience at the same school throughout the year, following a gradual release model. Some EPSTs did have to switch their fieldwork placements for a variety of reasons..

The college of education at this university articulates that they are focused on social change, empowerment, community engagement, interdisciplinary academics, and research with an impact. The program has the following learning outcomes:

1. Engage: The Teacher Candidate engages students in an inclusive and supportive learning community.
2. Plan: The Teacher Candidate plans rigorous and relevant, standards-and outcome-based lesson and unit plans.
3. Teach: The Teacher Candidate teaches equitably by establishing high expectations for student achievement and providing support.
4. Lead: The Teacher Candidate leads by exemplifying standards of professional practice.

This setting is a case of a teacher education preparation program that is, on paper, committed to preparing preservice teachers to develop the skills and mindsets necessary to become supportive and inclusive classroom teachers. These goals communicate to preservice teachers what is valued and devalued in the program. They explain the expectations of participation and presentation. Although these goals are supposed to assure universal application, they are vague and do not always give the *how*. The lack of clarity with equity causes teacher educators to significantly vary in their application of these goals across the program, creating tensions. In my practice, I gave my EPSTs the *how* so that there is action behind these words. Although I wanted my EPSTs to "engage, plan, teach, and lead," I gave them ways to do it authentically through a rehumanizing and ambitious and equitable framework that includes the practical *how*.

As creators and instructors of this course, Dr. Brette and I focused on our EPSTs' strengths through asset-based teaching. Throughout the course, we centered both mathematical sense-making (alternative solution paths, why 'wrong' answers are still fascinating, and persisting through difficult tasks) and pedagogical judgments (unpacking students' misconceptions, asking questions to elicit student thinking). This course prepared EPSTs with the skills and mindsets necessary for inclusive mathematics instruction in elementary classrooms. As we continued to redesign this course, we focused on theories of learning, the development of their future students' mathematical thinking, and research-based pedagogical practices in mathematics. EPSTs solved mathematical problems using various methods and manipulatives, practiced using skills they were learning in their own classrooms, engaged in continuous pedagogical improvement activities, and grappled with equity issues — race, class, gender, ability, and the intersections therein — pertaining to math teaching for understanding.

While planning this course, we kept a coherent vision of effective math instruction through deep content knowledge, learning orientations, and pedagogy that meets the needs of *all* learners through a rehumanizing and ambitious math teaching framework. This is reflected in the structure of our course in Table 1. We encouraged EPSTs to develop skills as reflective mathematics educators see the guiding questions and learning targets in Table 1. We considered current trends, issues, and controversies related to teaching mathematics in the 21st century. We prioritized what elementary math teachers need to know and be able to do; we organized these learning targets into pedagogical (learning to teach), practical (direct application in their classrooms), and mathematical (gaining a conceptual understanding of math) goals. Each course session we considered current trends and identified guiding questions and learning targets. We encouraged our EPSTs to cultivate more humanizing mathematics classes. Lastly, as teacher educators, we thought about dispositions that were important for us to model to our EPSTs and how our EPSTs can model those dispositions onto their students (Garner et al., 2022).

Table 1
Elementary Math Course Outline

Week	**Guiding Questions**	**Learning Targets**
1:	How can we create more humanizing mathematics classrooms? What is the importance of place value?	***Pedagogical:*** By rehumanizing mathematics, we can support all of our students who engage in meaningful mathematics– especially those who do not think of themselves as (or do not fit the typical profile of) “a math person” ***Practical:*** We will generate examples of rehumanizing mathematics in elementary settings ***Mathematical:*** Describe the conceptual development of place value in the base 10 system
2:	How are students’ identities, abilities, and backgrounds relevant to mathematics? How do students develop an understanding of numbers and operations?	***Pedagogical:*** Consider the ways that students’ identities may affect their experiences in math class ***Practical:*** Identify ways to make math class more inclusive through windows and mirrors for students (i.e., culturally relevant pedagogy) ***Mathematical:*** Focus on developing meaning and relationships among operations
3:	What does it mean to be *fluent* in mathematics? How do students learn basic arithmetic facts?	***Pedagogical:*** Supporting students to think fluently (i.e., flexibly and fluidly) about basic math facts ***Practical:*** Use dot images and basic fact games to support students’ numeracy ***Mathematical:*** Reasoning strategies– not memorization– are the foundation of mathematical fluency

4:	What kinds of tasks or problems are important for good math teaching? How do students develop understandings of shape and space?	***Pedagogical:*** Not all tasks are created equal! Using high cognitive demand tasks– called "procedures with connections" and "doing mathematics"-- allows for deeper student thinking ***Practical:*** We can increase the cognitive demand of a task by making it more open-ended ***Mathematical:*** It is important for students to understand the relationships between geometric figures– not just their names but also their features and the connections between categories
5:	How do standards and big mathematical ideas develop over time? How do students develop understandings of fractions and measurement?	***Pedagogical:*** The Common Core State Standards (CCSS) and the Colorado State Standards are written to help students develop big ideas over time ***Practical:*** By unpacking standards and connecting them to mathematical tasks, we can make sure that we are supporting students' conceptual understanding appropriately ***Mathematical:*** Fractions can be understood in multiple ways, including as numbers, lengths, parts of a whole, and parts of a set
6:	How do teachers maintain the cognitive demand of rich tasks? What strategies do students use to add and subtract?	***Pedagogical:*** Rich math lessons include a launch to get students ready to explore an idea and a concluding discussion to summarize different approaches ***Practical:*** Three-act tasks are a useful structure for setting up launch-explore-summarize lessons ***Mathematical:*** We can support students' understandings of addition and subtraction by encouraging their use of invented strategies. The underlying concepts for adding/subtracting whole numbers and fractions are similar, even if the algorithms look a bit different
7:	How can teachers support conceptual learning through discourse? What strategies do students use to multiply and divide?	***Pedagogical:*** Whole-class and small group discourse are important for supporting students' conceptual understandings ***Practical:*** Number strings are a useful strategy for facilitating whole-class discussion that emphasizes conceptual understanding

		Mathematical: We can support students' understandings of multiplication and division by encouraging their use of invented strategies. The underlying concepts for multiplying and dividing whole numbers and fractions are similar, even if the algorithms look a bit different
8:	What language demands do math lessons place on students? How do students develop an understanding of decimals and percents?	***Pedagogical:*** There are five areas of linguistic demand in math: reading, writing, listening, speaking, and representation ***Practical:*** We will analyze the linguistic demands of various tasks ***Mathematical:*** Decimal concepts and operations build on students' understandings of both fractions and whole numbers
9:	How do we know what students know? How do students develop an understanding of algebraic reasoning?	***Pedagogical:*** Figuring out what students really understand is hard– it has to go beyond looking at correct and incorrect answers ***Practical:*** Analyzing student work can give us deeper insight into student thinking ***Mathematical:*** Algebra is basically generalized arithmetics it builds on students' understandings of arithmetic with whole numbers
10:	How can elementary students model meaningful mathematics contexts? How do students develop an understanding of ratios and proportions?	***Pedagogical:*** Modeling with mathematics allows students to bridge mathematical reasoning with a real-world understanding ***Practical:*** We will do a sample modeling activity ***Mathematical:*** Ratio and proportional reasoning are the culmination of most elementary mathematics

Note. This table is the instructional schedule for the elementary math methods course. Most topics in this course address the needs of diverse students.

Participants

My participants, the EPSTs, drove this study's practical and future implications.

The end-product of this study is a collaborative dialogue between and amongst the co-researchers and all of the participants (Luenberg & Samaras, 2011; Wilding & Whiteford, 2005). I actively became the learner and co-created meaning with all my participants (Wilding & Whiteford, 2005). I documented their narratives and emotions as the driving force for this study. I shifted the research paradigm of conducting research 'on' participants to conducting research 'with' participants. Research 'with' my participants was critical to my study, as I attempted to shift positionality and participation within the classroom and desire to do the same in research. EPSTs questioned the study and gave me feedback on certain aspects of recording. I answered their questions and took their feedback and made changes (e.g. There was one day someone asked not to be recorded. there was also another day that someone asked what I was really going to do with all their data and I explained). Luenberg and Samaras (2011) claim that instructor transparency and genuine inclusion of participants increases their motivation to participate in the course. I was always transparent about the why behind my teaching and my research. This absolutely increased their motivation to be part of the study and engage with class. With our rehumanizing, ambitious and equitable framework, we promoted an inclusive classroom where our EPSTs can thrive.

I wanted to gain maximum variance of the phenomenon and reduce the individual to the phenomenon, so I conducted this study on the whole class instead of part of the class (Creswell & Poth, 2017). The course originally had 20 EPSTs enrolled, one left the teacher education preparation program before the class began, which brought the total to 19. All of the EPSTs enrolled in the class agreed to participate in this study. One of the EPSTs, Chloe, decided to leave the program and her data is only included in RQ1.

Their name and data will only be included in the before data. By the Week 6 there were 18 total participants. All 18 participants are to by pseudonyms (Table 2).

I invited all of the EPSTs to participate in the study. I gave a brief overview of what the study was and why I was conducting it to bolster transparency. I did not coerce them into participating and they had the chance to opt out of the study if they wanted. My participants were collected through a purposeful convenience sampling. They were a small group seeking elementary certification and enrolled in elementary math methods. If they had decided not to participate, they would have still received the same instruction throughout the course as the students who opted-in. There was no penalty for choosing not to participate. I made it very clear to them before the pre-questionnaire and in the first session of class that it was their choice and they could always opt out at any time. I did not weaponize a lack of participation as their instructor. This sample is an identical sample; the same people participate in both quantitative and qualitative measures across RQ1-RQ2.

Demographic information for all 19 participants is below in Table 2. There were three Asian American women enrolled in the class. Sixteen out of eighteen people in the class identified as women and two identified as men. Their ages ranged from 20s to their 50s. Four students majored in STEM in their undergraduate courses, the other 14 majored in non-STEM fields. All of the participants had taken some level of math in college, mostly statistics. I had four EPSTs placed in a kindergarten level placement, one in a k/first grade placement, three in first grade, four in second grade, two in third grade, three in fourth grade, and one across all grades as a paraprofessional.

Table 2
Participant Table

Pseudonym	Age	Self-Identified Gender	Self-Identified Race	Undergraduate Major	Grade Level
Brenda	20s	Woman	White	Human Development	1
Chloe*	20s	Woman	White	Communications	N/A
Colleen	20s	Woman	White	Exercise Science	4
Diana	30s	Woman	Biracial: Asian & White	Feminist Studies	4
Daisy	20s	Woman	White	Art	K
Emma	20s	Woman	White	Psychology	1
Hannah	50s	Woman	White	Accounting	1-5
Heather	20s	Woman	White	Communications	K/1
Ivy	20s	Woman	Biracial: Asian & White	International Studies & French	K
Jayden	30s	Man	White	Business	2
Kaila	20s	Woman	White	Studio Art	2
Kalla	30s	Woman	White (Arab)	Software Engineering	3
Karly	20s	Woman	White	Communications	K
Maggie	20s	Woman	White	Education	1
Martha	20s	Woman	White	Biotechnology	4
Mary	20s	Woman	White	Communications	2
Tamara	20s	Woman	White	Communications	K
Weston	20s	Man	White	Communications	3
Willow	20s	Woman	Biracial: Asian & White	Sociology & Journalism	2

Note. This table is a table of the participants in this study. Chloe, marked with an asterisk dropped the program after RQ1. Additionally, age is reported in decades to protect participants' identities.

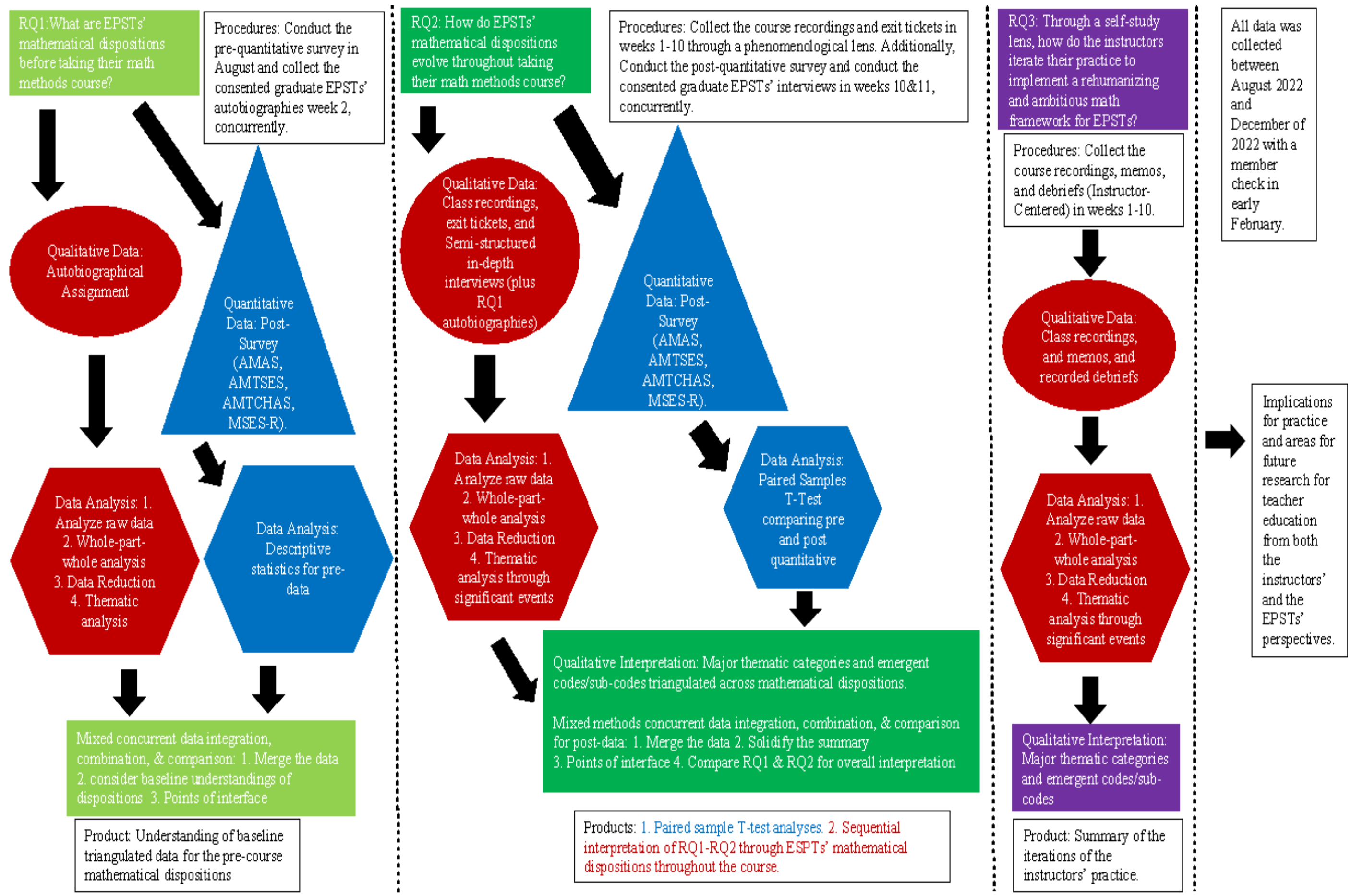
Research Design

The following section is an overview of the research design. Figure 4 below has an overview of the entire research design it includes: the research question, the procedures, the types of data collected, and how those data were analyzed. Figure 4 has qualitative data collection and analysis color-coded in red. This figure has quantitative data collection and analysis color-coded in blue. The two shades of green in RQ1 and

RQ2 denote the sequential nature of the before and the evolving phases. RQ3 is color-coded in purple as it is data collection and analysis from the instructors' standpoints instead of the EPSTs' standpoints. The purple RQ3 is the self-study throughout the course. This figure also denotes what procedures will be conducted and what products will result from every research question.

Figure 4

Overall Research Design Summary



RQ1: Math Dispositions Before

What are EPSTS' mathematical dispositions before taking their math methods course taught through an ambitious and equitable framework?

To address RQ1, I used a pre-course quantitative questionnaire and integrated autobiographical qualitative narratives to generate a baseline of ESPTs' mathematical dispositions, as seen in Figure 4. Both the quantitative questionnaire and the qualitative autobiographical narrative will be concurrently collected. The questionnaire included four constructs of math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy. I analyzed the qualitative autobiographies by reading through the raw data twice, conducting a whole-part-whole analysis, reducing the data, and conducting a thematic analysis. After separate quantitative and qualitative analyses, I integrated and compared both data types to generate a 'before' course baseline for each participant. This research question also set the tone for understanding EPSTs' mathematical dispositions that continued to develop sequentially from RQ1 through RQ2.

RQ2: Evolving Math Dispositions Throughout

How do EPSTs' mathematical dispositions evolve throughout the elementary math methods course taught through a rehumanizing, ambitious and equitable framework?

To address Research Question 2, I employed a mixed-methods approach. The qualitative data collection and analysis was conducted through a phenomenological approach. Figure 4 shows that I collected the qualitative data for RQ2 through class recordings, exit tickets, and final interviews. I also used the autobiographical data from

RQ1 to better understand EPSTs' evolution of their mathematical dispositions over time. I analyzed that data to describe the ESPTs' lived experiences with a rehumanizing, ambitious and equitable math teaching framework and how our teaching affected their dispositions throughout the course. Using the pre-course data from RQ1 and the post-course data from RQ2, I conducted a paired-samples t-test to see if there is a statistically significant difference in their mathematical dispositions before and after the course.

Part of the qualitative portion of this RQ2 was collected concurrently through semi-structured in-depth interviews. Another part of the data was collected through course recordings. I conducted a discourse analysis on all ten sessions of the course looking for especially salient moments for EPSTs and their mathematical dispositions. I analyzed both the quantitative and the qualitative separately, like in RQ1. Then, I triangulated both types of data to form a post-course level of mathematical disposition. Then, also a part of RQ2, I looked at the sequential aspect of EPSTs' mathematical dispositions from before (RQ1) and how they evolve (RQ2). This formed the pre/post mixed-methods sequential approach.

RQ3: Self-Study of Math Teacher Education

Through a self-study lens, how do the instructors iterate their practice from weeks 1-10?

To address RQ3, I employed a self-study methodology to analyze our lived experiences as co-instructors. I went week-by-week, looking at the analytic memos and the recorded debrief conversations to conduct an analysis of significant events. This data is coded by week to give a detailed understanding of how Dr. Brette and I reflected on and iterated the course content and our pedagogical strategies.

Data Collection Measures

The following sections are the measures I employed to collect data, both quantitatively and qualitatively.

Quantitative Questionnaire Measures

All of the following quantitative measures were a part of a single questionnaire given before and after the elementary math methods course (see Appendix D).

Abbreviated Math Anxiety Scale (AMAS).

Hopko and colleagues (2003) created the Abbreviated Math Anxiety Scale (AMAS). The measure has nine items ranked from *1 (low anxiety) to 5 (high anxiety)*. EPSTs responded to how anxious they would feel given certain contexts. They were instructed to imagine themselves in a college level math course. Hopko and colleagues (2003) ran a two-factor exploratory analysis: learning math anxiety and math evaluation anxiety. Both factors are relevant to this study and will be analyzed separately. Math evaluation anxiety has four items (2, 4, 8, 9). Learning math anxiety has five items (1, 3, 5, 6, 7). Scores range from 9 to 45, with higher scores indicating higher levels of math anxiety. They tested the measure's validity by comparing it to prior tested math anxiety measures, in which they found high convergent validity. Hopko and colleagues (2003) found the internal consistency of AMAS to be very high ($\alpha = .90$). They also tested the reliability through a two-week test-retest, in which they found the measure to be highly replicable (r = .85). The authors communicate that "the abbreviated measure may be an externally valid, more parsimonious, and superior measure compared with the original measurement" (p. 181). This measure will measure the EPSTs' math anxiety in both sub-constructs of learning and evaluation.

Adapted Math Teaching Anxiety Scale (AMTCHAS).

I am using the Adapted Math Teaching Anxiety Scale (AMTCHAS) measure that Bosica (2021) made minor alterations to from the original Teaching Anxiety Scale (TCHAS) for a math-specific setting. The TCHAS was developed in 1973 by Parsons for use with preservice teachers. Although this scale may seem antiquated, according to Bosica (2021), it is still heavily used today. This measure asks EPSTs to rate how frequently they feel anxiety in certain teaching situations. Bosica (2021) found an overall Cronbach alpha for the Adapted Math Teaching Anxiety Scale (AMTCHAS) to be $\alpha = .916$. This measure has a Likert scale from *1 (never) to 5 (always)*. There are 19 questions. Scores range from 19 to 95 after the researcher has reverse-coded the necessary items (3, 5, 8, 12, 13, 15, 17). A lower score indicates a lower level of math teaching anxiety, whereas a higher score indicates a higher level of math teaching anxiety. This single-construct measure will measure the EPSTs' math teaching anxiety.

Mathematics Self-Efficacy Scale Revised (MSES-R).

I employed the Math Self-Efficacy Scale Revised (MSES-R). The Mathematics Self-Efficacy Scale (MSES) predated the MSES-R and was created by Betz and Hackett in 1983 (as cited in Pajeres & Kranzler, 1997). The MSES-R was developed in 1995 by

Pajeres and Kranzler. This updated instrument tweaked the mathematical questions on the survey to focus on arithmetic, algebra, and geometry through three levels of cognitive demand: computation, comprehension, and application; in both real and abstract contexts. They also decreased the original Likert scale from 10 points to 5 points. The revised version is now a much more used version than the original. This measure asks someone to rate how confident they are in their ability to answer certain kinds of math problems. An important distinction, although people answering this survey will see math problems, they are not meant to solve them. They should only rate their confidence on their *ability* to solve them.

In 1997, Pajeres and Kranzler conducted an exploratory factor analysis on the MSES-R. They found that self-efficacy was the one substantial higher-order factor. They did find sub-constructs, but they did not stand out as much as the single factor. It has 18 items. The Likert scale used goes from *not at all confident (1) to completely confident (5)*. Scores range from 18 to 90. The higher the score, the more self-efficacy, and confidence the respondent reported. Pajares and Kranzler (1995) found Cronbach's alpha to be $\alpha = .95$, which is a very high internal consistency. This measure will measure the EPSTs' math self-efficacy.

Adapted Math Teacher Self-Efficacy Scale (AMTSES).

I used the Adapted Math Teacher Self-Efficacy Scale (AMTSES) in this study. This measure asked respondents to rate their level of influence as a teacher in certain contexts. The original version was the Teacher Self-Efficacy Scale (TSES) developed by

Tschannen-Moran and Woolfolk Hoy (2001). Tschannen-Moran and Woolfolk Hoy wanted to create a better scale to measure teacher self-efficacy based on Bandura's teacher self-efficacy scale. Bosica (2021) adapted the TSES to emphasize mathematics, which I named Adapted Math Teacher Self-Efficacy Scale (AMTSES). The AMTSES employed the short form of the TSES. This scale is rated on a 5-point Likert scale ranging from *1 (nothing) to 5 (a great deal)*. There are 9 items. Final scores range from 9 to 45. The higher the score, the higher the EPSTs' self-reported teaching efficacy. The AMTSES scale, adapted by Bosica (2021), found three underlying constructs: efficacy for pedagogical strategies, classroom management, and student engagement. The Cronbach alpha coefficient for these three subscales is .91, .90, and .87, respectively. Bosica (2021) found that a single construct for describing efficacy was better than the three for the preservice teacher setting (Bosica, 2021). So, I will see this as a single factor construct. This measure will measure the EPSTs' Math teacher self-efficacy.

Qualitative Measures

The descriptions of the qualitative measures are below. The autobiography was collected in Week 2, the course recordings were collected from Weeks 1-10, the exit tickets were collected Weeks 2, 4, 7, and 10, the analytic memos were after every course Weeks 1-10 and the interviews were conducted in the two weeks after the course had concluded.

Math Autobiography.

The EPSTs' first assignment in their elementary math methods course was a mathematical autobiography, due Week 2 (see Appendix D). All EPSTs in the course wrote this assignment and all were analyzed because all of them opted to participate in the study. In the past, students who did this assignment are extremely honest about their prior experiences with mathematics; this year was no different. The EPSTs' narratives were authentic to their own lived experiences. They were not afraid to share negative experiences they had experienced in the past.

As stated earlier, autobiographical writing is a powerful tool to discover and begin to reflect on and improve mathematical dispositions (Boylard & Valentine, 2017; Dowker et al., 2016; Karunakaran, 2020; Looney et al., 2017; Maloney & Beilock, 2012; Ramirez & Beilock, 2011; Quinn, 1998). Before starting the elementary math methods course, the mathematical autobiography was a critically reflective narrative account of EPSTs' prior mathematical learning experiences. This measure unearthed the EPSTs' sense of self in relation to teaching and learning mathematics. In particular, it helped the instructors learn about the influences and experiences that shaped EPSTs' mathematics learning. This assignment acknowledged and legitimized past mathematical traumas. Additionally, this assignment encouraged EPSTs to view themselves empathetically in relation to their peers (e.g.," I was successful in a traditional math classroom but now recognize the harm it caused others"). It also allowed EPSTs to notice a deep contrast in their prior lived experiences compared to their current experiences with rehumanizing, ambitious and equitable math teaching.

EPSTs had focus questions to help them guide their story (see Appendix D). They were also encouraged to describe other things that influenced their interest and experience in learning or teaching mathematics. Some of their reflections on prior mathematical experiences were positive. We celebrated these experiences. This assignment allowed the instructors to deliberately support and extend EPSTs' personal histories, interests, and skills through rehumanizing, ambitious and equitable math teaching.

Class Recordings.

Since 2020, the course sessions were recorded in case of absence, illness, or even if EPSTs just wanted to go back and review material. Those are all still robust rationales to record the course. We recorded all of the course sessions from the Zoom for remote students and we recorded from the SWIVL for in person students. A SWIVL is a device that moves and tracks the primary marker to collect video artifacts. SWIVL also has the ability to record individual audio tracks around the room to better understand what is going on in the classroom. Additionally, the course recordings allowed both myself and my advisor to reflect on especially salient moments in class for both EPSTs and instructors. Groups of students had their own individual audio recorded so that I was able to distill small group conversations. Note, Week 5 had audio troubles and the individual audio markers did not record. Additionally, Week 3 only has a zoom recording instead of a SWIVL recording. Both of these weeks ended up having technical issues, but still had recorded content.

Some students might be overrepresented in the recordings because of the frequency that they were in-person. Dr. Brette and I allowed the EPSTs to join our course remotely (via zoom) if they communicated that they needed the accommodation. Some of these accommodations were religious, family, illness, or even work-based. The EPSTs on Zoom were not recorded in the same method as those in-person, and therefore were not included in the analysis. Additionally, certain people were quieter or harder to hear on the recorded videos. Since I only recorded some students each class period (three groups, but there were often five total groups), there are some students that show up more in the recordings. This is by chance. Some students are also external processors versus internal processors and so some students might have been more vocal about their dispositions than others. These recordings tell the story of EPSTs' mathematical dispositions throughout the course.

Exit Tickets.

EPSTs filled out exit tickets on Weeks 2, 4, 7, and 10; I refer to each exit ticket by the week of the course (e.g., Exit Ticket 2 was administered in Week 2). These exit tickets helped Dr. Brette and I to understand EPSTs' evolving mathematical dispositions, how we needed to iterate the course content, and what lingering questions they might still have (see Appendix J). Exit Ticket 2 asked EPSTS about their key takeaways and if their understanding of what it meant to be a good math teacher or student had changed. Exit

Ticket 4 asked about what was going well in the course and what was not going well in the course. Exit Ticket 7 asked about salient shifts in EPSTs' mathematical dispositions and what sorts of feelings that they have about teaching a whole class lesson. Exit Ticket 10 was an informal course evaluation. It asked EPSTs to rank their confidence and preparedness in their math teaching. It also asked EPSTs what their favorite and least favorite parts of the class were. We also asked the EPSTs if there was anything extra in the curriculum or anything missing that they would like to see. Finally, we asked them to tell us one thing they wanted us to know about their experience this quarter and if they could change one thing about the course, what would it be. The data collected from these exit tickets contributed to RQ2 and RQ3.

Weekly Debriefs and Analytic Memos.

Both Dr. Brette and I had a meeting to debrief how the class went and to prepare for the upcoming week's content after every course. These sessions lasted about an hour each. They were directly following the course on Monday evening, from about 7:30-8:30pm. They were also video-recorded on Zoom. I documented these conversations through analytic memos (see Appendix F). This template was a living document, and if both Dr. Brette and I realized that we should change something or talk about something that was not on there, we did. This document served as guidelines and topics to start the conversation, not necessarily something that we had to follow.

These conversations had a natural shared power dynamic based on two previous years of debrief meetings. These conversations unearthed *how* we went about changing and reiterating our practice as math teacher educators. Either Dr. Brette or I posed a question or had a thought that drove the conversation. We worked together exceptionally collaboratively, and both took the lead in these conversations at different times. We were genuinely respectful of each other's voices, listened carefully, pursued clarifications, and created a deep level of synergy. When we disagreed, we sought out more information and additional viewpoints to improve our collective work. We consistently attempted to see the situation from each other's perspectives, which added to trustworthiness. Both Dr. Brette and I made ourselves vulnerable through these productive conversations. The dialogue from these meetings included analysis, reflection, critique, and action steps. Throughout the methods course, Dr. Brette and I served as critical friends, encouraging each other, asking insightful questions, and sometimes gaining divergent views. These conversations honored each other's strengths, valued each other's contributions, and considerately interrogated our practice. Hoban and colleagues (2007) highlighted the importance of social support to implement change when completing a self-study. Dr. Brette and I were each other's social support, accountability partners, and collaborators.

Semi-Structured Interviews.

I conducted interviews with all 18 EPSTs that consented to participate in this research. The interviews focused on the qualitative nature of the entirety of the EPSTs' lived experiences and shifts in mathematical dispositions throughout the course. The interview template is included in Appendix H. These interviews were about 30 minutes long, video-taped, and transcribed. Some of the interviews were in-person and some were online, based on the participants deciding which modality worked best for them. In-person interviews took place in my office on campus; online interviews took place on Zoom.

Data Collection Procedures

Figure 4 summarizes the procedures; the following section goes into more detail. The initial pre-quantitative questionnaire was given to the EPSTs in their second summer orientation session on August 25th. Dr. Brette presented the questionnaire to the EPSTs at their second orientation. The questionnaire included the four measures that make up mathematical disposition in this study. The questionnaire consisted of the following constructs and their measurements: math anxiety (AMAS), math teaching anxiety (AMTCHAS), math self-efficacy (MSES-R) math teacher self-efficacy (AMTSES). AMAS, AMTCHAS, MSES-R, and AMTSES were included in the questionnaire (see Appendix D) given to prospective participants. This Qualtrics questionnaire had implied consent for the quantitative questionnaire and then a secondary consent for the rest of the study throughout the math methods course (see Appendix C).

On September 12, the fall quarter began, which marks the beginning of the elementary math methods course. EPSTs had already decided if they wanted to opt in or out of the study through the questionnaire. All of them opted in. In Week 2, they all turned in their math autobiography (see Appendix E). All students completed the assignment and consented to be in the study, so all 18 submissions were analyzed. This data collection was concurrent and in the same first phase of the overall sequential design.

Throughout the course, there was data collected in Weeks 1-10 through analytic memos, exit tickets, and course recordings. I recorded every session of the course using the same SWIVL methods (except for Weeks 3 and 5, which had technical difficulties). Even in Weeks 3 and 5 there was a recording, just not a SWIVL and small group audio recording. So, these weeks still had video content to review. After every course session, there was an instructor post-debrief conversation reflecting and pre-planning meeting talking about our upcoming session. Both the instructors critically reflected, and I took analytic memos during the discussions (see Appendix G). This data collection was used in RQ2 and RQ3, the second phase of the research design.

The students retook the quantitative questionnaire at the end of the course. I conducted the questionnaire on the last day of the course in addition to the course evaluation. However, because of how tired EPSTs' were, many of them completed the survey in the following days, rather than the last day of class. All of the EPSTs did end up completing the post-questionnaire. The EPSTs then signed themselves up for a time to participate in an in-depth interview in the two weeks following the end of the course. This interview triangulated the post-methods course mathematical dispositions. During class collection of data, qualitative interviews and the quantitative questionnaire will be collected concurrently for the final evolving phase of the overall sequential data collection.

The final procedure for this study is member-checking. After all of the data was collected from the participants and an initial analysis completed, I conducted member-checking. Member-checking happened asynchronously via email on February 3rd. I presented EPSTs with a summary of how their dispositions evolved to ensure that my research with my participants is trustworthy and valid (see Appendix I). The participants were encouraged to respond via email, voice memo, or phone call with any comments or concerns. Two-thirds of the students responded and confirmed that their summary was indeed reflective of their experiences in the elementary math methods course. I told the EPSTs that if they did not respond within ten days that I would assume that their data was accurate; one-third did not respond. Additionally, there was one participant that I had additional follow-up questions for, Diana. I had to ask her about her sharp increase in math anxiety because of math testing anxiety.

Data Analysis

The following sections outline how I analyzed the data, both quantitatively and qualitatively, through an emergent lens (Saldaña, 2021). I hypothesized that the mathematical disposition scores, and qualitative data as a whole would evolve more positively throughout the course. It is important to note that RQ1 and RQ2 were analyzed through the disposition literature with some overlap from the rehumanizing, ambitious, and equitable literature. This overlap is because the course that aimed to employ this framework as the catalyst for change in EPSTs' dispositions. RQ3 was solely analyzed through the rehumanizing, ambitious, and equitable framework.

RQ1: ESPTs' Math Dispositions Before

Table 3

Summary of RQ1

Research Question	Design	Data Collection	Data Analysis
RQ1 What are EPSTs' mathematical dispositions before taking their math methods course taught through a rehumanizing, ambitious and equitable framework?	Mixed	Quantitative Data (Appendix D): Pre-Questionnaire (AMAS, AMTSES, AMTCHAS, MSES) Qualitative Data: Autobiographical Assignment (Appendix E)	Principal Conceptual Framework: Mathematical dispositions Qualitative Data Analysis: 1. Analyze raw data 2. Whole-part-whole analysis 3. Data Reduction 4. Thematic analysis Quantitative: Descriptive information on baseline dispositions Mixed: Integrate data from the questionnaire and their narrative reflections to create an understanding of their baseline mathematical dispositions.

This question described the EPSTs' range of mathematical dispositions before they began their elementary math course. To determine EPSTs' baseline mathematical dispositions, I analyzed the raw data and did a whole-part-whole analysis for the qualitative data. I found inductive codes from the autobiographies. I also had pre-determined deductive codes for mathematical dispositions. Next, I went through a data reduction phase. Lastly, I conducted a thematic analysis of EPSTs' mathematical dispositions that began to surface in the before section (e.g. Table 3).

I analyzed the data from two different inductive perspectives: future teacher and learner experiences with math. Future teachers' perspectives had to do with them imagining themselves teaching math and learners' perspectives had to do with EPSTs reflecting on their experiences in the past and what they predict the future will be like as math learners. In the autobiography, there were prompts for EPSTs to think about their prior experiences as learners and their thoughts about being a future math teacher. The learners' perspectives asked EPSTs to narrate some of their math educational experiences. The teachers' perspectives asked EPSTs to predict the impact of their relationship with mathematics on their students.

While analyzing the autobiographies, there were four deductive codes of math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy. In addition to the overarching perspectives of teacher or learner, there were two inductive categories of negative experiences and positive experiences. All of the EPSTs' reflections fit into a perspective of teacher or learner and then a positive or negative category. The sub-themes nested within the learners' perspectives in the negative experiences category are content specific, relationship specific, societal pressures, and mathematical dispositions. The sub-themes nested within the learners' perspectives in the positive experiences category are *content specific*, *relationship specific*, and *mathematical dispositions*.

Quantitative data for RQ1 was collected through the pre-questionnaire (see Appendix D). At this stage in the data analysis process, I conducted a descriptive analysis of the quantitative data by finding the mean, median, and standard deviation. I took the scores from the four different sections of the questionnaire and standardized them in both the pre- and the post-questionnaires by dividing each of them by the number of questions that the measure contained. This way, all of the measures' final scores were out of five so that I could better compare across measures. I did this because some of the measures had more or fewer or longer number of questions, making them difficult to compare across constructs. If they all have the same range or a 1-5 score, then comparison between measures is possible. Otherwise, attempting to compare scores across measures would be unproductive (i.e. comparing a score out of 5 to a score out of 19 would make analyses complicated). The highest score that an EPST could have is 5, and the lowest is 1.

I created a categorization for quantitative scores that would be specific and sensitive enough to differentiate across all 18 of my participants. I created six category descriptors for the quantitative data based off of a more specific version of Bosica's (2021) three category descriptors. The data in three categories did not show integral subtle distinctions for our EPSTs. The lowest category is *extremely low* (1.0-1.5). The next lowest category is 1.6-2.0, which is *very low*. *Low* is the response score of 2.1-2.5. *Some* is the response range of 2.6-3.0. *Moderate* is the response range of 3.1-3.5. *High* is 3.6-4.0. *Very high* is the response range 4.1-4.5. Lastly, *extremely high* is 4.6-5.0. These categories were created by me to ensure that they were sensitive enough to show the variation in mathematical dispositions. For anxiety, higher scores indicate a more negative disposition. For self-efficacy, higher scores indicate a more positive disposition

The quantitative data served as data triangulation with the qualitative autobiographies to generate a baseline of the 'before' mathematical dispositions. The quantitative data served as a descriptive understanding of what levels of mathematical dispositions the students came into our class with. I brought the two strands together by documenting points of agreement and disagreement through congruence. The first step was to compare and contrast the data, merge the data, and consider the potential overarching baseline understandings. While merging the data, I paid special attention to the interface points. I focused on how the quantitative data enhance the qualitative data and vice versa, or where there are points of contradiction. I will bring the two strands together by documenting points of agreement and disagreement through congruence and integration. These mixed methods results are both additive and comparative (Bazeley, 2017). They are additive in the sense that neither the qualitative nor the quantitative are as strong on their own and they contribute to a fuller understanding of mathematical disposition when presented together. However, at times the analysis is comparative because of the level of agreement or disagreement of the qualitative versus the quantitative results.

There are instances of the qualitative data enhancing the quantitative data (Bazeley, 2017). There are instances where the qualitative data confirms the quantitative data, or they both are in full agreement (Bazeley, 2017). There are instances of mixed results where both sets of data are in partial agreement (Bazeley, 2017). Lastly, there are also instances where the qualitative data contradicts the quantitative data, which is called dissonant (Bazeley, 2017). I will give examples of each of the categories that Bazeley (2017) created. Specifically, I explained how the data between the qualitative and quantitative either enhanced, confirmed, mixed, or was dissonant when comparing the two types of data.

RQ2: ESPTs' Evolving Math Dispositions Throughout

Table 4

Summary of RQ2

RQ	Design	Data Collection	Data Analysis
RQ2 How do EPSTs' mathematical dispositions evolve throughout their math methods course taught through a rehumanizing, ambitious and equitable framework?	Mixed	Qualitative: Class recordings, exit tickets (Appendix J), and semi-structured in-depth interviews (Appendix H) [+ math autobiography from RQ1] Quantitative: Post-Questionnaire (Appendix D) [Plus the pre-questionnaire from RQ1]	Principal Conceptual Framework: Mathematical dispositions Qualitative Data Analysis: 1. Analyze raw data 2. Whole-part-whole analysis 3. Data Reduction 4. Thematic analysis Quantitative Analysis: Paired Samples t-test comparing pre and post Mixed: Mixed methods concurrent data integration, combination, & comparison for post-data: 1. Merge the data 2. Solidify the understandings 3. Points of interface 4. Compare RQ1 & RQ2 for overall interpretation

In this question, I sequentially analyzed the results of RQ1-RQ2, or the before and the evolving mathematical dispositions of EPSTs. This research question is mainly phenomenological. Phenomenological studies start with multiple individuals' data and their commonalities as they experience a phenomenon (Creswell & Poth, 2017). I analyzed all forms of qualitative data in their raw form twice, then conducted a whole-part-whole analysis to reduce all of the data down to significant statements (horizonalization). For the course recordings, I conducted a discourse analysis, to see what aspects of mathematical dispositions changed and what stayed the same (e.g. Table 4). Not all eighteen EPSTs will be discussed in the results of RQ1 or RQ2. Some EPSTs' qualitative data stood out in different aspects of their mathematical dispositions and will be discussed in some of the themes and not the others.

Throughout surveying what aspects of mathematical disposition shifted and what aspects stayed stagnant, I realized that, like with the RQ1 data, RQ2 data should also be split into shifts in disposition from the future teachers' perspectives as well as shifts in disposition from the learners' perspectives. I created clusters of meaning (categories, themes, and sub-themes from the horizonalization). Next, I reduced the data and conducted a thematic analysis to see what understandings were forming in the 'evolving' phase of this sequential research.

The categories of analysis were the predetermined deductive codes for mathematical disposition. Within the categories, I found inductive themes from the qualitative data. Each construct of mathematical disposition had its own inductive themes. I distilled the "essences" of the phenomenon of EPSTs' experiences in an elementary math methods course taught through a rehumanizing, ambitious and equitable math framework (Creswell & Poth, 2017).

Quantitatively, the ESPTs took the same questionnaire that they took before the course to see if there is any significant statistical difference in their mathematical dispositions before and after the rehumanizing methods course. The data was analyzed through a paired samples t-test. I predicted that both the overall score of mathematical dispositions, and the individual constructs will improve.

Like RQ1, I will frame two (one positive and one negative) salient examples from the teachers' and the learners' perspectives of mixed methods comparison in the enhanced, confirmed, partial agreement, and dissonant categories. I detailed how the quantitative and the qualitative results synthesize into a better mixed methods understanding of the evolution of EPSTs' mathematical dispositions than either quantitative or qualitative data does on its own.

RQ3: Self-Study of Math Teacher Education

Table 5

Summary of RQ3

RQ	Design	Data Collection	Data Analysis
RQ3 Through a self-study lens, how do the instructors reflect and iterate their practice?	Qualitative self-study	Debrief recordings, exit tickets (Appendix J), and analytic memos (Appendix G)	Principal Conceptual Framework: Rehumanizing, Ambitious, and Equitable Math 1. Analyze raw data 2. Whole-part-whole analysis 3. Data Reduction 4. Thematic analysis through significant events

Throughout the course, RQ3 informed the results of RQ1 and RQ2. The iteration and practice of the instructors will encourage shifts in mathematical dispositions. This research question was entirely qualitative. I analyzed the debrief recordings, the analytic memos, and the exit tickets for RQ3 (e.g. Table 5). Like the other qualitative sections of this study, I analyzed the raw data twice. Specifically, this data was analyzed from the instructors' standpoints, so, Dr. Brette and my perspectives of our practice. Then, I conducted a whole-part-whole analysis and data reduction. Then I conducted a thematic analysis through the lens of significant events. The self-study had five themes that I wrote chronologically.

This self-study method was highly relational, just like the act of teaching and learning, and was always in connection with others. This method also encouraged instructors to critically reflect on their teaching to improve it. Both Dr. Brette and I participated in a social-constructivist version of *validating* (Billups, 2019). Validating is considered a process in self-study. The reader is the one who concludes that this self-study was valid when they consider if the information provided was informative and relevant. The conclusion summarized the lived experiences of the instructors changing and iterating their course through the rehumanizing and ambitious math teaching framework.

Chapter Four: Results

EPSTs' dispositions before taking the course were wide-ranging, especially quantitatively. Qualitatively, there were obvious shared experiences that began telling stories. Most EPSTs had a mix of positive and negative past experiences. Both their positive and negative prior experiences could be distilled down to content-based, relationship-based, and disposition-based reflections. Although many of the EPSTs had positive experiences, those reflections did not make as much of an impact on their dispositions as the negative experiences did.

This chapter outlines the results of all three of my research questions, beginning with RQ1, then RQ2, and ending with RQ3. RQ1 includes both the qualitative and quantitative data coalescing to illustrate EPSTs' dispositions before the course. I analyzed RQ2 data through a mixed methods explanation of how EPSTs' dispositions evolved throughout the course. Throughout the qualitative results, I highlighted the EPSTs' salient positive and negative experiences as they relate to the themes that I generated. RQ3 is the qualitative self-study looking at the iterations of Dr. Brette's and my teaching.

RQ1: EPSTs' Math Dispositions Before the Course

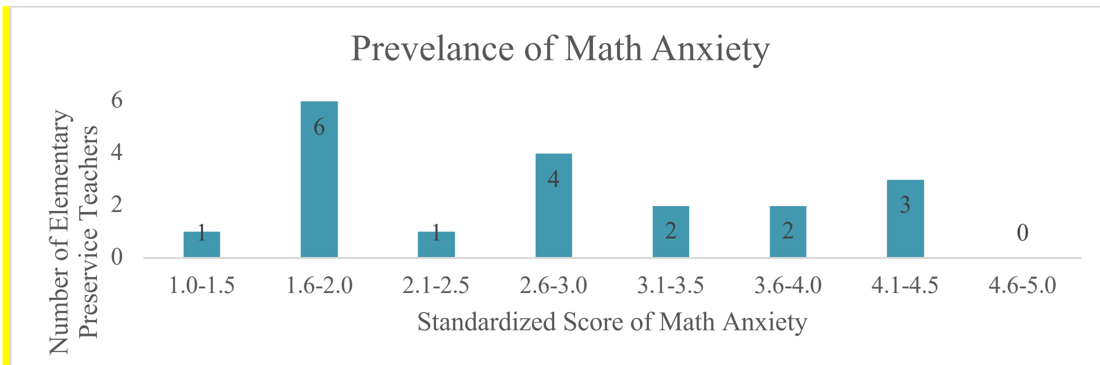
This research question was analyzed through the four constructs of mathematical dispositions; though, there was some overlapping data in the rehumanizing, ambitious, and equitable framework as well. The quantitative results revealed that EPSTs' described their dispositions in a diversified way— some students reported really positive dispositions, some reported really negative dispositions, and everything in between. Some of the positive dispositions were driven by *high* self-efficacy and *low* anxiety. Some of the negative dispositions were driven by *low* self-efficacy and *high* anxiety. There were also wide-ranging responses as to whether teaching or learning was the main source of negative dispositions, and vice versa— whether teaching or learning was the source of positive dispositions. In the upcoming qualitative and mixed methods sections, additional nuance from the triangulation of the data portray more complex stories. With the additional complexity from the EPSTs' autobiographical narratives, I gained a better understanding of the 'why' behind EPSTs' dispositions; I was able to see throughlines about how content, relationships, and societal pressures impacted EPSTs' mathematical dispositions.

RQ1: Quantitative: Pre-Questionnaire

Learners' Perspectives: Math Anxiety (AMAS).

EPSTs enrolled in the course reported a varied range of math anxiety before the course began, this range was anywhere from *extremely low* (1-1.5) to *very high* (4.1-4.5) math anxiety (see Figure 5 below). The average score of all of the participants was 2.71 and the median score was 2.78 (SD= 1.03). Again, EPSTs reported a variation amongst levels of math anxiety; these results have a large standard deviation, which demonstrates that there are a wide range of responses to the math anxiety questions in this questionnaire. Some EPSTs reported *low* math anxiety, some reported *high* math anxiety, and some were in between.

Figure 5
Prevalence of Math Anxiety



Note. This figure is a histogram distribution of math anxiety before the EPSTs took the elementary math methods course. Higher scores reflect higher math anxiety and therefore more potentially negative mathematical dispositions.

The scenarios that provoked the most anxiety for EPSTs were the math evaluation questions, which assessed a sub-construct of math anxiety that is often referred to as math testing anxiety. There were three questions about math evaluation/testing anxiety:

2. Thinking about an upcoming math test 1 day before.

[Low-1, Some-2, Moderate-3, Quite a bit-4, High-5]

Mean: 3.47

4. Taking an examination in a math class.

[Low-1, Some-2, Moderate-3, Quite a bit-4, High-5]

Mean: 3.40

8. Being given a pop quiz in a math class.

[Low-1, Some-2, Moderate-3, Quite a bit-4, High-5]

Mean: 3.60

The test anxiety questions invoked more math anxiety when compared to the math learning anxiety questions. Math testing anxiety means were between 3.40 and 3.60 for the questions listed above. The learning anxiety questions, however, invoked relatively less math anxiety, with means between 2.00 and 2.40. The EPSTs' responses to the math test anxiety sub-construct indicates that many EPSTs came into the elementary math methods course with higher anxiety around math tests than math learning. The pop quiz question being the highest level of anxiety also indicated that not knowing about an exam was more stressful than knowing it was coming, though not by much. A better understanding of where the EPSTs' math anxieties come from and in what contexts they present themselves allowed for Dr. Brette and me to have a more detailed and nuanced approach to beginning to shift mathematical dispositions of the EPSTs.

In general, EPSTs had a range of math anxiety entering the classroom, but the responses to the math testing anxiety factor had higher levels of anxiety than math learning anxiety. The higher levels of math test anxiety is similar to what both Hembree (1990) and Bosica (2021) found in their research. The range of math anxiety responses is comparable to what is found in Bursal and Paznokas (2006), where the breakdown was that about 30% of EPSTs reported *low*, 30% *moderate*, and 30% *high* math anxiety.

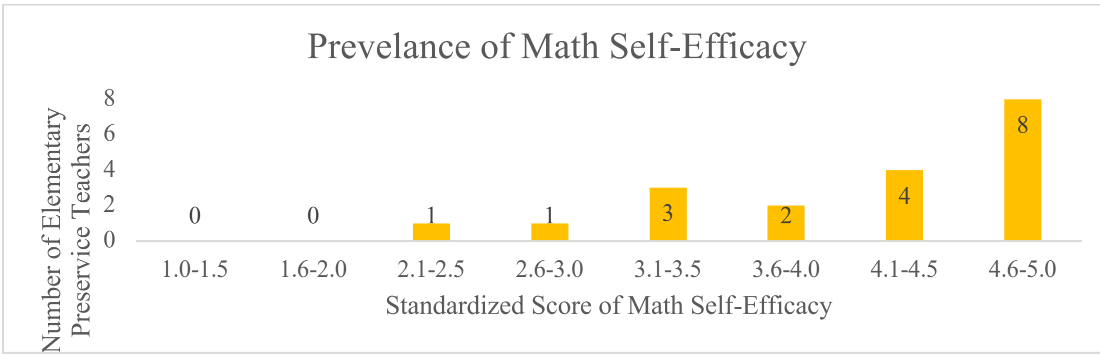
Learners' Perspectives: Math Self-Efficacy (MSES-R).

EPSTs enrolled in the course had anywhere from *low* (2.10-2.50) to *extremely high* (4.60-5.00) math self-efficacy (see Figure 6 below). The average score of all of the participants was 4.04, which is *very high*, and the median score was 3.83, which is *high* (SD= .76). EPSTs' responses to the math self-efficacy were less varied than math anxiety. They had a lower standard deviation and were more clustered together. Additionally, the math self-efficacy questions indicate the potential for much higher EPST dispositions. Figure 6. displays a trend of more positive mathematical dispositions than math anxiety.

Overall, EPSTs tended to come into this course with a belief in themselves as mathematicians. They believed that if they attempted to do math problems that they would be successful in doing so, as evidenced by 14 EPSTs reporting levels at or above *high* self-efficacy. Gresham's (2008) findings were analogous to my findings, that EPSTs come in with varied levels of self-efficacy. However, Looney and colleagues (2016) found that "a majority" of their EPSTs in the study had low efficacy, which does not correspond to the EPSTs enrolled in this class. Context matters for mathematical dispositions, something about our context might have encouraged higher self-efficacy than the Looney and Colleagues (2016) study. One contextual factor that might affect self-efficacy is that this course was taught in a graduate school setting and therefore EPSTs trended older. A second contextual factor that might have positively affected self-efficacy is the type of institution, our context is a selective private graduate school program. A third contextual factor is the cohort model of their teacher education program, these EPSTs all knew each other and began to form relationships since summer classes and orientation months prior, which could have increased their beliefs in their abilities because of the support that they feel and the relationships they have built.

Figure 6

Prevalence of Math Self-Efficacy



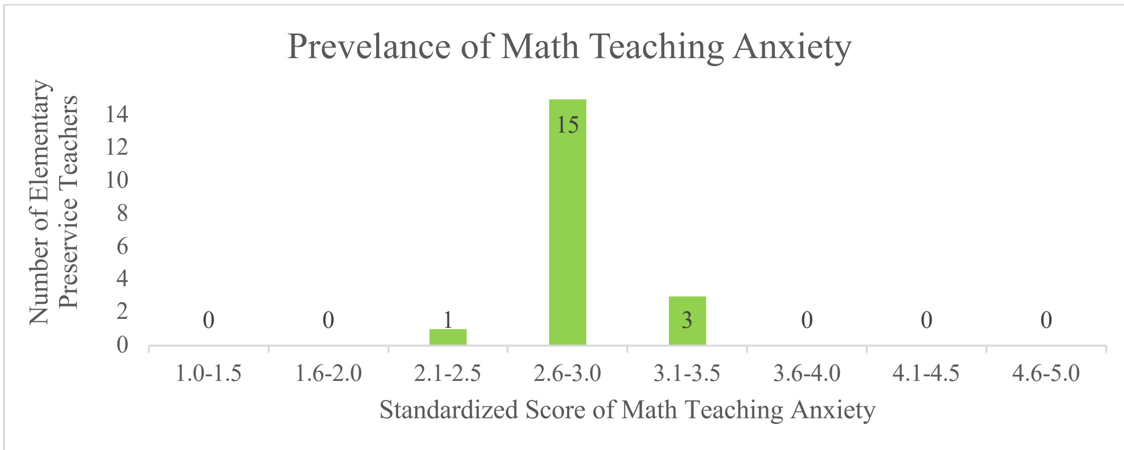
Note. This figure is the distribution of math self-efficacy before the EPSTs took the elementary math methods course. The higher the score the higher the mathematical self-efficacy and therefore the more positive the mathematical disposition.

Teachers' Perspectives: Math Teaching Anxiety (AM-TCHAS).

EPSTs enrolled in the course had anywhere from *low* (2.10-2.50) to *moderate* (3.10-3.50) math teaching anxiety (see Figure 7 below). The average score of all of the participants was 2.91 and the median score was 3.11 (SD= .528). EPSTs, on average, had more anxiety about teaching math than they had about doing it. Likely, this is because the EPSTs were beginning their teacher education program, so they might not have had as much experience teaching as they did with learning math. The especially salient finding from these results is that EPSTs' responses across all 18 participants are quite similar. They all fell within the range of *low* to *moderate*, with the modal score of 15 EPSTs that are in the *some* math teaching anxiety category. Math teaching anxiety has a clear theme for this group of EPSTs; they almost all came into this course with the same level of math teaching anxiety. This category has much less variance than the learners' perspectives categories of math anxiety and math self-efficacy.

Figure 7

Prevalence of Math Teaching Anxiety

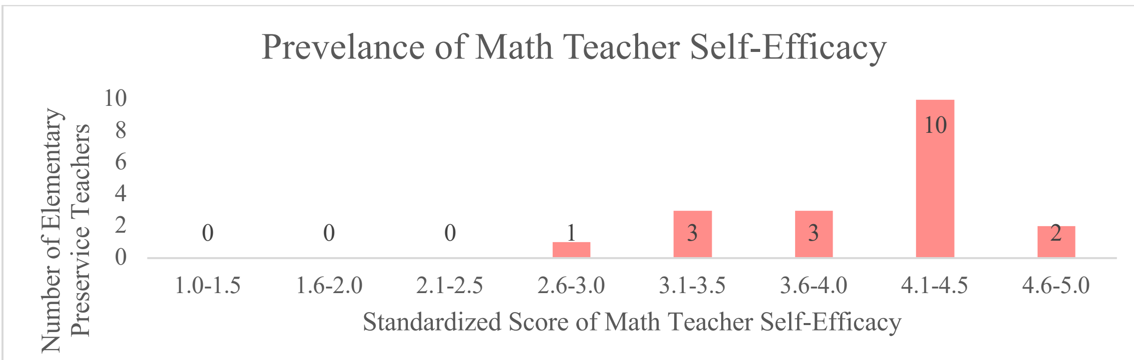


Note. This figure is the distribution of math teaching anxiety before the EPSTs took the elementary math methods course. The higher the score the higher the mathematical teaching anxiety and therefore the more negative the mathematical disposition.

Teachers' Perspectives: Math Teacher Self-Efficacy (AM-TSES).

EPSTs enrolled in the course had anywhere from *some* (2.10-2.50) to *extremely high* (4.60-5.00) math teacher self-efficacy (see Figure 8 below). Both the average (3.90) and the median (4.00) scores fell into the *high* math teacher self-efficacy category (SD= .54) EPSTs had higher math self-efficacy than they did math teacher self-efficacy. This suggests that they felt more confident in their abilities to do math rather than to teach it. Again, because the participants are at the beginning of their program so they lack experience teaching math. Their math teacher self-efficacy may be related to the fact that they were less confident around teaching compared to learning math, which they have done in K-12. Like math teaching anxiety, the math teacher self-efficacy results are also clustered. The range is from *moderate* to *extremely high*. Most of the EPSTs fell into the *very high* category. EPSTs who self-reported relatively higher math teacher self-efficacy are more likely to have positive mathematical dispositions from the teachers' perspective (Briley, 2012).

Figure 8
Prevalence of Math Teacher Self-Efficacy



Note. This figure is the distribution of math teacher self-efficacy before the EPSTs took the elementary math methods course. The higher the score the higher the mathematical teacher self-efficacy and therefore the more positive the mathematical disposition.

RQ:1 Qualitative: Autobiographies

As shown in the quantitative results, our EPSTs had pretty varied relationships with math. The narrative around teaching math was more concise and clear as a group than the narrative around learning math, which signals a wider range of prior experiences as learners. The qualitative autobiographical results give more insight and nuance into how these mathematical dispositions developed from the learners' perspectives.

A visual representation of the categories, themes, and sub-themes of the EPSTs' autobiographical narratives are below in Tables 6-9. Each table is either positive or negative and from either teachers' perspectives or learners' perspectives. EPSTs had experiences in both the positive and negative categories, which each had their own subsequent sub-themes (e.g. Tables 6-9). Also included in Tables 6-9 is the number of EPSTs that reported the sub-theme; the colors coincide with the subsequent smaller categories. For example, below in Table 6. negative learners' perspectives have specific themes and sub-themes. The first theme, negative content specific experiences (seen below in red); the content specific theme has four sub-themes of negative mathematical topics or methods of teaching, tracking, too much effort, and disengaging. The following sub-themes in Tables 6-9 are listed from most experienced to least experienced among this set of EPSTs. All of these categorizations are connected by color code across the tables.

(-) RQ1: Qualitative: Autobiographies

The EPSTs reported negative themes in their autobiographies surrounding the content of math itself, the relationships EPSTs formed in their learning environments, societal pressures, and mathematical dispositions. EPSTs most commonly reported negative experiences with mathematical content. Every single EPST narrated some negative occurrences in their past. Just because an EPST reported negative encounters with math does not mean that their overall disposition will be negative.

Table 6
Negative Learners' Perspectives

Category	Theme	Sub-Themes (# of EPSTs)
(-) ESPTs Negative Experiences in Math	Negative Content Specific (Inductive)	Negative Mathematical Topics or Methods of Teaching (12) Tracking (9) Too Much Effort (6) Disengaging (3)
	Negative Relationship Specific (Inductive)	Negative Teacher Specific Experiences (13) Negative Experiences with Other People in the Math Environment (5)
	Societal Pressure (Inductive)	Historically Marginalized Identities (4)
	Negative Mathematical Dispositions (Deductive)	Negative Math Self-Efficacy (9) Not a 'Math Person' (4) Negative Math Anxiety (4)

Note. This table includes the categories, themes, and sub-themes that came from the EPSTs' mathematical autobiographies from the negative learners' perspectives.

(-) Learners' Perspectives: Content: Negative Topics or Teaching Methods.

For many EPSTs, their negative experiences with mathematics were rooted in the content that they learned rather than their mathematical relationships (e.g. teachers, parents, or others in their lives) or societal pressures. Many of these experiences with mathematics were rooted in specific topics or instructional methods that EPSTs found to be particularly difficult and dehumanizing. This was the most common sub-theme, with 12 EPSTs noting negative experiences with how mathematics was presented to them (e.g. Table 6). This was so common, in fact, that some EPSTs with generally positive dispositions still described negative classroom experiences from the topic or the method of teaching. One of the negative mathematical methods of teaching that five EPSTs mentioned is their negative experiences with memorization.

The EPSTs shared experiences of harm when it came to memorization as a mathematical method of teaching. They further explained instances of their teachers' expectations with content and regurgitating it back to them, like Diana said in her autobiography: "I never fully understood the math in depth, but I was smart enough to skate by with memorizing the content." Diana went on to explain that this kind of math worked for her through calculus, which, she said, was her "demise" because she couldn't just memorize anymore. Diana's experience with memorization in math showed the damage that not knowing the conceptual side can do. An additional narrative around memorization that EPSTs illuminated in their autobiographies was speed and accuracy, they talked about those things taking precedent to a genuine conceptual understanding of mathematics. Memorization is a key tenet of more traditional pedagogical approaches, which position only some students as meaning-makers and contributors to the classroom as fast mathematical reciters. As Diana showed, even fast mathematical reciters end up being harmed by memorization methods; it catches up eventually.

Another student, Kalla, who had a very positive mathematical disposition overall, described in her autobiography that her tests were "timed to the milliseconds" and her teachers all employed a "sink or swim" strategy. Both timing and the traditional notion that someone either understands the math content or doesn't is embedded in a very traditional instructional style. This is not a supportive way to teach students, so it makes sense that her reflections were negative when they were taught math this way. Despite these experiences, she persevered and managed to get past her teachers' early focus on memorization as problem solving.

All of the EPSTs who disclosed memorization-based negative experiences experienced this in upper elementary school or early middle school. This is a pivotal age in math, as at this time, students learn multiplication and division for the first time; often, this is when the students no longer receive the 'why' behind procedures in math. They are just expected to apply procedures over and over, which does not benefit them.

Building on memorization as a negative method of teaching, four EPSTs noted a lack of logic and reasoning behind the mathematics they were learning in upper elementary school. One student, Brenda, another EPST with a generally positive disposition, said in her autobiography, "rarely did I have a true understanding of what I was being asked to complete." This statement resembled quotes from three other EPSTs in their autobiographies. Martha noted her stress in the math classroom with procedural methods:

> I felt that all my skills and efforts were insufficient. No matter how hard I tried, I couldn't stop making small mistakes. It was the same story every time. I did every step right, but because I wrote three instead of four, the whole problem was wrong, and I got a zero. I never got partial credit for getting the right steps or getting close. It was all or nothing.

Martha's experience was a dehumanizing manifestation of teaching procedurally. EPSTs reflected on the procedural nature of their prior math learning experiences, which is relevant to how they formed their understandings of learning math before our course. If most of the EPSTs were taught in a procedural way, then it could be difficult for them to relearn the content in a conceptual way. Despite the challenge, re-learning mathematical concepts allows EPSTs to recreate an understanding of self in relation to mathematics, wherein they begin to see themselves as mathematicians.

Many EPSTs also noted an inability to understand the content because of the lack of context and applicability of the math they were learning to their own lived experiences outside the classroom (11 EPSTs). In other words, they did not know the ‘why’ behind the math. They did not feel that what they were learning was applicable because they did not understand the big underpinning ideas. They were not motivated to learn math because they could not see how it applied to their lives. This sub-theme also addressed pedagogical approaches of their teachers. Often the pedagogical style and the content itself were so intertwined that they had to be coded together. EPSTs experienced math as systematic and boring. One student, Martha, noted in her autobiography that she experienced the subject of math through a lens of “sheer boredom." Two EPSTs explicitly called math a ‘chore.’ Additional aspects of teaching methods that were noted in the negative topics or methods of teaching were improperly implementing “flipped classrooms” with a lack of scaffolding, workbooks and worksheets, no real-world connections to daily life or jobs, and math not being hands-on enough. If EPSTs experienced math this way, then they were likely to have a negative disposition around math and are likely to default to teaching in these ways (Brady & Bowd, 2005; Geist, 2010; Vinson, 2001).

These experiences with negative mathematical topics or methods of teaching are directly relevant to how EPSTs enter their methods classroom and what mathematical baggage they bring with them. Prior research shows that EPSTs with negative experiences often keep their negative dispositions rather than evolve into a more positive disposition, they are also more likely to be resistant to teaching in conceptual ways (Althauser, 2018; Bosica, 2021).

(-) Learners' Perspectives: Content: Tracking.

Half of the class (9 EPSTs) mentioned negative experiences with tracking in their autobiographies. Five of the nine EPSTs mentioned that tracking caused segregation in their courses. All of the EPSTs that mentioned segregation explained that the lower tracked classes were more diverse in race and ethnicity than the higher tracked (e.g. honors, advanced, AP), which were all less diverse (i.e. more white, more middle class). Some students, like Colleen and Brenda, noted that the higher-tracked courses made their negative experiences with math more frequent and more intense. Specifically, Colleen noted in her autobiography that her advanced courses in high school "broke her passion" for math. Brenda explained that she was put into a pilot program for an advanced track of math and that was stressful, the pace was too fast, and she did not feel like she understood the content well. Tracking had a negative impact on these EPSTs, even those tracked into higher level courses.

Weston failed out of a higher tracked math classes in middle school because he did not keep his binder organized enough for his teacher. He explained in his autobiography that he knew the content, but the teacher cared more about compliance and structure. He continued to explain in his autobiography that his failing out of the higher tracked math class led to a completely different dynamic in the classroom for both teachers and students. He explained that the lower-track teachers taught math through more rote methods and gave less time for discussion. He explained his experiences in the lower math track were established in the 'drill and kill' methods versus a more discourse-based model in the higher-level math classes. Martha elaborated in her autobiography and said that, "the [lower-track] math teachers were often stricter, while there was a friendlier, more discussion-based atmosphere in my AP classes…The AP teachers expected high-quality, creative work, while the [lower-track] math teachers supplied us with an endless amount of monotonous worksheets." Both Weston and Martha's lower-track experience point to a more procedural and less conceptual mathematics learning experience. Teachers in the lower tracked courses also seemed to have lower expectations for their students, which in turn decreased the output from the students because they understood that their teachers did not think they could produce high-level work.

Another EPST, Chloe, told a story of her lower-track math teacher sitting down with her parent in a conference discussing Algebra I. In the meeting, her teacher said that it would be hard for Chloe to focus in a classroom with "all of these students." Chloe elaborated in her autobiography that the only students of color in her grade were in that algebra course with her and they were clearly being marked as disruptive. This meeting still sticks with her today and she now realizes the deep racist undertones that her teacher was sending, claiming that a classroom of students of color would make Chloe under-perform.

Like Chloe, Tamara also had a negative experience with tracking. She reflected in her autobiography that her teachers in the lower-tracked courses, which she actively chose to take, were more supportive of her learning. When she had the autonomy to track down to a lower course she was more comfortable and received better support from her teachers. Another EPST, Heather, echoed this type of positive experience when she chose to be in a lower-tracked class. Tamara's and Heather's experiences were different and much more positive than the EPSTs that were forced to go up or down a track. This sense of agency is important in tracking. Oftentimes, tracking is not a student's choice, but just a placement by the school. When the student does not have autonomy, the experience tends to be negative, no matter if the EPST was tracked high or low. But if the student got to choose the track, the experience tended to be more positive.

Only the self-selected experiences with tracking were ultimately supportive for EPSTs as learners. If EPSTs did not have a choice in the tracking then their experiences were deeply negative, which affected their mathematical dispositions (7 EPSTs). Throughout our elementary math methods course, both Dr. Brette and I debunk the idea of tracking. We reassured students that many tracked experiences were negative, and that their emotions around tracking are valid. We make it clear in our course that groupings like this are not beneficial to students. Eventually, students either learn to play the part of their track, or they get deeply frustrated with the content (Lampert et al., 2011). When students recognize that they are in tracked courses, and are not part of the "smart kids" they perceive their abilities to do math as lower than other students (Stoehler, 2015).

Prior research indicates stronger student success when classes are detracked (Lampert et al., 2011; Palovich, 2019).

(-) Learners' Perspectives: Content: Too Much Effort.

EPSTs mentioned that the amount of effort that they had to put into their math courses was too much (six EPSTs). They all noted the extra time spent with additional support, some explained it was support from the school like small-group intervention or a Teaching Assistant (TA); whereas, others reported out of the classroom support like a hired tutor or a parent. For the EPSTs, oftentimes, when math felt like too much effort it was because it was not connected to a conceptual understanding, a real-world application, or topics of interest to students.

Additionally, much of the extra effort and tension was during out-of-class time, like while they were doing homework. Sometimes EPSTs' efforts outside of the classroom without teacher support caused extreme frustration. Some EPSTs noted a tension between how their teacher showed them what to do on their homework and how their parents showed them what to do on their homework. This tension often resulted in arguments at home and a loss of points for not doing the homework exactly how the teacher taught it. Three EPSTs described spending many nights where they were in tears over their parents insisting on a method of teaching that was not like the procedure that their teacher taught. Martha said in her autobiography, "my dad was great at math, but when he tried to help me it was a nightmare." Another EPST, Kaila, said in her autobiography that her dad was "almost militant" with math practice.

Luckily, in our classroom environment that is focused on rehumanizing, ambitious, and equitable math, we prioritize low floors in mathematical sense-making. Low floors mean that everyone should be able to access the math task and it shouldn't feel like too much effort. We also prioritize multiple solution paths, which should solve the tension of there being one way to get an answer. All of our assessments in this class catered to the EPSTs' learning and were not rooted in being right or wrong.

(-) Learners' Perspectives: Content: Disengaging.

EPSTs reflected in their autobiographies that they disengaged in their math lessons (3 EPSTs). Their reasons for disengaging ranged from the pace of the class being too fast and therefore being lost in lessons, or just a feeling of "relentless overwhelm" with the math content. Karly said in her math autobiography that, starting in middle school, she felt lost and frustrated with mathematical material, and by high school she "fully gave up and I stopped trying." Karly giving up on math in middle school carried all the way into our elementary math methods course; those feelings affected how she showed up to class. Once she "gave up" on math in middle school, she persisted with a negative disposition towards math.

These students who had such negative math experiences that their natural inclination was to disengage is especially relevant to math dispositions. It is understandable that, after feeling lost in a math classroom time and time again, a student would choose to avoid math. Math avoidance is very closely related to math anxiety and has an intense impact on mathematical dispositions. EPSTs that are in school to be teachers no longer can avoid math, which means they have to engage. Re-learning math concepts from a learners' perspective through a conceptual lens, like in an ambitious and equitable classroom, is going to be harder for someone who disengages or tries to avoid math.

(-) Learners' Perspectives: Relationship: Teacher-Specific.

EPSTs' exposure to prior negative relationship-specific experiences was disastrous to their mathematical dispositions (13 EPSTs). Past teachers made especially consequential impacts on their mathematical dispositions, though other people in the learning environment also made an impact and will be discussed in a different section. The negative reflections in this theme had more to do with the relationship between the EPSTs and the people in their math learning environment rather than the content itself. EPSTs told stories of teachers who mocked them, were wildly unsupportive, and cared more about students' abilities to 'do school' rather than understand the mathematical content.

An overwhelming majority of the EPSTs, 72%, mentioned negative experiences with their teachers. Because these experiences were so common– and often absolutely awful– I will detail a number of them. Willow narrated a story of a teacher who was unsupportive and did not care if she succeeded. She continued to explain that this teacher made her whole class afraid to ask questions about the content. According to Willow, her unsupportive teacher would say things like "we are not going backwards" when students asked questions about certain concepts. The teacher made no effort to make sure that Willow, or some of her other classmates, participated in the course. This sense of indifference to students who did not understand the material is unsupportive to math growth. Once Willow knew that her teachers called students out publicly and did not provide additional help, she checked out of math, which had a negative impact on her disposition that still affected her in the methods course.

Tamara also had a negative experience with a teacher that stuck with her. She reflected in her autobiography that her lower-track physics teacher told her class that they “sucked at math, and that’s why we weren’t in honors courses." This made her feel “awful, academically and personally." She went on to say that “ultimately, this teacher's class was the most powerful and upsetting experience that disinterested me in math." Since that day, Tamara tried to avoid taking math and science classes and felt uncomfortable in those environments, which made her disposition worse.

Martha spoke out about a teacher that she had in middle school. She described the teacher as “taking a toll on her” through “the combination of her relentless teaching style and her lack of compassion." She described an instance where the same teacher would not let Martha go to the bathroom in her class. Unfortunately, Martha had gotten her period and was forced to bleed through her pants because she was not allowed to go take care of the situation. Martha felt “mortified” and lost all trust in her teacher, which spilled over into generalizing that lack of trust to the subject of math itself.

Karly was “brushed off by [her] teacher for not understanding ‘easy’ concepts." She had tried time and time again to ask her teacher about the content they were learning, eventually, the teacher gave up on her being able to understand the content and refused to be helpful. Karly further explained in her autobiography that that teacher made her feel like a “lost cause.” She began to believe her teacher’s attitude towards her ability in math and confirmed that she was a lost cause.

Kalla wrote in her autobiography that one of her upper elementary school teachers “was super strict, never happy with anyone’s effort and only expected students to answer math problems in a certain way. She always gave zero points for anything different from her method even if you get the right answer.” When teachers graded EPSTs on their ability to repeat procedures instead of understanding the ‘why’ of the mathematical content, EPSTs began to think that procedure is the most important part of math. Three other EPSTs noticed their teachers’ inability to bring the content to life and their reliance on procedure as a pedagogical style.

Some EPSTs’ explicitly used the word dehumanizing to describe some of their relationships with their teachers. These dehumanizing experiences were not only among EPSTs with negative mathematical dispositions; EPSTs with more positive dispositions also recanted dehumanizing stories. Though the EPSTs who experienced both negative mathematical dispositions *and* a dehumanizing experience tended to have more negative dispositions overall when compared to EPSTs who did not report dehumanizing experiences.

Seven EPSTs explicitly used the word “dehumanize” in their math autobiographies. In the first session of class, the only session that the EPSTs had before writing their autobiographies, Dr. Brette and I introduced rehumanizing math, which we contrasted with traditional, dehumanizing instruction. Two students, Martha and Colleen, explained that their instructors openly mocked fellow students in their math classroom.

Four of these EPSTs related the dehumanizing experiences to their instructors, but two related these experiences to the math curriculum itself. Weston had a uniquely dehumanizing experience: he had batteries thrown at his head multiple times in class from fellow students, and his teacher did not care. He recalled in his autobiography that his teacher even retorted with an inappropriate sentiment that there was “nothing he could do about it.”

Explicitly dehumanizing experiences are more likely to have more of an impact on mathematical disposition than just negative experiences. D'Emidio-Caston (1993) explains that any attempt to change the way math is learned “must also confront the ghosts of negative experiences” (p. 4). These ghosts are even more powerful when students themselves label the experiences as dehumanizing, which can make their dispositions harder to shift.

One really negative, or dehumanizing, experience can set the tone for a solidified negative mathematical disposition, no matter how long ago it was. As these adults entered our classroom, they were still upset about salient mathematical experiences that happened a decade or more ago. By encouraging EPSTs to reflect on past math traumas, EPSTs were allowed to consider how to cope and move on from those experiences. Like in past research, our goal is that their autobiographical reflections on past negative mathematical experiences promotes EPSTs to begin to change their dispositions around math (Finlayson, 2014).

(-) Learners' Perspectives: Relationship: Other People.

EPSTs' experiences around math were not just in the classroom with their teachers. They also had experiences with math at home, tutoring centers, or with their peers outside of the classroom. Five EPSTs narrated negative experiences with other people in the learning environment. Colleen had negative experiences with her parents because they did not know how to do the math that she was doing and so they couldn't help her, causing both her and her parents frustration. Brenda's dad was forced into a tutoring role when she was placed in a pilot advanced math track without any choice; the ensuing arguments harmed their relationship. Maggie and Weston had pressure from their parents to do well because of their parents' own STEM careers.

EPSTs sought out support outside of the classroom setting. Ivy disclosed one of her experiences learning math with a TA. When Ivy showed up to try to receive support in a college level class, the TA told her that she was "not trying", which made her cry, and never go back to receive support because of how awful she felt. Going to someone for support and receiving the direct opposite is a huge blow to mathematical dispositions. When EPSTs struggle in the classroom and then struggle to receive support outside of the classroom it's almost a one-two punch. If their experiences in the classroom did not turn them off of math, then the additional negative experiences outside the classroom did. These experiences often continue to manifest in a negative mathematical disposition.

(-) Learners' Perspectives: Societal Pressure: Marginalized Identities.

In the autobiographies, there were two historically marginalized identities that EPSTs reflected on: negative gendered expectations and the model minority myth. Most of our EPSTs in this sample were white. Other identities– especially Black, Latiné, and Southeast Asian are also marginalized in math, but they were not present in our class. Those who identified as EPSTs of color were East Asian American. Some of the EPSTs were fed a narrative that women are not as good as men are in STEM. Willow, Mary, Diana, Ivy, Kalia, and Maggie all reflected on this stereotypical — and false — trope in their autobiographies. Diana said that she was told in high school that, “men are more natural scientists and mathematicians." Kaila said in her autobiography that, “women are taught that it’s cute and fun and cool to be bad at math.” If EPSTs who identify as women learned math with the expectation that they would be worse at math than the boys and men in their classes, then they are likely to internalize these sexist ideas. This narrative creates a self-fulfilling prophecy and a dangerous cyclical pattern where women truly believe that they are not as good as men at math, so they end up performing worse.

Some EPSTs also recounted expectations of the model minority myth. The model minority myth suggests that Asians and Asian Americans are good at math because of their race. But this is a deeply racist narrative, with a negative impact, despite the “positive” expectation (Chen & Buell, 2018). Although this positions Asian Americans as successful, it puts undue burdens on them to reach expected levels of achievement. These stereotypes can lead to negative self-image and an immense amount of pressure. Additionally, these stereotypical expectations are often microaggressions that, over time, cause deep psychological harm.

Three Asian American EPSTs described experiences with the model minority myth. Willow said in her autobiography that her teacher said that “this was his first time teaching ‘so many quiet Asian girls together’ and he ‘didn’t really know how to navigate that’." Willow went on to say that it made her feel wildly uncomfortable, like she was supposed to change how she showed up to her math class. Ivy also explained in her autobiography that throughout K-12 learning she did not think she internalized the model minority myth, but she did. She said, “I didn’t think I was carrying it,” but she reflects back now and understands the weight of internalizing the model minority myth on her math experiences. These negative experiences so closely connected to these EPSTs’ identities are especially harmful. When part of someone’s identity is connected to a negative mathematical disposition it is an internal attribution. Internal attributions of mathematical dispositions are even harder to shift than external attributions (Sherman & Christian, 1999).

Historically marginalized identities can also intersect. Ivy spoke about her experience with gendered expectations and how they were compounded with religion as well as the model minority myth in a majority white parochial school. When multiple societal expectations converge at once, it creates a unique version of intersectionality. In her autobiography, she expressed that she was aware of the impact of all of these identities intersecting, and that she was actively working to combat them with a growth mindset. She shared that she had felt defeated and felt like she was ‘not a math person’ early on in her schooling, but now she is actively challenging that notion and attempting to create a more positive disposition around math learning.

(-) Learners' Perspectives: Negative Mathematical Dispositions.

According to the autobiographical reflections of the EPSTs, many of them felt that they had negative mathematical dispositions. Some of them reflected on their lack of confidence in their ability to do math, others claimed that they were 'not math people,' and numerous EPSTs demonstrated their anxieties around mathematics.

EPSTs reported low math self-efficacy for the following reasons: lack of motivation when learning math previously (3 EPSTs), a lack of confidence in doing math (Willow, Weston, Tamara, and Diana), feeling embarrassment and shame (Weston, Mary Campbell, Martha, Karly), as well as stress and frustration (Martha, Diana, and Karly). Diana clarified why she still felt like she had relatively lower self-efficacy: "Due to my shaky belief in my mathematical abilities during my undergraduate years, those old feelings of insecurity are still there even 10 years later." This quote reiterates the deep-rooted effects of prior math experiences and how it has profound effects on EPSTs' dispositions today.

There was also a trend in the math autobiographies where EPSTs claimed to 'not be math people.' Four EPSTs went on to explain how they have internalized this and how it has affected their schooling, career path, or life in general. There are two very salient quotes about this sub-theme. One comes from Martha, who disclosed that her parents:

> Told me that sometimes, people are just 'bad at math' and that's okay. I internalized this, and I honestly think it held me back. I had a deficit-based attitude from the beginning, I expected math to be hard, so it was. I expected to do poorly, and I was not surprised when I did.

This illuminates a cycle that was prominent in all four of the other students. Another quote divulged how math affected Brenda's career path, as she said in her autobiography:

> I wish I had never said that math wasn't my thing or that I would never need it because it has truly been the main source for my career advancements and helping me in discovering the pathway I wish to take.

Brenda understands that since she wrote math off at a young age that it had a large effect on what pathways she could and could not take in her career. Brenda shed her idea of 'not being a math person,' as she explained in her autobiography, when she took a job in data that altered her whole disposition towards math. However, the other three students did not have a similar disposition altering experience. From their math autobiographies the students who did not identify as a 'math person' truly claimed it as a part of their identity and it stuck with them as they continued to progress. This is an extremely problematic disposition, as they could pass the negative disposition on to their future students.

EPSTs also reflected on their math anxiety and how much this is still affecting their mathematical dispositions today. Maggie said that, "In fourth grade, math was taught directly after recess, and I remember a sinking feeling in my stomach each time the whistle would blow to line up for class" . Karly described her experience in college algebra and said that it was her "worst nightmare." She went on further in her math autobiography to mention her "fixed mindset" and anxiety surrounding math. Heather said, "I completely shut down through it, if I was not being taught how to do it right off the bat, why would I struggle and waste my time learning it potentially the 'wrong way'?" Kaila admitted to avoiding a math class in college because she "didn't feel smart when [she] was in that class." These EPSTs with math anxiety indicate a troubling theme of frustration with learning math and a desire to avoid it.

An overwhelming majority of EPSTs (12) reported having some level of negative dispositions around math. Strikingly, 44% of EPSTs enrolled in this class self-identified as “not a math person” in their autobiographies. EPSTs’ negative dispositions coming into the course proved much harder to positively evolve over the course than EPSTs coming in with neutral or positive dispositions. EPSTs’ with negative dispositions are inclined to disengage with mathematical content as a learner and as a future teacher. Negative dispositions are also an extreme concern for EPSTs’ future students, as pedagogy is deeply affected by teachers’ dispositions towards math.

Table 7

Negative Future Teachers’ Perspectives

	Category	**Deductive Themes**
Future Teachers’ Perspectives	(-) EPSTs’ Negative Reflections (Deductive)	Negative Math Teacher Self-Efficacy (7) Negative Math Teaching Anxiety (6)

Note. This table has the categories, themes, and sub-themes that came from the mathematical autobiographies from the teachers’ perspectives.

(-) Teachers’ Perspectives: Negative Mathematical Dispositions.

EPSTs wrote about their concerns with their abilities to teach their students effectively (7 EPSTs). Some of the EPSTs reported a negative teacher self-efficacy and some reported a negative math teaching anxiety (see Table 7). Mary recognized that she became an elementary math teacher because she did not want to specialize in math at any higher grade level with her “lack of confidence" . She also thought that her lack of confidence might be mitigated by re-learning the content. Jayden and Kalla noted that it was easier for them to learn the math material than teach it. This made both of them less confident in their abilities to teach it. Four of the seven EPSTs explained that they were nervous about their abilities to teach math. Like math teaching anxiety, a lack of math teacher self-efficacy comes from different places. Some students were worried about their own mathematical abilities, while others are worried they know too much math and therefore are worried about their ability to teach it. EPSTs who have a lower math teacher self-efficacy will struggle to form a positive disposition around math teaching and are more likely to be anxious around teaching math (Wenta, 2000).

Six EPSTs declared that they had math teaching anxiety in their math autobiographies. There seemed to be three reasons why they had anxiety. The first reason for EPSTs’ math teaching anxiety was that some EPSTs thought that since it was easy for them to do the math as learners that they were actually anxious to teach it. Emma had a great quote encapsulating all three students’ math teaching anxiety: “My biggest fear with teaching anything math related is that since I found the subject to be so simple - I will rush past the little things that some students in my class may need.” These future teachers were worried about identifying with struggling students and knowing how to help them when they, themselves, did not struggle.

Another reason that EPSTs had math teaching anxiety was because of the opposite root cause: instead of being worried to teach because they knew the content so well, this second group of EPSTs was worried to teach because they did not know the content well enough (3 EPSTs). Tamara described her math anxiety as, "My experiences with math have created some reservations about teaching the subject; frankly, I'm a little nervous." Willow and Karly used words in their autobiographies like "intimidating" and "lacking confidence." Anyone going into this elementary math methods course with teaching anxiety has a higher likelihood of being resistant to learning to teach math (Althauser, 2018). They may also have more difficulties forming a positive disposition around teaching math.

(+) RQ1: Qualitative: Autobiographies

Not all EPSTs' experiences with learning math were negative. EPSTs also reflected on some of their positive experiences. More EPSTs mentioned positive experiences with math than negative experiences. Unfortunately, these positive experiences did not outweigh the impact of the negative experiences, as many EPSTs who did have positive experiences still had a negative mathematical disposition.

Table 8
Positive Learners' Perspectives

Category	Theme	Sub-Themes (# of EPSTs)
(+) ESPTs' Positive Experiences in Math	Positive Content Specific (Inductive)	Math is Enjoyable (11) Positive Topic or Method of Teaching (11)
	Positive Relationship Specific (Inductive)	Positive Teacher Specific Experiences (15) Positive Experiences with Other People in the Math Environment (11)
	Positive Mathematical Dispositions (Deductive)	Positive Math Self-Efficacy (5)

Note. This table are the categories, themes, and sub-themes that came from the mathematical autobiographies from the positive learners' perspectives.

(+) Learners' Perspectives: Content Specific: Math is Enjoyable.

Table 8 shows the themes and sub-themes for positive learners' perspectives. Within the positive experience category, there was a theme of content-specific positive reflections (15 EPSTs). When EPSTs reflected on their past, it was the subject itself that caused them to have positive experiences. This theme has sub-themes including math is enjoyable and positive topics or methods of teaching. EPSTs who reported that math is enjoyable said that they liked the objectivity, how good they were at the subject, how math was a rewarding challenge for them, and that they felt like they understood the topic. Positive topics or methods of teaching were coded when the source of the positive reflection came from the topic of math or the method of teaching, not the teacher themselves. Positive topics or methods of teaching most often came when the EPST felt that the math they were learning was directly related to something that interested them or had a real-world context.

EPSTs had many reasons why the content of math was enjoyable to them. Jayden talked about the absoluteness of elementary math and how he really gravitated towards math being right or wrong. Hannah said that she was particularly good at math and did not have any memories of negative experiences in elementary or middle school. Daisy said that she picked up the concepts quickly in middle and elementary school. Emma went a step further and illustrated her anxiety with other subjects, but not math. In her autobiography, she described, “Learning math has always come naturally to me compared to other subjects. It was almost peaceful and relieving when it came time to do math because matters such as reading were way more stressful." Brenda, Colleen, Heather, and Emma also indicated that they enjoyed math. Brenda and Heather came to learn to enjoy it, whereas Emma and Colleen always enjoyed it.

Three EPSTs noted that math was a rewarding challenge for them. Weston felt like math was a “puzzle.” Colleen said that she felt that it was challenging enough to feel rewarding. Mary reflected in her autobiography that:

> It took me a long time to grasp an idea or learn how to solve a problem, but once I was able to solve and understand the math lesson, I felt satisfied and proud that I was able to come to the right conclusion.

When EPSTs approach math as a challenge, then they tend to persevere and have a growth mindset around math and mathematical dispositions.

There were two EPSTs who reflected and felt that they understood math content. Emma understood everything clearly when she took algebra. Kalla understood math and its purpose once she got to college and applied all the things she learned throughout K-12 to a college curriculum. These positive experiences make positive evolution of EPSTs' mathematical dispositions more plausible by the end of our course.

(+) Learners' Perspectives: Content Specific: Topic or Teaching Methods.

Some of the aspects that made EPSTs' prior math experiences more positive were related to the contexts in which they did math. EPSTs favorably reflected on their teachers employing multiple solution paths, positive feedback, making math fun (e.g. crafts, games, puzzles; 11 EPSTs).

Context for the math that EPSTs were expected to do was meaningful; their positive experiences included "the context was something I cared about" and "there were multiple ways to get the answer." Many EPSTs mentioned games as a mathematical context that held positive memories for them. Hannah took one class in bookkeeping, which encouraged her to have a "love of accounting." She went on to say, "Accounting had just the right amount of math, mixed with money and precision." . According to her autobiography, Kalla preferred math that included "critical mathematical out-of-the-box thinking." She said that engineering finally gave her applicable mathematical contexts. Two other students wrote positive experiences with math when in the context of designing, music, and crafts.

Four EPSTs were successful and had positive association with traditional math classrooms. On the other hand, Emma felt that mathematical contexts were always intriguing and fun; she did not need specific contexts to enjoy math. She wrote in her autobiography, "I never felt [math] was a burden to learn or that the lessons were pointless. For me, math was always something I became eager to do." Heather said that "very straightforward math classes worked better for me. The ones where we sat through a lesson about a new concept, got some practice time with this concept, had homework to go along with it, then finished with a test about it" . Heather described her comfort with a typical math classroom. She attributed her comfort with traditional instruction because she had negative experiences with innovative curriculum. She explained that a traditional math environment was predictable, which made her more likely to engage. An additional two EPSTs, Diana and Colleen, commented on the reliability of math and the routine of school and how that made them feel certain and safe. EPSTs who felt good in a traditional math classroom likely had less negative dispositions towards math.

Our class immersed EPSTs in a non-traditional environment rooted in rehumanizing, ambitious, and equitable math. This experience gave our EPSTs a long-lasting positive experience surrounding the topic and method of teaching, even if they did not already have that experience.

(+) Learners' Perspectives: Relationship Specific: Teacher Specific.

EPSTs' largest positive theme from the qualitative math autobiography is experiences with specific math teachers. 83% of EPSTs reflected on positive prior experiences they had with math teachers. Many of the EPSTs' positive reflections were when their teacher implemented tenets of rehumanizing, ambitious, and equitable math — when their teachers were more understanding, enthusiastic, understood math to be 'gray' and not black and white, and did not prioritize grades.

Willow and Martha both had positive experiences with their professors in college. Tamara said that she had much more understanding teachers in high school when she chose to go into the ‘regular’ track for math as opposed to an advanced track in math. Maggie, Karly, Kalla, and Hannah all reflected positively about teachers that they had who differed from the traditional pedagogical style that they were used to. Kalla went on to write that, “my high school teacher gave me back my confidence [in math], she taught me that math can be gray, not only black-and-white. She welcomed us challenging the curriculum and finding different ways to reach answers.” Multiple EPSTs talked about their teachers' attitudes– 4 EPSTs. Brenda recounted her math teacher as being very passionate: “it was almost impossible not to get excited in their class." Weston thought about one of his high school math teachers and said that, “His enthusiasm was infectious. I wanted to be in his class and I wanted to learn. It was because of mutual respect that I was motivated to take part in his class." Lastly, when describing a school that she went to that did not give students grades, Diana said:

> They would evaluate our understanding of the content and use this as an indicator to see whether or not we were ready to continue on to deeper learning. We did not have designated instruction time per se, it was more so up to us as students to complete our work independently and to ask questions as they arose. I think the culture of care and ease in a school setting such as this was incredibly therapeutic for many different reasons. Mainly, the absence of grades and tests took away the stress that so often comes with traditional schooling. Dr. Monroe made sure to

create and cultivate this environment, making all subjects, math included, much less stressful.

Dr. Brette and I do every single one of the things that EPSTs reflected on to build our positive and welcoming classroom environment, which created a positive and rehumanizing experience for our EPSTs. More of these positive experiences with teachers sets EPSTs up to have more opportunities to shift their mathematical dispositions more favorably.

(+) Learners' Perspectives: Relationship Specific: Other People.

People in ESPTs' learning environment who were not teachers (e.g. parents, friends and tutors) also had a positive impact on EPSTs' experiences in math. Often, these experiences led EPSTs to receive positive support within mathematics; sometimes it was content-based, other times it was emotional support. Five EPSTs mentioned tutors providing support for their math learning outside of the classroom. All of the EPSTs who engaged with tutoring received one-on-one support, which was different from their typical classroom setting. They also indicated that the tutors taught in more fun and accessible ways than their teachers did. EPSTs said that people outside of the classroom itself employed a much different curriculum, which seemed to work better for those who sought out additional math support. Two EPSTs made it clear that their tutors lauded them for getting extra support, which had a positive impact on their mathematical dispositions.

An additional positive influence on mathematical dispositions was parental support (6 EPSTs). Many of the EPSTs told powerful stories about how their parents supported them both emotionally and mathematically. One EPST, Daisy, said the following about her parents in her math autobiography:

> My mom has always affectionately given herself the nickname ‘numbers freak,’ and my dad was educated as a mechanical engineer, so they were both very supportive and very invested in making sure my brothers and I knew how to do math and were competent at it. Flashcards were a nightly occurrence while we were learning our multiplication tables, they made sure we practiced over the summer with our math facts assignments, and when we got stuck on our math homework they were always willing to help, even when our questions went right over their heads.

Another EPST, Kalla, said this about her support from her parent in her autobiography: “Having my dad’s support made me flourish my interest in math and helped me shape it and turned it into a career in engineering." These positive supportive experiences with people outside of school made it easier to shift EPSTs' dispositions to be even more positive, if they aren’t already. If they can reflect on what it was like to feel supported and in turn allow themselves to feel supported in our elementary math methods course, they are likely to continue to decrease anxieties and increase efficacies.

(+) Learners’ Perspectives: Math Dispositions: Math Self-Efficacy.

Positive mathematical dispositions are math learners’ internal monologues about their abilities to do math. In this theme, I focused on the internal pressures coming from the learner themselves. Five EPSTs described instances of positive self-efficacy in their math autobiographies. Kalla recounted that she felt that she had a “resilient and knowledge seeking personality” when it comes to learning math. Hannah noted that she loves math. She sees math as a challenge, and enjoys being able to be a problem solver. Brenda detailed how she learned to trust her mathematical abilities over a long period of time, especially after a data job. Maggie reflected that an undergrad math methods class helped her to build her self-efficacy:

> When I was in college, an elementary math class helped me reframe my mindset from feeling like I was bad at math to recognizing that anyone can succeed at math, and it is crucial to make mistakes and ask questions, because both of those things are part of the learning process.

Lastly, Ivy portrayed her shift to a growth mindset beginning in undergrad throughout her math autobiography. She explained that she increased her belief in her abilities to do math by changing her internal monologue to, “I am good at math, and so is anyone who gives their best effort to learn it." These EPSTs who explained that they have a relatively high level of efficacy or are actively working towards a higher level of efficacy were able to shift their dispositions more easily than EPSTs who did not report positive math self-efficacy. A positive belief in mathematics abilities can result in a higher interest in some of the doing and exploring math that happens throughout the elementary math methods class. EPSTs with higher self-efficacy tend to continue to be persistent when faced with new ways of approaching math in the course.

Table 9
Positive Future Teachers' Perspectives

	Category	Deductive Themes
Future Teachers' Perspectives	(+) ESPTs' Positive Reflections (Deductive)	Positive Math Teacher Self-Efficacy (4)

Note. This table has the categories, themes, and sub-themes that came from the mathematical autobiographies from the positive teachers' perspectives.

(+) Teachers' Perspectives: Positive Math Dispositions.

EPSTs' put positive internal pressure on themselves as future teachers. Table 9 displays the EPSTs' positive math teacher self-efficacy. Some EPSTs indicated a very positive belief in their ability to become successful teachers (4 EPSTs). Four of the EPSTs had feelings that they could relate to students who struggle in math and therefore have empathy. They believe this empathy will make them better teachers and therefore have a better belief in their abilities to teach math. Heather pointed to recently understanding the research and pedagogical perspective behind math and how that has made her belief in her teaching abilities increase. Emma had a stand-out quote about positive math teacher self-efficacy: "Math is single-handedly the subject I am most excited to teach to my future students and is something I will forever enjoy throughout my life." All of these EPSTs come at a positive teacher self-efficacy from a different angle, either that they struggled and therefore believe that they will be a good teacher, that they understand the pedagogy and therefore they will be a good teacher, or that they already had a really positive disposition around math and math teaching. EPSTs with positive math teacher self-efficacy are more likely to teach conceptual, inquiry-based, and student focused lessons (Cady & Reardon, 2007).

RQ1: Integrated Comparative Mixed

To fully understand the triangulation of EPSTs' qualitative and quantitative data, I employed Bazeley's (2017) mixed methods integration framework. I coded at the individual and construct-levels. So overall, I looked at all four constructs (i.e. math anxiety, math teaching anxiety, math self-efficacy, and math teacher self-efficacy) across all 19 EPSTs. Four constructs multiplied by nineteen individuals gave me a total of 76 instances. My interpretation of Bazeley (2017)'s integration framework of enhanced, confirmed, mixed, and dissonant is below. I compared EPSTs' qualitative data to see if they told a stronger story together (enhanced), if they created a clear theme (confirmed), if there were mixed results (mixed), or if the two forms of data told different stories (dissonant). For the qualitative portion of the data, we did not explicitly ask about specific constructs, I placed the data into those categories. Therefore, my analysis of which category the data belong in after becoming integrated is seen through my own perspective.

The quantitative data showed a lot of variation across constructs, but when the qualitative data was integrated there were more obvious shared experiences. All of the EPSTs had a mixture of positive and negative experiences and manifested them differently. Negative experiences were not deterministic, yet still had an extensive impact on EPSTs' mathematical dispositions, more so than the positive experiences. Individual combinations of these experiences made some prior experiences more or less salient to EPSTs mathematical dispositions.

The qualitative data expanded my understanding of the quantitative data; there are times when the qualitative data reinforced what the quantitative data said, other times that the qualitative data painted a much more complex picture. Again, there were 76 individual and construct-level integrations. 37.5% of the comparison between the qualitative and the quantitative enhanced each other; or told a stronger story together, 16.6% confirmed each other, 16.6% have mixed results, or told a more complicated story when paired together, and .05% are dissonant with each other, or told opposite stories. Lastly, 24.25% had no qualitative data to do a comparison. The lack of data to compare is because not all of the quantitative questionnaire constructs had a parallel question in the math autobiography section.

Eight EPSTs had completely agreeable and/or enhanced mixed methods analysis. The other ten EPSTs' past mathematical stories and current dispositions became more complicated when I triangulated the two forms of data, or they told more than one story about that EPSTs' disposition. These mixed methods understandings allow for more nuance and will make more sense as I analyze the evolution of their dispositions over time. It is important to understand that mathematical dispositions are complicated and fluid so that I can best describe how they evolve over time. These complex integrations between qualitative and quantitative data in the beginning of the quarter are quintessential to understanding the potential transformations of mathematical dispositions. The quantitative data was clearly not enough to tell the detailed variations in EPSTs' dispositions.

For many of the EPSTs the math autobiographies told a deeper narrative than the quantitative data did on its own, what Bazeley (2017) calls enhanced. I will give two examples, though almost 40% of EPSTs' data fit into this category. When comparing the qualitative and quantitative data, there was often a construct with a quantitative label of *some.* In these instances the qualitative helped to illuminate the 'why' for the *some* categorization. This example is from the negative disposition from the teacher's perspective. For instance, Willow's level of math teaching anxiety was *some*. Her autobiographical data further explained why she had *some* math teaching anxiety; she said that math is "more intimidating because it changed so much since I have learned it." So, she was worried about her comprehension of learning math and bringing that into how she taught math. She immediately recognized that there would be a tension between her prior learning and her future teaching, which caused her to be anxious about teaching math. These are details that could not be understood through just the quantitative label of *some*.

Another example of both quantitative and qualitative data enhancing each other, this time from the learners' perspectives and as a positive disposition is Emma's self-efficacy. Her quantitative results were *extremely high* in math self-efficacy. In her autobiography she said, "I never felt math was a burden to learn or that the lessons were pointless. For me, math was always something I was eager to do." In this instance the qualitative description helped to better understand why Emma's self-efficacy was so *high*. She was confident in her ability to do math because she was eager to do math and enjoyed it, which is why she had a strong belief in her mathematical abilities. Both of these mixed method comparative examples gave me a better insight into these EPSTs' mathematical dispositions.

For the confirmed comparison of mixed methods data, I will give two examples. This is less common than enhanced with only 12 instances of this individual construct-level analysis. Colleen's results on the quantitative portion of math anxiety indicated that she had *low* math anxiety. Her qualitative response in her autobiography included phrases like "math was relatively easy" and that she "had mainly positive experiences." The addition of the qualitative data here signaled that the quantitative measure accurately portrayed Colleen's lack of math anxiety. She wasn't anxious because she had positive past experiences and was confident in her mathematical abilities. Another example, this time from the teacher's perspective, was Tamara's math teacher self-efficacy. Her quantitative score indicated that she had *very high* math teacher self-efficacy. In her math autobiography she described that she has empathy for the students who may struggle with math because she did and this will make her a better teacher. The qualitative data explained why Tamara felt comfortable teaching math and it was because she struggled with it herself. Both of these comparisons of qualitative data to the quantitative data confirmed the level of disposition and told a more individualized story of why their mathematical dispositions were reported at certain levels.

Most EPSTs, almost 50% of the individual construct-level instances were enhanced or confirmed. The qualitative data in these categories helped me to make a better narrative about EPSTs' individual dispositions. When EPSTs' data agreed when combining them it permitted me to meet my epistemic goal of gaining a baseline of the EPSTs' mathematical dispositions.

For the partial agreement comparison of mixed methods data, I will give two examples that began to give me insight into EPSTs' dispositions, but in a more ambiguous way than the previous categories. This category also only had 12 instances out of 76. EPSTs' integrated data in this category began to allude to a clear account but did not solidify that account. The first example is Ivy's response to the math anxiety measures. Her quantitative score was that she had *moderate* math anxiety. Her qualitative data from the math autobiography was mixed with both promising positive moments of math anxiety and negative moments of math anxiety. She said that a supervisor pushed her to develop skills with data, which led to her realizing that, "experience improved my confidence in my math abilities." She also stated that in middle school she "internalized the idea that I was not good at math and never let it go. I still worry about my mathematical abilities." One of these quotes of qualitative data supports a positive disposition around math anxiety and the other supports a much more negative disposition. This analysis leads me to believe that Ivy's *moderate* math anxiety has a chance to change, though not necessarily only more positively; her disposition also has the potential to swing more negatively. As her past experience is mixed, it is possible that her future experiences in this class will be even more important.

Another example of partial agreement is Jayden, he noted that "teaching math is going to be very hard for me" and yet had a *very high* score on the quantitative portion of math teacher self-efficacy. Jayden seems to think that teaching math is going to be difficult and yet he still believes that he will be successful. When I integrated the data Jayden's qualitative worry did not come out in the quantitative score. Since this study was over a long period of time, I was eventually able to see which side of the partial story was emphasized as I continued to collect data and these two EPSTs continued to experience elementary math methods.

For the dissonant comparison of mixed methods data, I will give two examples. Though I am keeping the analyses parallel with two examples, this kind of comparison was rare with only three instances. From a learner's perspective, Martha's results on the quantitative portion of math self-efficacy indicated that she had *extremely high* math self-efficacy. Her qualitative response in her autobiography included memorizing math procedures instead of truly understanding the content as well as saying, "I felt that all my skills and efforts in math were insufficient." This is an example where the qualitative level of self-efficacy did not align with the quantitative score. She had feelings of inadequacy, yet still had *extremely high* math self-efficacy. She did not feel prepared and yet she was confident that she could persist and be successful in doing math. Martha was holding onto feeling insufficient and yet also believing strongly in her ability to do and learn mathematics.

Another dissonant example, this time from the teacher's perspective, was Diana's math teacher self-efficacy. Her quantitative score indicated that she had *very high* math teacher self-efficacy. In her math autobiography she described that she found herself "feeling really unsure of my future abilities to be an effective math teacher despite the fact that I enjoyed this subject in the past and had great success." These were the only two comparisons that were dissonant. It was rare that when I combined the two forms of data that they told two completely different stories, like Martha and Diana's data.

RQ2: EPSTs' Evolving Mathematical Dispositions

In this section, I discuss both the quantitative and qualitative results from RQ2, or "How do EPSTs' mathematical dispositions evolve throughout the math methods course taught through an ambitious & equitable, and rehumanizing framework?" The data in this stage of the research was collected before, during, and after EPSTs participated in our course sessions. This research question was analyzed through the four constructs of mathematical dispositions, like RQ1; though, there was some overlapping data in the rehumanizing, ambitious, and equitable framework as well. The results from the before data (RQ1) demonstrated the variance of EPSTs' mathematical dispositions at the start of the elementary math methods course. From this mixed methods baseline, there were then additional measures of both qualitative and quantitative data collected to gain an understanding of EPSTs' mathematical dispositions over time (RQ2). In RQ2, the EPSTs reported generally more positive mathematical dispositions since the beginning of class.

Quantitatively, once I removed Diana's outlying data point because of her reported confounding general anxiety with math anxiety, this construct overall was statistically significantly lower in the post-questionnaire than it was in the pre-questionnaire. Math self-efficacy, the second construct in the learners' perspective category, was approaching statistical significance. 11 EPSTs increased their self-efficacy from pre- to post-questionnaire. Additionally, math teaching anxiety statistically significantly decreased from the pre- to post-questionnaire; so EPSTs had less math teaching anxiety at the end of the course. Math teacher self-efficacy also had a statistically significant increase. 14 EPSTs increased their math teacher self-efficacy.

Qualitatively, the analysis of the baseline data from RQ1 in combination with the weekly course recordings and interview data also supported the claim that EPSTs' dispositions positively evolved over time. Some EPSTs' dispositions evolved more than others, but the course made an impact on all of the EPSTs.

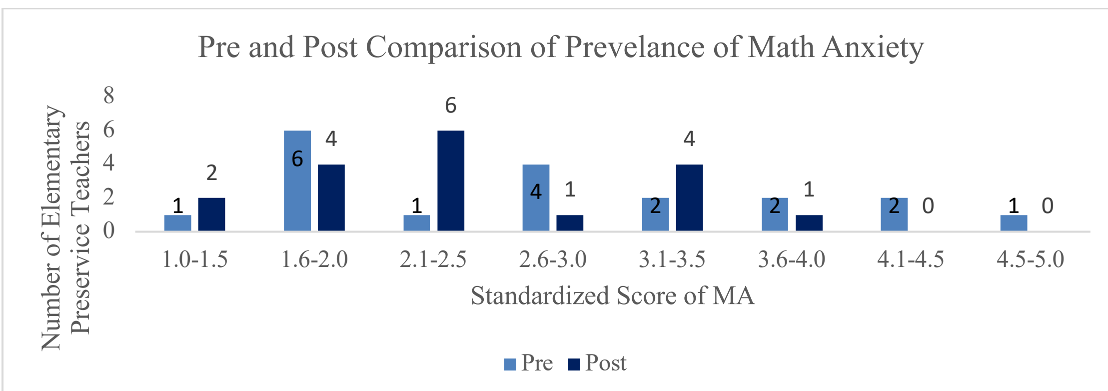
RQ2: Quantitative: Post-Questionnaire

Learners' Perspectives: Math Anxiety (AMAS).

After the course, there were no EPSTs that reported *extremely high* or *very high* results, which was a decrease from the pre-scores. The pre-scores included three EPSTs in the range of 4.00-5.00 before taking the course, however, after the course there were no EPSTs that reported very *high* or *extremely high* levels of math anxiety. EPSTs' mathematical dispositions evolved throughout the course, as shown by a lower mean and median math anxiety score (see Figure 9). The mean score dropped from 2.71 (pre) to 2.29 (post), while the median score dropped from 2.78 (pre) to 2.22 (post), which suggests that the course played a role in lowering EPSTs' math anxiety but is not statistically significant. The standard deviation indicates that there was still a fairly wide range of responses for EPSTs in math anxiety (SD=.80).

Like in the pre-questionnaire, math evaluation questions still invoked the most anxiety for EPSTs in the post-questionnaire. These questions make up math testing anxiety, a sub-construct within the math anxiety construct. The medians are also reported here because they are less susceptible to the outlier, which made it important to report for the math testing anxiety construct in math anxiety. Question 2 had a mean of 2.89 (pre) that increased to 3.43 (post). Question 2 had a median of 4.00 (pre) and decreased to 3.00 (post). Question 4 had a mean of 2.76 (pre) increased to 3.11 (post). Question 2 had a median of 4.00 (pre) and decreased to 3.00 (post). Lastly, Question 8 had a mean of 3.57 (pre) and decreased to 3.06 (post). Question 8 had a median of 4.00 (pre) and decreased to 3.00 (post).

Figure 9
Pre and Post Comparison of Prevalence of Math Anxiety



Note. This figure is a comparison of pre (light blue) and post (dark blue) EPSTs' math anxiety dispositions. The higher the score the higher the mathematical anxiety and therefore the more negative the mathematical disposition.

Math Anxiety t-test.

The results of the difference between the pre- and post-questionnaire for math anxiety are not statistically significant; the t-statistic is below the critical value and the p-value is not under .05, but it is approaching significance at p = 0.12 (e.g. Table 10).

Despite these results only approaching statistical significance, there were thirteen out of eighteen ESPTs who reported a decrease in math anxiety on this measure.

Overall, Diana's pre-test math anxiety score was a 1.67, whereas her post math anxiety score was a 3.33. In the pre-score she answered all of the math test anxiety– Questions 2, 4, and 8– with a 2.00 or lower, whereas in the post-score she answered all of the math test anxiety questions with a 5.00. This large increase in score was because of the math test anxiety questions, not because of any other math learning anxiety questions. During member-checking emails with Diana, she said the following when asked about her math anxiety increase from 2.00 to 5.00 on the math test anxiety questions: "scoring higher when it comes to test anxiety was due to my higher anxiety levels overall when it came to being in the program." Her increased levels of general anxiety in the program is a confounding factor that affected her math anxiety score.

Table 10
t-test: Paired Pre & Post Means Math Anxiety Including Outlier

	Pre	*Post*
Mean	2.63	2.29
Variance	0.96	0.64
Observations	18	18
Pearson Correlation	0.519	
df	17	
t Stat	1.63	
P(T<=t) two-tail	0.12	
t Critical two-tail	2.11	

Note. These were the results from the paired samples t-test for pre- and post- math anxiety; including Diana's outlier.

Table 11
t-test: Paired Pre & Post Means Math Anxiety Without Outlier

	Pre	Post
Mean	2.69	2.22
Variance	0.964	0.61
Observations	17	17
Pearson Correlation	0.65	
df	16	
t Stat	2.49	
P(T<=t) two-tail	**0.02***	
t Critical two-tail	2.12	

Note. These were the results from the paired samples t-test for pre- and post- math anxiety without the single outlier. The asterisk denotes a statistically significant result. This t-Test does not include Diana's outlier.

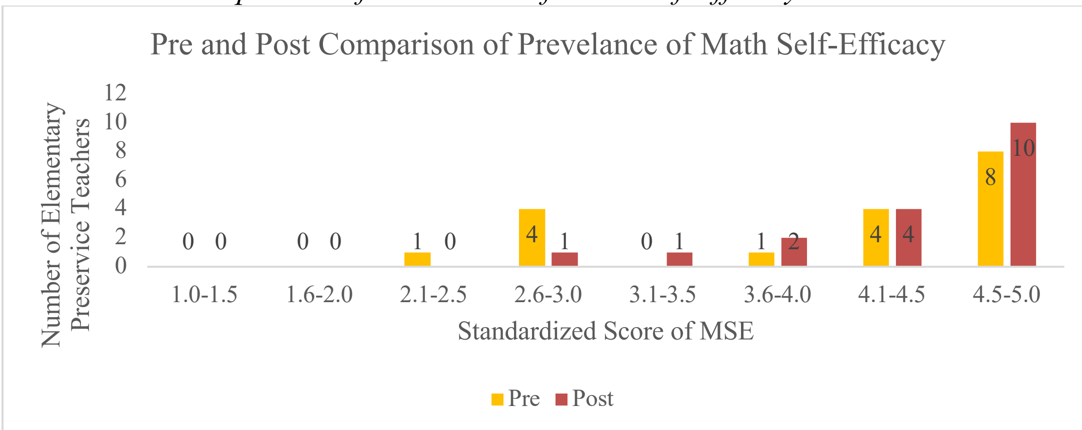
When I remove Diana's one outlier response, the results for math anxiety in Table 11 are statistically significant, the t Stat is above the critical value and the p-value is under .05, p = .02 (e.g. Table 11). So, we significantly decreased EPSTs' math anxiety.

Learners' Perspectives: Math Self-Efficacy (MSES-R).

To explore the evolution of math self-efficacy I compared the pre- and post-questionnaire responses on the MSES-R. Before the course, EPSTs' average self-efficacy score was 4.06, compared to after the course, which was 4.36. The increase in math self-efficacy shows a more positive disposition, as a higher level of efficacy is a stronger belief in one's ability to learn mathematics. There were eleven EPSTs that increased their scores between pre- and post-questionnaires. Three EPSTs decreased and four EPSTs stayed the same. Additionally, the small standard deviation indicates that the scores were still clustered, like in the pre-questionnaire (SD=.37).

Figure 10

Pre and Post Comparison of Prevalence of Math Self-Efficacy



Note. This figure is a comparison of pre (light orange) and post (dark orange) EPSTs' math self-efficacy dispositions. The higher the score the higher the mathematical self-efficacy and therefore the more positive the mathematical disposition.

Math Self-Efficacy t-test.

I conducted a paired samples t-test to compare EPSTs' math self-efficacy before and after the course. These results for math self-efficacy were not statistically significant; the absolute value of the t Stat is 1.70, which is below the critical value and the p-value is over .05 (e.g. Table 12). The negative t Stat indicates a positive directionality, or an increase in self-efficacy. Despite the lack of statistical significance, eleven out of eighteen ESPTs reported an increase.

Table 12
t-test: Paired Pre & Post Means for Math Self-Efficacy Means

	Pre	*Post*
Mean	4.06	4.35
Variance	0.61	0.40
Observations	18	18
Pearson Correlation	0.51	
df	17	
t Stat	-1.70	
P(T<=t) two-tail	0.11	
t Critical two-tail	2.11	

Note. This table are the results from the paired samples t-test for before and after data for math self-efficacy.

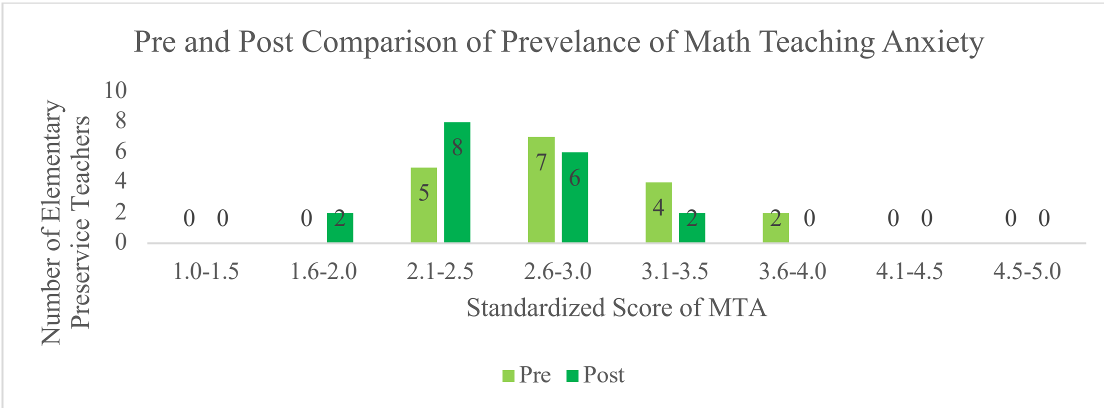
The results for math self-efficacy in Table 12 are approaching statistical significance, the t Stat is almost above the critical value and p = .11. So, we did increase EPSTs' math self-efficacy, just not significantly.

Teachers' Perspectives: Math Teaching Anxiety (AM-TCHAS).

I conducted a paired samples t-test to compare EPSTs' math teaching anxiety before and after the course (see Figure 11). Before the course, EPSTs' average score was 2.83 compared to after the course, which decreased to 2.40. The standard deviation indicates a more varied spread than self-efficacy, but a smaller spread than in math anxiety (SD=.63). This decrease is statistically significant. There was less teaching anxiety at the end of the course than at the beginning of the course with p=.01 and the t-Stat higher than the critical value.

Figure 11

Pre and Post Comparison of Prevalence of Math Teaching Anxiety



Note. This figure is a comparison of pre and post EPSTs' math teaching anxiety dispositions. The pre is the light green and the post is the dark green. The higher the score the higher the mathematical teaching anxiety and therefore the more negative the mathematical disposition.

Math Teaching Anxiety t-test.

These results for math teaching anxiety are statistically significant, the t Stat is above the critical value and the p-value is well under .05, p = .01 (e.g. Table 13). EPSTs reported less math teaching anxiety at the end of the course than they did before.

Table 13
t-test: Paired Pre & Post Means for Math Teaching Anxiety Means

	Pre	Post
Mean	2.834	2.48
Variance	0.28	0.14
Observations	18	18
Pearson Correlation	0.27	
df	17	
t Stat	2.71	
P(T<=t) two-tail	**0.01***	
t Critical two-tail	2.11	

Note. This table are the results from the paired samples t-test for before and after data for math teaching anxiety. The asterisk denotes a statistically significant result.

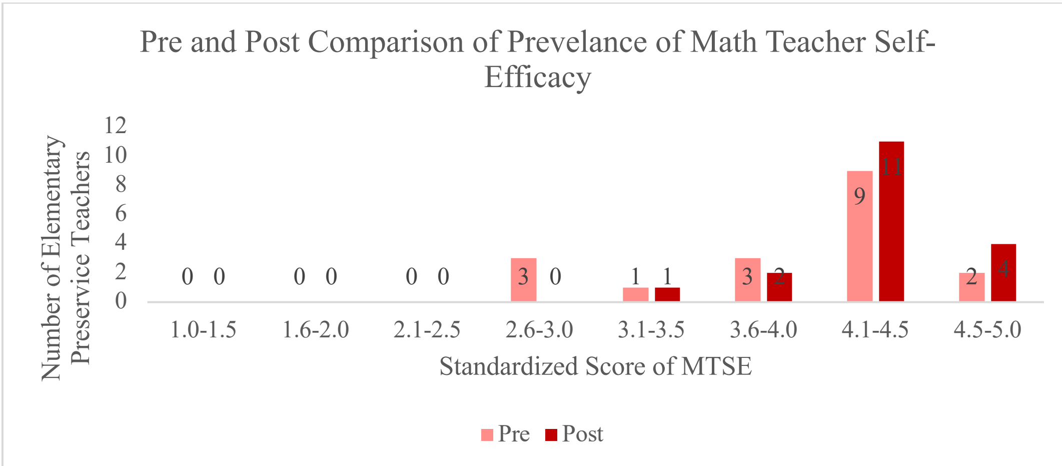
EPSTs' math teaching anxiety statistically significantly decreased from before our course to after our course.

Teachers' Perspectives: Math Teacher Self-Efficacy (AM-TSES).

I conducted a paired samples t-test to compare EPSTs' math teacher self-efficacy before and after the course (see Figure 12). Before the course, EPSTs' average score was 3.93, compared to after the course, which was 4.22. This increase is not statistically significant. There were fourteen EPSTs out of eighteen that increased their math teacher self-efficacy scores. The standard deviation indicates clustering for EPSTs. where they all have similar *moderate* to *extremely high* belief in their abilities to teach math (SD=.44).

Figure 12

Pre and Post Comparison of Prevalence of Math Teacher Self-Efficacy



Note. This figure is a comparison of pre and post EPSTs' math teacher self-efficacy dispositions. The pre is light pink and the post is dark pink. The higher the score the higher the mathematical teacher self-efficacy and therefore the more positive the mathematical disposition.

Math Teacher Self-Efficacy t-test.

These results for math teacher self-efficacy are statistically significant. The negative t stat has no effect on the significance; instead, the t Stat for this paired samples test is negative because the directionality of the change is different than the anxieties (e.g. Table 14). The EPSTs accrued more self-efficacy as time went on. Since the absolute value of -2.38 is 2.38 and it is lower than the degrees of freedom, 17, these two groups of means are statistically significant. The p-value is under 0.5, p = .03 and the t Stat is (|-2.38| = 2.38), which is higher than the critical value (2.11). I reject the null hypothesis and support the claim that there is a statistically significant increase between these two means. Fourteen EPSTs reported an increase in math self-efficacy on this measure.

Table 14
t-test: Paired Pre & Post Means for Math Teacher Self-Efficacy Means

	Pre	*Post*
Mean	3.93	4.22
Variance	0.28	0.20
Observations	18	18
Pearson Correlation	0.453	
df	17	
t Stat	-2.38	
P(T<=t) two-tail	**0.03***	
t Critical two-tail	2.11	

Note. This table are the results from the paired samples t-test for before and after data for math teacher self-efficacy. The asterisk denotes a statistically significant result.

This statistically significant difference in math teacher self-efficacy means that the course had a positive impact on EPSTs' belief in their abilities as teachers.

RQ2: Evolving Mathematical Dispositions

In this section I narrate how EPSTs' dispositions evolved from before the course, to during, and through the end of the course. I paired both the quantitative and the qualitative data together to explain the themes of each construct. Math anxiety and self-efficacy are paired together for the learners' perspectives. For math anxiety, there are four themes: high and stayed high, high but notably decreased, low with nuance and low and stayed low. For self-efficacy there is high and stayed high, and course increased.

In the teachers' perspectives, I detailed math teaching anxiety and math teacher self-efficacy. In math teaching anxiety EPSTs had a shared experience of still being anxious about teaching math, yet attributed these anxieties to all different rationales. In math teacher self-efficacy, like self-efficacy there are two themes of high and stayed high, as well as course increased it.

Learners' Perspectives: Math Anxiety: High and Stayed High.

Some students started our course with a relatively high level of math anxiety, unfortunately, for some of these EPSTs, their anxiety was still high by the end of the course (4 EPSTs). From my analysis, the levels of math anxiety that these EPSTs had at the beginning of the course was so high that 10 weeks was not enough time to meaningfully decrease their anxiety. Even though quantitatively and qualitatively these EPSTs still had a very negative disposition around learning and doing math, there were still moments of hope as they engaged in their smaller group collaborative work.

At the end of the course, four EPSTs reported relatively high level of math anxiety. Willow still lacked confidence in her abilities to do math. In the course recorded videos from Session 6, Willow also said in an exasperated tone after trying an area model multiple times, "I just literally do not understand how to do an area model." This type of quote signifies to me that when she is not comfortable with the content being presented, she can get easily frustrated. Additionally, in the Session 7 course recording, Willow said, "I still second guess myself with fractions." Karly said, "Math has never been my strong suit. I just have always felt that I am not good at it" and she still feels that way (Session 7 Course Recording). Also in Session 7, Karly was referring to the math journal assignment on fractions and she said "I had *SUCH* a hard time. I did it over the span of like two days because I was getting *SO* tired and frustrated." As a learner, Karly explained both at the beginning and at the end of the course with low levels of confidence and high levels of concern about doing mathematics. Kalia said in her interview that she has a "tumultuous" relationship with math. She also said that, "Math still frightens me as a general concept." Lastly, Heather said in her interview that she is still "not very confident in my math skills. I was always under the impression that I wasn't good at it." She elaborated by saying that her feelings are "not so much anxiety, it's more 'I don't know how to do this so I am just not going to try.' Like, I am emotionless towards math and very pessimistic." Even though Heather did not associate feelings of helplessness with anxiety, that is often considered a part of math anxiety — or it reflects a negative mathematical disposition. In Session 7, Heather said "[Fractions] are fully over my head, they like, mess me up. I shut down." All four of the EPSTs in this section mentioned fractions in Week 7 being an especially insurmountable mathematical challenge for them from a learner's perspective. This high level of math anxiety affects their confidence in their abilities. Fractions have tended to be a difficult content area and continued to be in this class.

All of these EPSTs had glimmers or even weeks of positive mathematical engagement and moments of lowered mathematical anxiety. However, their deep rooted worry about their mathematical abilities did not dramatically change over the ten weeks. Both the quantitative data and the qualitative data for the EPSTs in this category pointed to some small shifts in their understanding of self in relation to math. Although these EPSTs generally assumed that they were not able to productively participate in mathematical tasks, they still tried. By the end of the course, it was clear that these students had made strides, even if those positive shifts seemed quantitatively minimal. The EPSTs in this category are at the beginning of their mathematical disposition shifts and the quantitative measure might not have reflected just how much of an impact this course made on these ESPTs.

Throughout the whole course, these EPSTs either did not engage in mathematical thinking or were more likely to give up faster than their peers. If they are less likely to engage in doing conceptual, ambitious and equitable math as learners, then they are less likely to employ it in their classrooms as teachers (Bekdemir, 2010). The EPSTs who had high math anxiety sometimes also had lower self-efficacy around learning mathematics.

Learners' Perspectives: Math Anxiety: Still High, but Notably Decreased.

As the quarter progressed four EPSTs had a notable decreases in math anxiety. Overall, this looked like more participation in both small group and whole group discussions, kinder self-talk, a growth mindset, or less disengagement. Two examples of this positive shift in the learners' perspectives were Maggie and Tamara.

Tamara and Maggie both had obvious moments where their dispositions evolved. Tamara said, "I have learned a lot of really helpful strategies that have taken the scariness out of math" (Interview). Tamara also said in her interview, referring to the elementary math methods course and its instructors, “You all should have taught elementary math, my whole outlook would have been different." Her mathematical outlook during her elementary years was very negative and rooted in dehumanizing experiences, which carried on into the rest of her math learning. Another example of her evolving mathematical disposition is Tamara saying in her interview, “Before, I wouldn't put much thought into math because I did not have confidence, but I can focus on it so much more now." By the end of the course, she let go of some of these dehumanizing experiences and leaned into the current rehumanizing experiences.

Maggie, like Tamara, said in her exit interview, "I feel more comfortable taking risks and making mistakes in math." In her interview, Maggie also said, "I am not sure I would get a math problem 100% correct, but I feel confident in my ability to try and give it my best effort now." By the end of the course, Maggie was displaying a growth mindset, which was a large shift from her fixed mindset at the beginning of the course.

EPSTs in this category still reported high levels of math anxiety, however, they had *much* higher levels at the beginning of the course. Both of these examples showed positive shifts in their disposition, however, overall, they are still highly anxious about doing math as learners. Ten weeks was not enough time to really solidify a larger shift for EPSTs that started so anxious around doing math. EPSTs in this category explicitly called out the class as one of their reasons for shifting their dispositions to become more positive than they were at the beginning of class.

Learners' Perspectives: Math Anxiety: Low with Nuance.

During the course, Six EPSTs came in with low anxiety and also finished the course with low anxiety, but there was nuance to this aspect of mathematical disposition. Quantitatively these EPSTs described their math anxiety as *low* to *extremely low.* Though the quantitative score is helpful information, it is not a full understanding of their mathematical dispositions. EPSTs in this category also had some negative qualitative aspects to their data that complicates their quantitative data.

Diana started out with some math anxiety, mainly around test and performance anxieties, and by the end of the course she noted that "I would get stressed out by other people getting it more quickly… my brain would shut down when everyone was talking aloud versus doing it by myself." This is aligned with her original feelings of math anxiety at the beginning of the quarter. However, she still did not have high math anxiety, but she did have high math test anxiety. In her member-checking email exchange, she explained that the increase in test anxiety for her was due to an increase in anxiety in general. Diana said that being a student teacher and dealing with all of the pressures that come along with graduate school and teaching cause her anxiety to increase.

Daisy had an ambivalent relationship towards math and said, “I never hated it." She had relatively low math anxiety to begin and to end the course but had the nuance of no strong feelings towards math in a positive or negative way. She is the only EPST who had no strong feelings either positively or negatively towards math.

Lastly, Colleen had positive feelings towards math but still reflected and said that she had, “a very little bit” of anxiety she had to do math front of people. So, she did not necessarily have math anxiety, but more anxiety about performing in front of a group. She was put on the spot in Session 4 and was not confident in her geometric abilities, which supports the idea that she had performance anxiety in math. In Session 6, she explained that she had trouble thinking through adding and subtracting fractions conceptually. Colleen remarked that she was very good at “playing school” and she was good at reproducing the procedures that her teachers asked her to. So, even though she had quantitatively *low* math anxiety, there were subtle distinctions for her about the context of the math.

Unlike the previous two high groups, although these EPSTs have nuanced dispositions they are not as threatening to transfer math anxiety onto their students. Although their qualitative data do not pose a huge concern when it comes to math anxiety, they still have a complicated relationship with doing math. Some of the conflicting data in this section came from math testing anxiety, performance anxiety, or ambivalence towards math. Although their math anxiety was *low*, other factors illuminated the complex relationship between EPSTs and doing math. Even EPSTs who do not have an overtly negative approach to doing math may still struggle with their mathematical dispositions.

Learners' Perspectives: Math Anxiety: Low and Stayed Low.

Throughout the quarter, four EPSTs came into the course with relatively low levels of math anxiety and by the end of the course their anxiety was still relatively low. The course cannot decrease someone's anxiety much further if they already had low levels of anxiety. That does not mean that there weren't other aspects of their mathematical dispositions that positively shifted throughout the course. Brenda was one of those students: she said, "I feel confident in my math abilities." Hannah had relatively low math anxiety that stayed low and said, "I love math." Weston, Emma, Jayden, and Kalla also had relatively low math anxiety to start the quarter and finished with low math anxiety. These students have at least a partially positive mathematical disposition because of their confidence as math learners that will help them in their classrooms.

Learner's Perspective: Self-Efficacy: High and Stayed High.

Six EPSTs had high math self-efficacy and kept that high level throughout the course. They were successful math learners and they all continued to see themselves as successful. Kalla said in her final interview, "I have a good relationship with math. It has always been my favorite. Since [my career is in STEM] I have studied a lot of math. I feel confident doing math." Martha said in the Session 6 course recording, "Up until this class, I was doing invented strategies like this in my head and I thought it was wrong. I did not know that it was an okay way to do it." Martha having this a-ha moment about her brain and the way she has been problem-solving is really positive and rooted in conceptual mathematics helped her solidify her math self-efficacy. EPSTs who came into the course with relatively high self-efficacy could not always be shifted more positively, as they were already in that category. These EPSTs had strong beliefs in their abilities to be able to do challenging math problems and positive outlooks on their abilities as math learners. There were also a few EPSTs that decreased (3 EPSTs) and a few EPSTs that stayed the same (3 EPSTs) in self-efficacy. The decreases were extremely small and the EPSTs who stayed the same had relatively high self-efficacy.

Learner's Perspective: Self-Efficacy: Course Increased.

In this theme, six EPSTs' self-efficacy increased throughout the course. For these EPSTs, the course validated them and their abilities, which made them more comfortable and made them have more confidence. All of these aspects often sparked a growth mindset in the EPSTs. Tamara explained in her interview, "After taking this class, I have more hope for math… I don't hate it. As opposed to how I used to feel. I don't look at it with that much dread anymore, it’s a doable thing.” Maggie explained in her interview that her self-efficacy changed because she "feels more comfortable taking risks and making mistakes in math." Maggie went on to say, "I feel more comfortable trying multiple things and asking for help, which is important for solving complex issues. I am not sure I would get it 100% correct but I feel confident in my ability to try and give it my best effort." Martha excitedly explained in her interview that she has developed a growth mindset in math over time. Ivy also spoke to having a newfound growth mindset in her interview, "I think in the past my mindset was pretty negative. I did not think of math as a strong suit of mine. Even before this class I have been trying to rethink this 'math sucks' mentality.” She went on to say, "Lately, I have been shifting to a growth mindset and telling myself that I am good at math, and so is anyone who gives their best effort to learn it.” Kaila wrote in her Exit Ticket 10, “This course made me more confident in my abilities with the subject.”

All of these students had a more positive shift in disposition from the beginning of the course to the end of the course. A main catalyst for these shifts was mathematical discussions. Maggie, in her interview, pointed to our frequently employed teacher move of “can you tell me more about that?” she said that not automatically feeling wrong when she shared an answer helped her reposition herself in relation to mathematics. Colleen also reiterated a similar discussion based stimulus that helped her to shift her understanding of math. In Exit Ticket 7, Colleen said, “You all allow everyone to share out without feeling the pressure. This class is really fun and full of laughter. I’ve never felt like my math thinking is wrong.” Martha said in her Exit Ticket 7, “even though a lot of the strategies we're using are really challenging for me, our small group discussions are fun and I don't dread having to learn more about the strategies." Lastly, in Exit Ticket 7, Ivy said, "I am nervous to teach math to a whole class, but the way that Dr. Garner and Christine have taught this class has helped me learn to be more flexible and allow for discussing multiple ways of thinking about math." Changes from the learners' perspectives seem to be deeply rooted in how Dr. Brette and I approached discourse in our classroom.

Conclusion: Learners' Changes in Dispositions.

Many EPSTs' understandings of math changed — they shifted from thinking of math as procedural to appreciating more conceptual understanding. They shifted from thinking of mathematics as about providing worksheets for lots of practice to discussion and high cognitive demand tasks. Dr. Brette and I made sure to communicate to EPSTs that it is okay to make mistakes, and it is important to learn from those mistakes through error analysis. EPSTs left our classroom knowing that all prior understandings about math can be relevant and helpful, no matter how extensive their knowledge might be.

Our teaching encouraged EPSTs to see that math can be joyful. Brenda said that this course "reframed math for me to find joy in something I did not align with before" (Interview). Ivy also chimed in in her interview, "My experiences learning math in this class has shown me the importance of creating a joyful learning environment." Brenda referred to the way that we realigned joy to math and how that kind of teaching move was an important prompt for her to shift her learner's disposition.

While this way of teaching generally shifted mathematical dispositions positively, we didn't do magic. Some EPSTs' dispositions were negative coming into class and were still negative leaving class. We were not able to shift the more drastically negative dispositions in the short time period that we had. There were also some EPSTs that were less susceptible to our teaching or even to us as humans. Some students in the class never really connected with us as individuals or our teaching framework.

The topics that EPSTs reported were difficult in their autobiographies, like fractions, were still hard for the EPSTs at the end of the course. We are still not reaching the EPSTs very well on that subject. There was a consensus in the data that the EPSTs still lacked a conceptual understanding of fractions, which is a huge growth area for Dr. Brette and I to consider. Our teaching and pedagogical choices affect EPSTs dispositions and we were not flawless.

Also, the course was only ten weeks — Dr. Brette and I can get EPSTs into positive habits of mind surrounding doing and learning math but EPSTs are still going to have to continue to form and extend those habits for themselves. From the learners' perspectives, EPSTs fit into a spectrum of mathematical dispositions. There is not one way to describe the whole class's dispositions, instead it was very rooted in personal experiences both before and during the course. Though, the general trend was the course made the most impact for EPSTs' with dispositions in the middle of the spectrum that are easier to shift than those staunchly at the negative end of the spectrum.

Teachers' Perspectives: Math Teaching Anxiety.

Math teaching anxiety was still a struggle for EPSTs at the end of the course. For all EPSTs, they started with relatively high math teaching anxiety, which decreased throughout the course but for different reasons. There were primary clusters that almost all of the EPSTs' math teaching dispositions fell into both at the beginning (*moderate*) and the end of the course (*some*). Although EPSTs' math teaching anxiety quantitative data statistically significantly decreased, EPSTs were still concerned about math teaching. While the EPSTs followed similar trajectories, there were different concerns driving their math teaching anxieties (e.g. Table 15). These concerns, unlike the other constructs are not mutually exclusive or distinct; there are EPSTs who fit into multiple of these categories of concern surrounding math teaching anxiety.

While this wasn't something I was initially seeking out, this data is integral to gaining a better understanding of how math teacher educators can encourage even more positive shifts in dispositions. EPSTs' attributed their qualitative responses around math teaching anxiety to clear shared experiences with: preparation (12), meeting all students' sense-making needs (11), curriculum (10), grade level (8), lack of content knowledge (3), and too much content knowledge (2).

Overall, the EPSTs in this study had more math teaching anxiety than math anxiety. They were more worried about teaching than doing the math and often explicitly said that it was harder to teach math than to do it. Every single one of the 18 EPSTs reported a quantitative level of math teaching anxiety that was higher than 2.0 out of 5.0

and qualitative data that backed up their teaching anxieties. The themes below are where their math teaching anxieties come from and how they manifest for this group of EPSTs.

Table 15
Math Teaching Anxiety Theme Results

Theme	**Number of EPSTs Reporting**
Preparation	12
Meeting all students; sense-making needs	11
Curriculum Tensions	10
Grade Level	8
Lack of Content Knowledge	3
Too Much Content Knowledge	2

Note. This table is a breakdown of where the EPSTs attributed their math teaching anxiety to be coming from.

Teachers' Perspectives: Math Teaching Anxiety: Preparation.

Twelve EPSTs were worried about preparing to teach math. They were concerned about the time it takes to practice teaching math, the time it takes to practice planning math, and the time it takes to potentially have to switch preps or grade levels. The way that the fieldwork placements are set up, sometimes EPSTs do not get the time that they need to plan and lead whole group math lessons until well into the course; they might not have led many, or any, math lessons. The ones that they have led, they put countless hours into perfecting them. As they progress in their career as teachers, they will start to better understand the cadence of lesson preparation. Additionally, for any teacher, but a preservice teacher especially, the idea of being in one fieldwork placement and then having to learn a whole new grade level prep is daunting. Many of our EPSTs mathematical dispositions around teaching math were affected by the reality of teacher preparation. This reality is a product of the profession of teaching as well as the result of an 18 month graduate teacher education program. In future iterations of this course Dr. Brette and I could take more discussion time to talk about common pitfalls and struggles of preparing and teaching a lesson.

As preservice teachers, they are actively being inundated with new aspects of teaching that they should consider integrating in their practice from multiple teacher education courses all at once. Often, when EPSTs are presented with too many things to consider in their classrooms they feel, momentarily, that is unattainable to be successful teachers. They often expect that it is immediately possible to execute all of the things they are learning. Instead, EPSTs have to discover that they can only focus on certain aspects of teaching. Dr. Brette and I described making these changes manageable by choosing only a portion of action items at once—so teaching feels more attainable. These planning worries all manifested in math teaching anxiety. The ESPTs were concerned that they would not have the time they need, or the ability to prioritize what they should start with to get comfortable with teaching math.

Teachers' Perspectives: Math Teaching Anxiety: Students' Sense-Making.

Eleven EPSTs explained that they are most nervous about their ability to teach the content so that the students can make sense of it. Some of this concern might have been prompted by Dr. Brette and me. As we went through class we put a precedence on exposing EPSTs to the many layers of students; sensemaking, which might in fact have made them more anxious about teaching. If EPSTs had not previously considered all of the potential solution paths to math as learners, then it will likely be even harder for them to consider those paths as teachers. There is a dearth of examples of ESPTs worries about student sense-making. I want to position these EPSTs' voices through direct quotes because of how consequential these understandings are to teacher educators. When EPSTs are finished with their teacher education programs, one of the most meaningful things they can take away is how to promote students' sense-making, which is why this specific concern deserves a comprehensive analysis.

Weston said in his interview, "I feel nervous about knowing the answers to all the questions. It is hard for me to imagine all their possibilities for solution paths." Heather said in her interview that she has math teaching anxiety around, "Being able to ask the right questions and being able to pivot to the students' needs on a whim." Diana reported being worried about answering student questions and knowing when to pivot or move on from a "rabbit hole" without shutting a student down (Interview). Hannah said that she does not have math teaching anxiety, yet went on to voice her concerns about making mistakes: "Am I doing the best for this kid in this lesson? My anxiety comes from worrying that I won't be the best everyday…" Colleen described her feelings around whole class lessons, "[I am] nervous because it takes a lot of time for me to understand the lesson and I feel like I do not explain the concepts in the most concise and effective way. I also do not know what thoughts the students are going to bring to the lesson." She then went further and said that she is "worried in my abilities to produce math for the students to understand. Am I presenting it correctly? Are people understanding it?"

(Interview). These EPSTs are worried about their ability to make changes in real time—they are worried about sometimes making the wrong decisions (e.g. they are concerned that they won't always know when to continue to pursue a tangent or when to shut it down).

I think that one potential option to ease EPSTs' math teaching anxieties is some decision-tree type analyses—considering what might happen in classrooms based on X or Y decision in a specific contextualized situations. Though, I am not sure if more exposure to the decision making analyses explained above around would actually make students less anxious. Since some of their teaching anxieties revolve around feeling overwhelmed with all of the things that they are expected to do in the classroom as a teacher, throwing more content at them might not be the answer. Exposing teachers to tasks like this could have a negative side effect of actually increasing their anxiety.

What is arguably more important than additional opportunities for practice is for EPSTs to endorse their mistakes. There are going to be times as teachers—even with expert teachers—that they make a pedagogical decision that did not have the impact that they wanted (e.g. deciding to go down a rabbit hole that is indeed *more* confusing than helpful for student sense-making). There are an innumerable amount of decisions that every teacher makes in every classroom. It is impossible—even for highly committed teachers—to always make the *right* pedagogical moves; there are no right and wrong pedagogical moves. In our course we could do more to address variation in these kinds of pedagogical decisions. Dr. Brette and I could do more to affirm EPSTs to sit in the uncomfortable—to understand that teaching is never going to be a perfect practice.

Emma also remarked in her interview that “I think that I maybe get stressed about if a kid doesn’t know how to do it. I am worried about getting angry and frustrated. How can I calm myself down to help them… how do I get unstuck and shift my thinking?." Her response exposes gradation in nerves around student sense-making. Her concern is more pointed towards her response to situations, rather than students’ understandings. This is important to point out because it is a different type of rationale for math teaching anxieties around student sense-making than the other examples. Meeting the sense-making needs of all students is quite difficult to do and every classroom of students has different needs. There is no *best practice* solution to feeling overwhelmed about meeting the needs of dozens of kids in a classroom.

Teachers’ Perspectives: Math Teaching Anxiety: Curriculum.

Ten EPSTs described math teaching anxiety around the curriculum at their schools. Jayden described his school curriculum as “piss poor” in his interview. He continued to explain that he was worried about his school enforcing the expectation of sticking to the curriculum. He pointed out that he is concerned with his ability to have enough time and freedoms to supplement the curriculum. Hannah is worried about a very similar aspect of curriculum; she is worried about her school’s push for “fidelity” to the curriculum (Interview). She characterized even deeper concerns as she explained that the curriculum at her school just teaches to the standardized tests. Mary, Colleen, and Emma talked about the rules and policies that their schools have about curriculum and how that also causes them math teaching anxiety.

Reconciling the tension between the curriculum that EPSTs have at their schools and their own thoughts about curriculum can cause a sort of teaching dissonance. Where, EPSTs want to follow the regulations from their schools, but they also know that if they do it likely will not support their own pedagogical goals. EPSTs are getting pulled in multiple directions; follow the curriculum but also be inclusive for your kids. Sometimes—thought, not always—the curriculum at a school is built on traditional math. If they have a moral obligation that they do not want to teach traditional math, then EPSTs' have to weigh which side to favor.

In the future, I think that Dr. Brette and I can do more to name the tension and talk with the EPSTs about how they can navigate it. Maybe, we could give examples of how to settle the cognitive dissonance of wanting to appear to be supporting the school curriculum and also creatively insubordinating some of the recommendations if they do not work in their classrooms (Gutiérrez, 2016). We could also give examples of how EPSTs might talk to their lead teacher or an administrator at their school if they want to implement something that is not on the school curriculum.

Teachers' Perspectives: Math Teaching Anxiety: Grade Level.

Some EPSTs noted that specific grade levels caused them teaching anxiety. When talking about teaching K-5, EPSTs split up elementary math into two levels K-2 and 3-5. Eight EPSTs noted that they feel comfortable teaching math grades K-2, but were anxious about teaching grades 3-5.

Some of the EPSTs that recognized their discomfort said that they would just have to refamiliarize, relearn, and take more time planning if they were teaching 3-5 (3

EPSTs). These ESPTs are the ones with higher levels of positive mathematical dispositions. It is not the content that they are worried about, but how to present the content to students. On the other hand, the other EPSTs had concerns about their content knowledge for teaching the upper elementary grades. Willow self-rated herself out of ten on her level of confidence. She noted that she felt that she had a 6/10 level of confidence in teaching K-2 but a 2/10 confidence level in 3-5. Karly said in her interview that she wants to "be with the younger grades so I feel confident" she then expanded and said that she "Only feels confident teaching K-2nd." Heather said that she would be "*A LOT* less confident in grades 3-5" (Interview). Maggie is worried that with upper level elementary math she would not be able to answer her students' questions and that would cause her teaching anxiety. These students have worries that are rooted in the content itself and they do not have overall positive mathematical dispositions, which is not the same reasoning behind the first group.

Math teaching anxiety around grades 3-5 is especially problematic because this course is supposed to prepare EPSTs for K-5 instruction. Many of them are walking out of this class saying they are worried and do not feel prepared for 3-5. They did not have enough time to really grapple with some of the content for the higher grade levels, especially those who were already struggling with their content knowledge. As an instructor in this course, one of the most troubling sources of content anxiety is fractions content in Sessions 6 and 7. To better prepare EPSTs to feel more comfortable both with the upper elementary content and with how to teach this content we would need additional credit hours. A potential solution would be to teach a second elementary math methods course; one for K-2 and one for 3-5 content. This way there would be a total of 8 credits of math before EPSTs graduate and teach on their own, which is supported by AMTE's standards for preparing teachers of mathematics (2017). I believe this would help both reasons for math anxiety in this category, fear of the content itself and fear of not being able to communicate the content to students.

Teachers' Perspectives: Math Teaching Anxiety: Lack of Knowledge.

Three EPSTs clearly expressed that their math teaching anxiety came from their lack of content knowledge. Karly said in her interview, "I am not very confident in my math skills and the thought of teaching math to children makes me somewhat anxious." Kaila is also struggling with a lack of math content, when describing how she sees her relationship with teaching math she said that she feels "incompetent" and goes on to ask "how can I teach something I don't understand and have forgotten most of?" (Interview). In her interview, Willow said, "It's hard to teach something that you feel like you don't know. Explaining math is hard for me."

All three of these EPSTs were not confident in their abilities to do math and therefore were worried about their abilities to teach math. This multi-layered anxiety around doing and teaching math is something that cannot be tackled in a ten week course. Again, the solution here would be an additional math course for the EPSTs, in which all of the EPSTs would benefit—not just the ones that reported a lack of content knowledge.

Teachers' Perspectives: Math Teaching Anxiety: Too Much Knowledge.

On the other hand, there were two EPSTs — Kalla and Emma — who worried about having too much content knowledge. They were worried that a high level of content knowledge would possibly make them worse teachers. For example, Emma said in her interview, "My biggest fear with teaching anything math related is that since I found the subject to be so simple - I will rush past the little things that some students in my class may need." Kalla and Emma's experience is a sharp contrast to the theme above, which is a lack of content knowledge. Instead, Emma and Kalla believe that because they were naturally good at math and enjoyed it that they will have a hard time relating to some of their students. When they learned it in K-5, it came easily to them and so they do not empathize with struggling students easily.

EPSTs with too much content knowledge and math teaching anxiety are often struggling to relearn the conceptual content because they don't always see issues with the procedural and algorithmic ways that they were taught in the past. Encouraging them to consistently put themselves into their students' shoes and to re-learn the conceptual ways to teach things can better support teachers with this kind of teaching anxiety; because they are also more at risk of teaching in traditional formats because they were successful in that format.

Teachers' Perspectives: Math Teacher Self-Efficacy: High & Stayed High.

Seven EPSTs came in with high math teacher self-efficacy, describing things like, "I feel pretty confident about being a teacher. I will stay open-minded and have a positive attitude." (Mary, Interview) and "I feel like because I know math, I can be a really good teacher." (Hannah, Interview). These EPSTs feel confident in their abilities to successfully teach students math. They felt that way before the course and after the course. Even though this theme of EPSTs did not move quantitatively in big ways, they still qualitatively evolved their dispositions.

For an example of one of these qualitative shifts, Mary said in her interview that Dr, Brette and I were "the first teachers that said that there's more than one answer [in math] and that we have to be more flexible to more possibilities. This opened my mind to just how big math can be. It's not just hardcore and rigid." Mary went on to explain that her recently developed adjustment to thinking about math has also persuaded her to have a new thinking about teaching math as well. So, even though she was in the high and stayed high category, the course still provided her with opportunities to shift her disposition even further.

On the other hand, Emma thought that "complicating" math and having more than one right answer was going to be a difficult shift for her as a teacher, which made her feel less likely to be successful. So even though Emma's quantitative math teacher self-efficacy score was *high*, she still had concerns about being able to translate some of the new things that she was learning into her teaching. This second example shows how there were still changes to her disposition from the qualitative data; in this instance this shift was not necessarily a more productive one.

Jayden explained in his interview that, "initially, teaching math is hard, but everything is hard as a first year teacher. I feel confident teaching math, but it's a work in progress." He understood that he is going to have to practice, make mistakes and "get in the groove." Despite the challenge, he is still confident in his abilities and has relatively high math teacher self-efficacy. The above quotes from Jayden points to another example of an EPST who had high math teacher self-efficacy from the beginning, but still reported shifts in his mathematical dispositions. There were also two EPSTs that decreased and two EPSTs that stayed the same in teacher self-efficacy. The decreases were minimal and the EPSTs who stayed the same were relatively high.

Teachers' Perspectives: Math Teacher Self-Efficacy: Course Increased.

Seven EPSTs had an increase in math teacher self-efficacy throughout the course. Willow said that she is "feeling more confident about [her] ability to be a good math teacher" (Interview). Tamara explained in her interview that the course made her "feel more confident teaching math, but it's a work in progress." Tamara also explained that in her kindergarten placement she does everything she can to avoid saying that her students are wrong because she knows how that can shut them down. She said that she gained this understanding from our course. One of our assignments, fascinating student thinking, encouraged Tamara to see every answer that her students give as contributing to mathematical discourse. Even if she might not have originally thought a student's mathematical understanding furthered the mathematical discussion she now wants to take the time to see the logic of all of her students thinking. Maggie is quoted saying, "I feel more confident in accepting incorrect answers and turning them into fascinating ways of thinking" (Interview). Lastly, Martha narrated,

> My relationship with math has gotten so much better and it will improve my teaching. I have been on a math journey of self-discovery. If I had started teaching

> before, like right out of university I would have had a more negative disposition towards math which would have affected me and my students. I would have taught the way I was taught. BUT with reflection and growth it will help me avoid the mistakes and the trauma that was inflicted on me (Interview).

These relationships with teaching math shifted because of EPSTs' newfound understanding that math is complex and not objective. Martha also explained that the course encouraged shifts in her relationship with math teaching because she did not know that there were so many ways to find solution paths to math problems. She joked in her interview that when she was first prompted to use her manipulatives and consider teaching with them that her response was, "use your manipulatives… IDK HOW??? Like, WHAT is this?" Although this was her reaction at the beginning of the course, by the end of the course she was confident that manipulatives could be a powerful teaching tool for her.

EPSTs with an increased math teacher self-efficacy tend to believe that they will be more successful in student outcomes (Setra, 2018). The more math teacher self-efficacy someone has is also correlated to positive student outcomes (Henson, 2002; Setra, 2018). Both the belief in your teaching and the relationship to positive student outcomes are linked to higher mathematical disposition from the teachers' perspectives.

Conclusion: Teachers' Changes in Dispositions.

Many EPSTs' understandings of math teaching changed — they grappled with unlearning traditional pedagogies and how they saw themselves in relation to math teaching. Overall, they had more beliefs in their abilities to teach math, but were also still pretty worried about it. Part of this teaching anxiety is anticipated as teacher education programs overload EPSTs with information on all of the things they should be doing in their practice.

Some EPSTs who reported relatively negative dispositions around math teaching still had negative teaching dispositions at end of the course. Many of these EPSTs reported that they are still developing their relationship with teaching math. While, with other EPSTs there was a marked difference between their pre- and post- teaching dispositions. Many of these EPSTs thrived in a learning environment that was meant to increase their dispositions around teaching and gained both confidence and beliefs in their math teaching abilities.

RQ2: Integrated Comparative Mixed

Like in RQ1, I employed Bazeley's (2017) framework. Again, I looked at the 76 instances— 18 EPSTs multiplied by the four separate constructs. The qualitative data expanded my understanding of the quantitative data; there were times when the qualitative data reinforced what the quantitative data said, other times that the qualitative data painted a much more complex picture.

All EPSTs had some level of positive evolution in their dispositions around teaching and learning math. Some of the evolutions were giant leaps towards a more positive disposition and other evolutions were smaller shifts. However, even these small shifts could plant the seed for EPSTs' dispositions to continue to evolve. I can confidently say that all of the EPSTs were more comfortable in a math classroom by the end of the course. EPSTs changes throughout the course were palpable: as the weeks went on, they were more and more likely to engage in mathematical discourse, they were more open to new mathematical strategies, and they felt more empowered that their personal cultural funds of knowledge in math were important and helpful to their learning.

42.97% of the comparisons between the qualitative and the quantitative enhanced each other throughout the duration of the course, which is about 33 individual construct-level instances. 33% confirmed each other, or 25 of the 76 instances. When comparing the qualitative and quantitative data, 18 instances, or 24% have mixed results. Lastly, only 2 instances out of the 76 were dissonant, or .03%. Almost three fourths of the quantitative and qualitative comparisons told a stronger and clearer narrative when integrated together. One fourth was mixed or told more nuanced stories, and it was extremely rare that when comparing the mixed methods they told different stories.

One example of the enhanced comparison from the RQ2 mixed methods data Tamara and her math anxiety from a learner's perspective. She started out with *very high* quantitative math anxiety, which paired with a sense of lacking confidence, yet an enjoyment in doing math. She then said throughout this course that she learned helpful strategies that "took the scariness out of math" and her final quantitative math anxiety score was *very low*. So, in this case the qualitative and quantitative enhanced my understanding of Tamara's lived experiences in shifting to a more positive math anxiety. In the qualitative data she got to explain her why. Her anxiety decreased because of additional mathematical strategies that she learned. Without the qualitative data, I would have known *that* her math anxiety went down but not *how*. I understand that she still has anxiety, but not anywhere near as dramatically high as she once did. Her relearning of new mathematical strategies as a learner helped her cope and shift her anxieties.

Another example of enhanced understanding from mixed methods is Ivy's teaching anxiety. She came into our course with *some* quantitative math teaching anxiety. In her autobiography, she said that she had anxieties around mathematical content and the pre-set curriculum. Then in exit ticket ten she said, "this class was very helpful for me in reversing some negative ideas I held about teaching math and pushing me towards a growth mindset." Her final quantitative score in math teaching anxiety decreased and was considered *low*. Similarly to Tamara, Ivy's qualitative data explained *how* she decreased her math teaching anxiety. She went from *some* to *low* by allowing our course to push her math mindset growth mindset.

Two confirmed comparisons for RQ2 is Hannah and her math teacher self-efficacy and Brenda's math teacher self-efficacy. Hannah started out with a *moderate* belief in her abilities to successfully teach math. Her qualitative data from the second half of the class illustrated the following: "I love talking math with my students" and "because I know math I know I can be a really good teacher." In her interview she said that she, herself, was what gets in the way of her becoming a successful teacher: she said "I am a huge thinker and I have to pull my ideas all the way back down for it to make sense to my students." She ended the course with a *very high* math teacher self-efficacy score. This example fits in the confirm category because that last tells a bit of a different story than the first two quotes. Hannah is comfortable with math content but is at least a little worried about her ability to translate that to her students.

The second confirmed RQ2 mixed methods example is Brenda's math teacher self-efficacy. She quantitatively started out the course with *some*, which is on the relatively lower end of math teacher self-efficacy, and she ended it with reporting a *very high* quantitative score. The turning point for her was when she realized that all of her past data experience could "improve [her] confidence in [her] math teaching abilities." That qualitative quote was quite early on in the math autobiography, but this shift in her thinking allowed her to harness her past experiences in new ways.

Throughout the RQ2 results 75% of the individual construct-level instances were enhanced or confirmed. The qualitative data in these categories helped me to make an easy to understand narrative about EPSTs' individual dispositions. When EPSTs' data agreed when combining them it permitted me to meet my epistemic goal of getting to the essence of the EPSTs' possible mathematical dispositions.

Next, is partial agreement, where combining both forms of data only incompletely support each other. This is only one fourth of the data collected throughout this course. An example of this is Weston's math teaching anxiety. Before the course, he quantitatively had *some* math teaching anxiety. After the course, he had *low* math teaching anxiety, so it decreased. Yet, his reflections in his math autobiography and his interview point to more anxiety than the post-questionnaire reported. In his autobiography he said, "I have a difficulty explaining things." In his interview, he noted that he was nervous about the amount of time he had to prepare for lessons. He also said, "I am nervous about knowing the answers to all the questions." In this example, the qualitative data makes Weston seem like he is more nervous than the quantitative data shows, hence partial agreement.

Another partial agreement example is Jayden's math teacher self-efficacy. He came into the course with *very high* teacher self-efficacy and ended the course with *very high* teacher self-efficacy quantitatively. But he said in his math autobiography that "teaching math is going to be hard for me." He also is worried about being a successful math teacher because of the requirement to follow his school's "piss poor" curriculum. Again, here the mathematical disposition looks *very high* quantitatively, but when you add more qualitative data you only get partial agreement and a more intricate story of Jayden's understanding of his math teaching ability.

Lastly, when comparing mixed methods, rarely there are dissonant forms of data, where the qualitative does not support the quantitative. In fact, there were only two across all of the instances. One of these examples is Willow. She reported *some* math teaching anxiety both before and after the course. However, her qualitative data does not agree with just a *some* level of teaching anxiety. She said, "it is hard to teach something you feel like you don't know" in her interview. She also said her self-confidence for K-2 was a 6/10 but her confidence for grades 3-5 was a 2/10. To me, this indicates a much higher level of math teaching anxiety than the quantitative portion reflected.

RQ3: Qualitative Self-Study

In this section, I discussed the qualitative results from RQ3, or "Through a self-study lens, how do the instructors iterate their practice to implement a rehumanizing, ambitious and equitable math framework for EPSTs?" This research question was analyzed through the rehumanizing, ambitious, and equitable framework. Dr. Brette and I were perpetually reflecting on our practice to make sure that we were doing everything that we could to build the best classroom environment for this group of EPSTs. All of the changes that Dr. Brette and I decided to make were rooted in rehumanizing, ambitious, and equitable mathematics.

The results from this data will show the pedagogical responsibility (Horn, 2019), relational agency (Edwards, 2005; 2010), and teacher sense-making through changes in our classroom practice as co-instructors. Relational agency, in this sense, is Dr. Brette's and my capacity to act flexibly to address unpredictable aspects of our practice by engaging with each other working on the same problems of practice and discussing our perspectives (Edwards, 2005; 2010). Our pedagogical responsibility describes aspects we viewed as essential in our reconstructions of our practice — our obligations to ethical principles and or situational constraints (Horn, 2019).

When I reviewed the course recordings in tandem with the debrief recordings, they revealed the what and how of Dr. Brette's and my reiterations of our course. We pivoted our practice based on questions asked, topics presented, or other contextual factors to support our goal of achieving an ambitious, equitable, and rehumanizing classroom. If one of us forgot something that would have made a certain session more supportive to students, the other chimed in; if a conversation was sparked that would encourage our EPSTs to be more reflective and ambitious and equitable teachers in their own classrooms, then we let the conversation wander. Below, I give a synopsis of the changes that Dr. Brette and I made to our course by theme.

1. Adjusted the order or content of the course curriculum

   Adjustments during Fall 2022

   Adjustments for the future

2. Elicited and responded to student feedback
3. Encouraged unplanned, sidebar conversations
4. Supported shifts in dispositions

   Frames for Assignments

   Math with New Understandings

   Seeing their Instructors as Humans

5. Noticed EPSTs' bodies and emotions

Adjusted the Order or Content of the Course Curriculum

Dr. Brette and I iterated our practice to make sure that we were implementing a rehumanizing, ambitious and equitable math framework by changing course curriculum. Sometimes, we would change the order or the content, or ensure that we were being transparent with EPSTs about why they should be engaging with certain aspects of class. Below are some examples of how and why we reiterated our practice.

Adjustments in Fall 2022.

In previous years, EPSTs noted that the fraction content was the hardest content for them to productively struggle with, which was weeks six and seven. To give our EPSTs more time to sense-make with fractions, we cut some of our originally planned content and changed the order of the content. We thought the way we re-aligned the whole number operations on the same day as the fraction operations would encourage students to see a clearer throughline between the two. We hoped that this would persuade the EPSTs to directly apply the whole number operations to the fraction operations.

We also thought that splitting fractions into two different course sessions might have a positive impact. In the past, we did all of the whole numbers in a single course session and all of the fractions in another. Based on EPSTs' feedback, fractions were still the hardest content for them to relearn, however, this new structure of the content received more positive feedback than past versions. The fraction changes encouraged the EPSTs to see math as a living practice, one of the tenets of rehumanizing math (Gutiérrez, 2018). The newly structured lessons provided the EPSTs to see math as interconnected and different from the first time they learned these topics in elementary school. We shifted Session 6 to contain both whole number and fraction addition and subtraction in one session. We also changed Session 7 to contain whole number and multiplication and division. This made the math even more interconnected than it was in the past, harkening back to supporting this tenet of rehumanizing math. This new frame for EPSTs to see math as a holistic and deeply interwoven is also a tenet of ambitious and equitable math, which our course exemplified with this change (Horn & Garner, 2022).

Adjustments for the Upcoming Years.

This section covers the adjustments that Dr. Brette and I plan to make in upcoming version of this course. After Session 1, we thought that we should add more base ten riddles, or even encourage EPSTs to create their own base ten riddles to make our originally planned activity even juicier with a higher level of cognitive demand (Yeh et al., 2017). This addition gives EPSTs more time and practice grappling with the concept of base ten.

To dive deeper into the rehumanizing math content that was presented in Week 1, Dr. Brette and I also discussed a potential option to analyze the EPSTS' dehumanizing experiences reported in their math autobiographies. To analyze their experiences we would ask the EPSTs to think about ways to rehumanize certain shared common experiences in the math classroom that come up in their autobiographies (e.g. timed tests, zero points for even the tiniest computational mistake, and being punished with a bad grade for not using the exact same procedure that the teacher used). With this change, we would encourage them to consider ways that they can break the cycle and not replicate some of those dehumanizing experiences by coming up with different moves in the classroom to achieve the same learning objectives in a more rehumanizing way. This will help to bridge the theory to practice gap with applying the rehumanizing math tenets to their own classrooms.

During Session 2 and Session 3 Dr. Brette and I were too heavily based in lecture. In the future, we want to make sure we are positioning EPSTs as meaning-makers instead of talking at them. In Session 2, Dr. Brette and I had a goal that our EPSTs would begin to understand that *all students are brilliant* in math, no matter what identities they carry with them, like having different cultural funds of knowledge or their brain working in a different way because of being neurodivergent. In Session 3, we wanted our EPSTs to understand the importance of arithmetic fluency and delaying the standard algorithm. To make Session 2 less lecture-based we will pose reflection questions like "what does it mean to be smart in math? Or, who gets to be seen as smart in math?" These questions would lead into a discussion section instead of Dr. Brette or me just telling the EPSTs about all students being brilliant. For Session 3, instead of just explaining the methods, we want to encourage EPSTs' to apply invented strategies in a much more interactive format. These shifts promote students to think about this on their own and reinforces a rehumanizing participation in class (Gutiérrez, 2018).

Throughout the entirety of the Fall 2022 version of this course, Dr. Brette and I noticed that one of the assignments, Fascinating Student Thinking, was generating much more shallow discussion than in years past. I wondered if this was because we had a pool of EPSTs that skewed into lower elementary school than we did in the past, which can sometimes make it hard to find robust examples of fascinating student thinking. Dr. Brette and I plan to give our students an exemplar of this assignment next year so that they know the extent of conversation we expect from a Fascinating Student Thinking discussion. This takes the guesswork out of what we are expecting as instructors, and is more supportive of EPSTs' agency and participation with the content (Gutiérrez, 2018).

Elicited and Responded to Student Feedback

Dr. Brette and I iterated our practice by asking students for feedback and responding to that feedback. Below are some examples of how and why we reiterated our practice based on student feedback elicited from exit tickets (Appendix J). Sometimes feedback was positive and it motivated us to keep certain aspects of class. In other EPSTs' feedback there were points of critique that Dr. Brette and I tried to address as best we could.

Critiques of the Course

Exit Ticket 2 helped us to understand how our EPSTs' dispositions were evolving after submitting their autobiography and grappling with the new rehumanizing math framework (Appendix J). Based on EPSTs' feedback from this exit ticket, we changed the classroom to a quiet space. Multiple students noted that they were overstimulated by the end of the day, and Dr. Brette and I wanted to make sure that students had a space where they can escape stimulation for a bit; this move supports EPSTs bringing their bodies and emotions into the classroom (Gutiérrez, 2018). So, when there is a break built into the course, we would remind the students who wanted to chat, to chat outside the classroom.

EPSTs also responded to what was not going well in Exit Ticket 4. One of the things that Dr. Brette and I do not have the power to change, but was noted by 22% EPSTs, was the length of the class. Ivy suggested activities away from screens. Heather suggested shortening some of the small group activities. Daisy said that she would like less sitting and more moving. Lastly, Brenda said that she felt that the summarized portions at the end of class felt like a filler and that it could be shortened or cut. In response to EPSTs' feedback, we made sure to make some of the groupwork activities on paper. We also created a gallery walk, which was on paper and got the students up out of their seats. As instructors we always made sure to talk about timing and to make sure that we were not taking too long for discussion at the end of class. All of these iterations were made because of student feedback and supported their learning in our classroom.

In the final Exit Ticket 10, students were asked what their least favorite aspects of our class were. Some of the EPSTs responded with specific content, assignments, or course structures that they did not enjoy; just like with their favorite aspects of class. Tamara said that the video analysis assignment was her least favorite. Both Brette and I believe that this is an important activity and will stay in the curriculum. Two students responded that the math journals assignments were their least favorite (Willow and Emma). I think that the repetitive nature of the math journals can make them extremely arduous, but I also believe they are necessary to make sure that the EPSTs grapple with the content before coming into class. Willow thought the fraction journals were too difficult. Emma found discussing questions in the journal during class time was too repetitive; I actually tend to agree with her and would like to make a plan to have less repetition.

Weston asked for more explicit instruction on differentiation. Jayden asked for more direct modeling of changing a given curriculum to be more rehumanizing, ambitious, and equitable. Three students reported that the group discussions were too long. Dr. Brette and I could break up group discussions a bit more; however, I also think that the EPSTs who found the discussions to be too long already had a *very high* level of content knowledge. In the future, I think I would pull these EPSTs aside and explain to them why it is so important for them to engage with the discussions even if they fully understand the content. Fourteen EPSTs mentioned that they really disliked the length and scheduling of the course. Like I have said previously, there is nothing that neither Dr. Brette nor I could do about the timing or scheduling of the course.

Positives of the Course

EPSTs responded with many things that were going well in Exit Ticket 4. The thing that was referred to the most was the small-group work. Small-group work provided EPSTs with the opportunity to engage in mathematical discourse to generate sense-making (Yackel & Cobb, 1996). 50% of students mentioned that they appreciated the small group collaborative work. The next most mentioned response was how the collaborative Google Docs supported EPSTs' understandings of course content (39% reported). 22% of EPSTs mentioned how Dr. Brette and I prioritized relationship building in the classroom and that made them feel good about the course. 22% of EPSTs said that the weekly math journals and the breaks during class were beneficial to their learning. As instructors, we responded by continuing to prioritize relationship building, and keeping the group work, breaks, and math journals. In this session we were also reassured that we were indeed implementing the rehumanizing, ambitious, and equitable framework that we were attempting to implement.

In the final Week 10 exit ticket, students were asked what their favorite aspects of our class were. Some of the EPSTs responded with specific content, assignments, or course structures that they enjoyed. Willow said that the textbook was her favorite. Tamara responded that the math autobiography assignment was her favorite. Emma and Maggie most enjoyed the math journal assignments. Brenda and Maggie liked the video analysis assignment. The Suh et al. (2018) reading about math modeling was a favorite of Ivy and Kaila. Three EPSTs mentioned the Yeh et al. (2017) reading about task rich math environments. Four EPSTs responded with the fascinating student thinking assignment. Five EPSTs really appreciated the Gutiérrez (2018) rehumanizing math article. Lastly, twelve EPSTs, or 65% of EPSTs mentioned the 'hands-on' activities in the small collaborative groups. All of these favorite aspects of class support our framework and support EPSTs' experiences within this framework. Since many EPSTs found so many aspects of our instructional materials to be supportive, they will be kept in the next iteration of this course.

Fourteen out of our eighteen students mentioned our teaching practices explicitly in Exit Ticket 10 when prompted by "if you want us to know one thing about your experience this quarter what would it be?" (see Appendix J). Five students mentioned having fun in our class and the joy we bring to teaching. Some of the words that the students used to describe our course were: enthusiasm, kindness, sense of humor, and patience. In the Week 10 exit ticket, Willow said, "I feel so lucky to have learned from Dr. Brette and Christine because math is not my strongest subject as a learner or as a teacher and to feel so supported over the course of these 10 weeks has made a huge difference." Karly said, "I like that you make it fun and valued mental health over deadlines." Two students explicitly vocalized that we made the course environment a rehumanizing one (Ivy and Brenda). Diana stated, "I feel as though you and Christine showed up every day giving us your very best effort." Mary said, "I found a lot of comfort and flexibility with thinking in your class. I love your attitude towards math and felt like you were always on our side when it came to assignments. You understood us and where we were coming from which allowed me to trust you as professors." Lastly, a quote from Ivy was, “I truly appreciate your approach to rehumanizing math and your support this quarter. I felt seen as more than just a student. This class was very helpful for me in reversing some negative ideas I held about teaching math and pushing me towards a growth mindset.” The analysis of this data supports the idea that our teaching encouraged EPSTs to shift their mindsets around math. It also deeply supports the claim that we created an ambitious and equitable and rehumanizing classroom.

Participated in Tangents

We iterated our practice in real-time to make sure that we were implementing a rehumanizing, ambitious and equitable math framework by engaging in tangential conversations that were not planned. These conversations were in response to students’ needs. EPSTs would sometimes bring something up or ask certain questions that would cause Dr. Brette and I to go down sociomathematical paths that we were not expecting to go down. They were unplanned tangents that were driven by students’ wonderings. Below are some examples of how and why we reiterated our practice based on these EPST prompted conversations.

One of the instances of rehumanizing math in the Session 1 was when Dr. Brette had a sidebar conversation with the whole class surrounding her History of Math course when an EPST asked about why math has been recently privileged in the United States. Dr. Brette made a quick pitch to EPSTs to take her course and then explained how math came to have an “unearned” privilege in society, which is linked to capitalism, fear of communism, the Space Race, and the government push for STEM to fulfill the U.S. government’s policy priorities. I also chimed in to talk about the historical significance of imperialist propaganda during the late 50s through the mid 70s. How the United States Government was pushing rhetoric out to "beat the commies" in the Space Race. We both went on to conclude that this is the crux of why people think that STEM is the most important. Dr. Brette clarified that math is important, but being "fast and accurate" (e.g. human computers, like Katherine Johnson) and having the pinnacle of a math career be calculus is rooted in historical and U.S. imperialism. EPSTs were presented with an understanding of math rooted in politics, math being value-laden, and math's top tier position in society all being deeply affected by history. In this tangent, Dr. Brette made this class and math itself more rehumanizing through a broadening of mathematics and histories (Gutiérrez, 2018). This part of the class encouraged EPSTs to see math in a new way based on its historical roots.

Later in the first session, a group of EPSTs asked about showing your work (e.g. procedural steps of your mathematical thinking on pencil and paper for homework or tests). While I was talking with the EPSTs I said that the *why* teachers are asking their students to show work matters. If the sole purpose of showing your work is for surveillance or to make sure that students aren't cheating, then that is not a good reason to ask a student to show work. However, I said, "showing your work to communicate your ideas can be really helpful." With this tangent EPSTs understand math as much more gray and subjective. There is no one right approach, but weighing context and rationale is integral.

During Session 4, an EPST made a comment about one of their students wanting their "ridiculous" answers on the board. To this comment, Dr. Brette responded that "sometimes kids just want their answer on the board and that's it. They just want attention." She made it clear that was okay. This action of giving students attention when they need it squarely fits within the tenet of participation/positioning within rehumanizing math. Dr. Brette reiterated the importance of meeting students' needs, even if they are not necessarily mathematical.

Also in Session 4, a group of EPSTs brought up the idea of student choice when it came to mathematical tasks. Dr. Brette responded that agency is often a great way to build elasticity into the math classroom. Building this kind of autonomy creates a more flexible and open-ended version of math, supported by creation in rehumanizing math. An EPST inquired about what a teacher should do when students are not challenging themselves. Dr. Brette responded with one of her own experiences in English language arts, when her 4th-grade teacher told her to stop reading *The Babysitters' Club* books because her reading level was so much higher than that. This was not a good experience for her; she explained that you can encourage students to try the challenge but not to discredit what they are currently engaging in. Reading or doing math at any level is better than not engaging with the subjects. At the end of this very important diversion from our stated learning outcomes, I made it clear to our EPSTs that "every student shines and is confused sometimes, no one is incredible all the time," which supports the idea of student choice; depending on the topic people might get more or less comfortable with the math. This discussion about agency in the classroom is directly related to the rehumanizing tenet of ownership within the math classroom.

In Session 6, Dr. Brette and I reiterated the importance of building fraction strategies off of the whole number strategies. We had our EPSTs understand why this supports more flexible thinking and why it also helps to delay the standard algorithm. An EPST asked what shifted about instruction from when she went to school (in the early 2000s) and now. Here, she was insinuating that the old instruction was procedural and the new instruction was much more rooted in conceptual understanding. Dr. Brette explained that there has been a conceptual push to better understand the math behind the standard algorithm. I went on to suggest that No Child Left Behind also pushed teachers to be beholden to standardized tests, which did not help the shift to more conceptual math. Now, more and more research is supporting the conceptual push. With less emphasis on standardized tests, knowledge — and power in relation to knowledge — shifts. This shift promotes ambitious and equitable math teaching and learning over the traditional methods.

In Session 9, Dr. Brette said that many teachers use standardized tests as a main or only data point to measure student success. In this session, both Dr. Brette and I explained the many issues with standardized tests. Standardized tests that are often thought of as objective are really "racist, classist, and gendered" (Course Recording Session 9). Dr. Brette concluded this portion of class by explaining that the best predictor of a student's test score is their score last year, so teachers often do not have control over standardized test scores. This continued to encourage EPSTs to see math differently from when they went to school; it encouraged them to see that math can be biased and subjective.

The practice of following tangents in class resulted in EPSTs seeing math through new lenses. When any of them posed a question that would help them perceive math as more related to rehumanizing, ambitious, and equitable math we made sure to illustrate how. With these tangents EPSTs were presented with a more gray, subjective, politically-laden, biased, and contextual versions of math.

Supported Shifts in Mathematical Dispositions

Dr. Brette and I iterated our practice through supporting shifts in EPSTs' mathematical dispositions. Our scaffolding for prompting EPSTs to evolve their dispositions looked different. The sub-themes in this section are frames for assignments, math with new understandings, and seeing their instructors as humans. Below are some examples of how and why we reiterated our practice to support shifts in EPSTs dispositions towards math.

Frames for Assignments.

Dr. Brette reminded the EPSTs that our weekly assignments are meant to be formative assessments. These should be low-pressure assignments where our EPSTs can feel comfortable to say "I do not understand." Dr. Brette then reiterated that saying you do not understand is actually more powerful than just leaving some of the questions blank. The counternarrative of changing the instructor as disseminator of knowledge is a rehumanizing math tenet (Gutiérrez, 2018).

This year we also wanted to make a point to scaffold the Launch, Explore, Summarize final lesson plan assignment. Last year, our assessment was the first lesson plan the EPSTs had written and it seemed to be a pretty confusing process for them.

Making the change to explicitly point out places where they were learning the material in class to be applied to the lesson plan really helped. Additionally, Dr. Brette and I annotated the assignment and showed EPSTs where they should be integrating course content into the final lesson plan. We also decided to share past exemplar lesson plans for the EPSTs to engage with on our learning management system. These exemplars spanned the grade levels that our EPSTs were teaching and scaffolded the lesson plan assignment.

We were also transparent with our EPSTs in explaining the purpose of the lesson plan draft weeks before their final assignment was due. We told our EPSTs not to "lose sleep over it," that submitting a draft was really just to get some initial thoughts down on paper and to get some feedback. An additional layer to the final assessment was the peer review. I organized EPSTs into groups, based on the content that they were teaching in the lesson plans. This peer-to-peer feedback set up a strong expectation of EPSTs' as meaning-makers that can share in-progress work and receive additional feedback.

By being transparent with our expectations, Dr. Brette and I explained what we were looking for in the final assignment, which took some of the worry out of the final lesson plan. This allowed EPSTs to approach the assignment through a supportive and understanding lens. These teacher moves made EPSTs more likely to positively evolve their mathematical dispositions because of encouraging and providing opportunities for EPST ownership and creation in their final. When we gave our students more guidance it takes the guess work out of assessment and provides opportunity for EPSTs' to really show what they know. This supports a shift in disposition because it encourages EPSTs to see the assessments as tools for their learning, not tools for our expectations.

How we approached both the final and the weekly assignments supported EPSTs' mathematical dispositions by taking the worry of being *right or wrong* out of the process. We advocated for a conceptual understanding of the content, which promoted ambitious and equitable math through fostering connection among their mathematical knowledge as teachers and learners.

Math with New Understandings.

In Week 1, I prompted a small group of EPSTs to think about manipulatives through an explorative lens. We discussed how much time is enough to explore a mathematical concept with manipulatives. Specifically, we talked about how much time is enough time for them to explore, but not too much time for them to get frustrated, not have proper scaffolding, and maybe disengage. This group was grappling with how to encourage their students to come up with their own invented strategies with the manipulatives. We left this conversation very open-ended; there was no "right" answer about the how or the timing, but it helped the EPSTs in that group confront some of their understandings around manipulatives. Providing the space for EPSTs' to think about teaching math through a more hands-on and concrete approach also encouraged EPSTs to question how they were taught in K-12 and therefore question the dispositions that they have formed in their pasts.

In Week 2, we randomized the groups to make sure that EPSTs got the opportunity to work with other EPSTs and in an effort to encourage equitable participation among all of the students. Randomizing students also allowed them to hear different viewpoints from their different colleagues, increasing the collaborative role of the groups. Randomization of discourse groups supported ambitious and equitable math's goal for genuine discourse within the classroom because more EPSTs built more relationships with each other across the class. They also heard more ideas from a more diverse set of fellow EPSTs. The more rehumanizing and conceptual mathematics ideas EPSTs were exposed to in this class the more opportunities they had to consider rethinking their relationship with math and rethink how they might teach it.

I made a teacher move in Session 2 to consistently remind folks to use visual and physical representations for the math that they were doing as learners. The EPSTs' default was not to use visuals because they had not in the past, so it was something that had to be reinforced as a norm of participation and an important pivot from how they learned math previously. Again, this lack of using visuals shed light on how differently their students' experiences can be than the ways that they learned math a decade or more ago.

Dr. Brette really wanted our EPSTs to walk away from Week 3 understanding that teachers can and should delay the standard algorithm, which coincided with the idea of teaching math through invented strategies in a more concrete way– an example of seeing math through a creative lens. These invented strategies foster an ambitious and equitable environment focused on deeper mathematical understandings, again encouraging EPSTs to see math and themselves in relation to math in new ways (Gutiérrez, 2018; Horn & Garner, 2022).

During Week 8, we talked about grouping students during instruction. Dr. Brette explained that sometimes there is a need for "short, temporary, and targeted specific instruction in homogenous groups" can be helpful, but longer term homogenous groupings are harmful to students. Dr. Brette went on to explain that even stratified groupings (e.g. low, medium, high) are detrimental to students, they will know who is who and act accordingly in a social math setting. This reminder that grouping students is harmful to student learning encouraged the EPSTs to critically reflect on the power and positionality in their own classrooms (Gutiérrez, 2018).

Seeing their Instructors as Humans.

In Session 6, at a small group, I disclosed that one day my host teacher was out when I was student-teaching, and the topic that I was supposed to teach was dividing decimals. I had to reach out to my dean, who also led the math department, to come and teach the students so I could learn how he did it and then I would teach the rest of the classes that day. I told this story to remind these EPSTs that it is okay not to know the answer to everything all the time, and that I also had to re-learn a lot of math content in order to teach it well. This was a rehumanizing experience for students because they saw me as human too, again, as someone without all of the answers.

During the seventh session, I validated the EPSTs emotions and said that it was really hard for me to engage with math this way when I was in my teacher education program at first as well. I reminded them that it takes time. Many of the EPSTs really appreciated this validation as they were struggling to re-learn math content in a more conceptual way. Tamara was someone who especially benefited from hearing that I struggled not to default to the standard algorithm, which is how I was taught. In her week seven exit ticket Tamara said, "Christine mentioning that having the mindset of doing the standard algorithm is pretty normal. It can be tricky for my brain to learn inventive strategies that are new to me, and that felt very validating." I imagine more EPSTs felt the way Tamara did, but did not necessarily say it. The way that I validated EPSTs' emotions and difficulties shifted their dispositions towards understanding that changes in how they understand math will not happen overnight.

The dividing decimals narrative I told endorsed EPSTs seeing that I do not position myself as a disseminator of knowledge. I showed our EPSTs that I, too, had anxious experiences with math as a preservice teacher. Additionally, the EPSTs getting a glimpse into how hard it was for me to go through an unlearning and relearning of math content allowed them to grasp just how difficult it may be to relearn some of these topics.

Noticed Their Bodies and Emotions

A final theme of how Dr. Brette and I iterated our practice was by noticing EPSTs' bodies and emotions during classes. Below are some examples of how and why we reiterated our practice based on how EPSTs showed up to class in certain sessions and in certain situated contexts.

In Session 3, there was an issue with the cooling in the room during this session. The temperature inside the classroom was 85 degrees, which is over 10 degrees hotter than it normally is. I kept reminding the students that we were very happy that they were hanging in there with us despite the temperature of the room. The lesson did not go exactly as planned because of the temperature in the room. We offered during small group moments for EPSTs to leave the room or step outside to do the groupwork. This option supported their bodies within the math classroom (Gutiérrez, 2018).

Course Session 6 was supposed to be when the draft of the lesson plan was due for the EPSTs. Many EPSTs submitted on time, but many asked for an extension because of so many other deadlines in other courses around midterms. Upon reflection, Dr. Brette and I decided to move the lesson plan draft to Week 7, so a week later, next year to make the deadline more rehumanizing and give students more spread out midterms. Another aspect of our reiteration of course content during the course was offering to look over the lesson plans in-person or offering to meet EPSTs outside of class to talk over their lesson plans. Four EPSTs decided to take me up on the additional review. This gave the EPSTs peace of mind in knowing that they were on the right track and that they could get all of their questions answered.

Throughout Session 7, some EPSTs were so emotional that they cried. This is a typically very heavy assignment week as the time between midterms and finals is extremely short. They were overwhelmed and feeling defeated with the amount of material they were supposed to engage with. Many of them thought that they weren't meeting their own expectations because of all the new things that they were expected to try to implement in their classrooms. When this happened, Dr. Brette and I encouraged them to take an additional break. Then, Dr. Brette and I explained to them how proud we are of them and that they will make great teachers. We also made sure to tell them that the fall quarter of this program is by far the most intense and that this will get better. They were clearly extremely overwhelmed at this point in the quarter. Dr. Brette also offered hugs to students if they wanted to have a hug. All of the tweaks that were made during class time made the students feel like they could be their whole selves.

In the last session, I had a conversation with EPSTs about ADHD symptoms and coping mechanisms, which supported their expression of their own neurodiversities in the classroom. Throughout Week 10, EPSTs seemed to be sluggish and tired. They did not engage in discussions like they had in weeks past. About halfway through the class, I stopped to ask a group of students why they were especially out of it. They responded that they had a standardized test the same morning. This is a test that is new to the licensure process and it is part of their literacy class. They have to pass this test in this class. If the EPSTs did not pass the test, then they had to retake the course. Once Dr. Brette and I knew why they were especially zoned out, we did not push them much further on their mathematical participation. This was a unique choice based on the situational factors of the test; if one were to observe just this class it would have seemed like we were not advocating for high cognitive demand, when in reality our understanding of the context changed our expectations. In the future, we plan on encouraging the faculty to move that test to Week 11, exam week. This will be better for the EPSTs' mental health, and for their instructors in Week 10.

RQ3: Conclusion

Throughout the course Dr. Brette and I made changes to curriculum that may have had a constructive effect on EPSTs' understandings or math and their mathematical dispositions. We also participated and championed in tangential conversations that moved the needle on purposefully complicating their understandings of math. In these tangential conversations we painted math in a grey and subjective light, potentially encouraging a turn to a less traditional mathematical understandings. Additionally, we attempted to support shifts in mathematical disposition. We did this by adding transparency to assignments, pushing new mathematical thinking, and being vulnerable with our EPSTs about our own past experiences. Lastly, we were open and willing to make in the moment changes to our practice based on EPSTs' bodies and emotions, which had the possibility of being extremely rehumanizing.

Chapter 5: Discussion

EPSTs' experiences in my course — and subsequently their students' experiences in their classrooms — are the most important outcome of my dissertation. The potential impact that these eighteen preservice teachers will have on all of their incoming students and even their colleagues at their schools is by far the most significant part of my work. Although not all of the EPSTs' mathematical dispositions dramatically increased, they all positively evolved over the ten weeks of the course.

In the following chapter, I will outline the intersections of mathematical dispositions, or how math anxiety and math teaching anxiety interacted and why that matters. Next, I will outline the teacher educator design principles that I created with robust support from scholars and how they made deep impacts on EPSTs' mathematical dispositions. Then, I will disclose what advice about mathematical dispositions that EPSTs have for future preservice teachers. Lastly, I will conclude with what EPSTs plan to do in their own classrooms. In the conclusion of this chapter, I will explain the limitations of my study, suggestions for future research, and an overall conclusion for this dissertation.

Intersection Between Math Anxiety and Math Teaching Anxiety

In the literature, there were different intersections amongst the constructs. Sometimes there was even conflicting evidence with the intersections amongst the constructs, where some scholars said that there was a strong positive correlation, and other scholars found a more complicated relationship among the constructs. Like Levine (1993) discovered, math teaching anxiety emerged as a separate construct from math anxiety in my findings.

One intersection between math anxiety and math teaching anxiety included matching levels of math anxiety and math teaching anxiety. Bates and colleagues (2013) and Vinson (2001) both found that there was a strong positive correlation between math anxiety and math teaching anxiety. Half of the EPSTs had matching anxieties. Some EPSTs had matching anxieties (3 EPSTs) and some of the EPSTs had a matching lack of anxieties (7 EPSTs).

Two examples of EPSTs that fit in this category were Karly and Willow. They both were very worried about their ability to do and teach math. Additionally, it seemed that their lack of content knowledge directly contributed to their math teaching anxiety. In her interview, Willow said, "It's hard to teach something that you feel like you don’t know. Explaining math is hard for me." This qualitative research matched her final quantitative scores of *moderate* math anxiety and *moderate* math teaching anxiety. In her interview, Karly was not as obvious in how her relationship with math affected her teaching. She explained that she easily gives up and shuts down when presented with a math challenge as a learner. She also said things like “math has never been my strong suit” and “I only feel confident teaching K-2nd grade” and "I have the most anxiety around teaching math." This qualitative research matches her final quantitative scores of high math anxiety and high math teaching anxiety. Both of these students support an aligned relationship between math anxiety and math teaching anxiety. This relationship, at least for these two EPSTs, comes from a lack of confidence with content knowledge.

Content knowledge as a learner and doer of mathematics was also part of the reason EPSTs like Tamara and Maggie had math anxiety and math teaching anxiety aligned to each other. They explained that grappling with the mathematical concepts as learners in the elementary math methods course helped them better understand math teaching, which caused a mirrored positive effect on their anxieties. Maggie said in her interview that between an undergraduate course in math methods and this course in math methods she started to "fix some of the scary feelings, which helped me change my perspective." Tamara said that after learning math in a new conceptual way, she "has more hope for math." Both of these EPSTs saw significant decreases in their quantitative sections of both math anxiety and math teaching anxiety and they attributed that decrease to additional content knowledge. Fostering a deeper conceptual understanding of mathematics as learners had a direct impact on EPSTs' mathematical dispositions, which is similar to prior scholars' findings (Amato, 2004; Auslander et al., 2016; Bosica, 2021).

Furthering the matching relationship, another intersection was EPSTs who reported a lack of anxieties. Hannah and Emma were examples of the strong positive relationship in the opposite direction. These EPSTs felt confident in their abilities to do and teach math because of their level of content knowledge. In her interview, Emma said that she is "very fond of teaching math because math was always her favorite subject." Hannah said in her interview "I feel like because I know math, I can be a really good teacher." Hannah and Emma both had quantitative scores that reflected their matching lack of anxieties.

The relationship between content knowledge and anxiety is well researched. A lack of content knowledge relates to high math anxiety and high math teaching anxiety. On the other hand, conceptual content knowledge relates to low math anxiety and low math teaching anxiety (Bates et al., 2013; Vinson, 2001).

The results of the intersection between math anxiety and math teaching anxiety also revealed two additional complex conflicting intersections. Instead of math anxiety and math teaching anxiety being aligned, there were EPSTs who reported contradictory anxieties. Half of the EPSTs had unmatching anxieties. Some EPSTs had a higher math anxiety (2 EPSTs) and some of the EPSTs had a higher math teaching anxiety (6 EPSTs). In the first case, Mary and Diana EPSTs had higher math anxiety but lower math teaching anxiety. These EPSTs felt that since they struggled in math themselves that they were less worried about teaching. This is atypical for this set of EPSTs. It seems like they are coping differently with their anxieties about doing math than their counterparts who had math anxiety, therefore also had math teaching anxiety. They felt that they could empathize with their students and that understanding of struggling and math anxiety in math makes them believe that they will be better teachers. They actually felt that their anxiety helped them in the classroom. On the quantitative measures, Mary and Diana scored in the *moderate* category of math anxiety and the *low* category of math teaching anxiety. EPSTs showed some level of mismatched anxieties.

In the second case, EPSTs had low math anxiety, but relatively high math teaching anxiety. The six EPSTs in this case felt that they knew the math content so well that they were worried about teaching it; two examples of this are Jayden and Colleen. They both noted that it was easier to learn content than it was to teach it. They also felt a tension in the way that they learned math and the way that they were expected to teach math (Althauser, 2018; Bosica, 2021). Jayden reported quantitatively that he had *extremely low* math anxiety and some math teaching anxiety. Colleen scored in the *very low* category for math anxiety, but in the *some* category for math teaching anxiety. Both Jayden and Colleen displayed mismatched anxieties. Half of our EPSTs displaying divergent anxieties is atypical (Brown et al., 2011). This divergent display might be because some of our EPSTs are older, they are not all out of undergrad. Potentially, our EPSTs that went right into a graduate teacher education program from undergrad might have a different understanding of their mathematical teaching anxieties, or lack of anxieties.

More research should be conducted around the relationship between math anxiety and math teaching anxiety because it is more complex than just a positive correlative relationship. However, what is clear in these results is that content knowledge directly affects both forms of anxiety. Sometimes too much content knowledge spurs teaching anxiety over worry of not being able to relate to their students. On the rarer occasion, lower levels of content knowledge spurs confidence over being able to relate to their students. These results have implications for math teacher education. The first is that we should fortify conceptual mathematical knowledge. However, too much knowledge for

EPSTs' in this sample related to a worry about their ability to translate their thoughts to their students. So, in addition to adding more conceptual understandings to teacher education, teacher educators must also make sure to give EPSTs' practical examples of how to help students who are not grasping the material.

Intersection Between Math Self-Efficacy and Math Teacher Self-Efficacy

Like the anxiety constructs in this study, the efficacy constructs had similar intersections of matched and unmatched. Similarly to the anxiety constructs, content knowledge was a relevant factor in the efficacies as well. Something a bit different from anxiety is how self-talk seems to be an important element of efficacy. There were 14 EPSTs that had matched efficacies and 4 EPSTs with unmatched efficacies.

All of the matched efficacies were EPSTs that reported relatively higher self-efficacy and higher math teacher self-efficacy (14 EPSTs). These EPSTs had strong positive beliefs in their ability to do and teach math. Two examples of this are Kalla and Weston. Kalla reflected on her relationship with doing math, which made her confident in her abilities to teach it. They both reported high levels of belief in their ability to teach and do math across quantitative and qualitative measures. Weston and Kalla seemed to have high math teacher self-efficacy because they had high math self-efficacy. Kalla reported in her interview that she felt that "because she knew math she can be a really good teacher." Since these EPSTs do not have anxieties surrounding their own abilities to do math, they are not concerned about their abilities to teach. It is one less barrier for them to become comfortable in their classrooms. This is similar to the positive correlation that Ünlü and Ertekin (2013) found between self-efficacy and teacher self-efficacy.

One EPST reported an unmatched relationship among self-efficacy and math teacher self-efficacy with a relatively higher math self-efficacy, alongside a relatively lower math teacher self-efficacy. Colleen had high self-efficacy but low math teacher self-efficacy. She was worried about her ability to translate her abilities as a learner into her abilities as a teacher. Colleen said, “Understanding it myself is easy but I am worried about conveying that to students." Colleen’s quantitative results showed a huge discrepancy in her efficacy to do math (*extremely high*) and her efficacy to teach math (*moderate*). Colleen was not confident that her abilities to do math would translate into their abilities to teach math.

Another intersection where efficacies are not correlated is seen with a negative belief in self, but a positive belief in teaching ability (3 EPSTs). They had relatively lower self-efficacy but relatively higher math teacher self-efficacy. Kaila and Maggie’s quantitative scores supported the unmatched relationship, with her self-efficacy only being *some* but her teacher self-efficacy being *very high*. Karly’s difference between self-efficacy and teacher self-efficacy was extreme. Her math self-efficacy fell into the *some* category while her teacher self-efficacy fell into the *very high* category. Their personal struggle in math led them to believe that they would have stronger teaching abilities. In her interview, Maggie reflected on an experience she had teaching the whole class that showcases her low self-efficacy. She had a student who gave a solution of 27+27 = 62. She said “I felt really uncomfortable in my own ability and I couldn’t do it in my head. I was embarrassed." This is an example of her lack of confidence in her abilities to do math. This example feels dissonant to her *very high* math teacher self-efficacy.

These data points support a more nuanced relationship between self-efficacy and teacher self-efficacy. EPSTs' with this relationship among efficacy believe their lack of belief in self will help them have sensitivity towards students who also have a lack of belief in their abilities. There is currently no other research on EPSTs and their relationship between efficacies.

More research should be conducted around the relationship between math self-efficacy and math teacher self-efficacy because it is more complex than just a matched relationship. A small number of EPSTs reported an unmatched relationship; they were more likely to report a lack of belief in self to learn math than they were to report a lack of belief in their abilities to teach math. In the isolated occasion of Colleen, her relatively high belief in her ability to learn math was not enough to propel a relatively high belief in her ability to teach math. These results have implications for math teacher education. Teacher educators should be sure to foster both math self-efficacy and math teacher self-efficacy separately for those students who need to evolve their dispositions on only one of the constructs.

Intersection Between Math Anxiety and Self-Efficacy

Past research indicates that math anxiety and math self-efficacy are negatively correlated (Gresham, 2008; Swars et al., 2006). So, if an EPST reported high math anxiety, they likely would report low self-efficacy. 11 EPSTs had this unmatched and predicted relationship with self-efficacy and anxiety. However, 6 EPSTs had a matched relationship with self-efficacy and anxiety.

One unmatched relationship is relatively high math anxiety and relatively low math self-efficacy, which is not supportive to math teaching or learning (2 EPSTs). This was indeed the case with Karly and Kaila; They were anxious about doing math and not confident in their abilities to be successful. Kaila said in her autobiography, "I do not feel that I do exceptionally well or honestly, even learn anything in math." She went on to explain that this belief makes her anxious in math and avoids the subject at all costs. Karly had a similar reaction to math in her autobiography, she said that she often disengaged in the content because she "did not even want to attempt to pay attention." These anxious feelings stuck with these two EPSTs and had an effect on their beliefs in their abilities.

Additionally, there was another unmatched relationship, but this time in the opposite and supportive direction: relatively low math anxiety and high self-efficacy (9 EPSTs). These EPSTs were not anxious about doing math and therefore had a strong belief in their abilities to be successful in solving math problems. Many of these EPSTs noted the importance of their positive mindset around math in not developing anxieties around math.

One EPST reported matched and relatively low math anxiety and math self-efficacy. Maggie started to feel comfortable in her growth mindset that she developed, but this did not overcome her math anxieties. By the end of the course she was still very worried about doing math, but started to have a belief in her abilities.

Whereas others reported matched and relatively high math anxiety and high math self-efficacy (4 EPSTs). Some EPSTs with high math anxiety still had a high math self-efficacy. They were anxious about doing the math, but it did not mean that they weren't confident in their abilities to get through it. They felt like they could cope and overcome their anxieties with doing math to be successful. Two scholars have claimed a more varied view on the relationship between math anxiety and math self-efficacy. Brown and Colleagues (2011) and Adeyemi (2015) found that not all EPSTs who had high levels of math anxiety also had low levels of efficacy.

Intersection Between Math Teaching Anxiety and Math Teacher Self-Efficacy

The intersection of the teachers' perspectives has higher anxiety and lower efficacy than the learners' perspectives. Some of the EPSTs in the course had matched math teaching anxiety and math teacher self-efficacy. Some reported high math teaching anxiety and high math teacher self-efficacy (7 EPSTs). So, they were highly anxious about teaching, yet, also had a belief in their abilities to do it. They felt that they could overpower their teaching anxieties and still flourish teaching math. Daisy is an example of this category, she is anxious about teaching math and yet said in her Exit Ticket 7, "I am 100% confident in my math teaching placement." This is a positive coping mechanism that will help them to conquer their teaching anxieties. Likely, they will feel bouts of anxiety but this will not be the driver in their dispositions. These EPSTs are not as likely to pass on their partially negative dispositions.

One iteration of unmatched teaching anxieties and efficiencies is the most productive. There were 9 EPSTs in the unmatched version of low math teaching anxiety and high math teacher self-efficacy. These EPSTs were not worried about their abilities to teach and therefore were confident that they will have positive student outcomes in their classrooms. One example of this is Mary, who said in her math autobiography, “since I could remember I knew I always wanted to become a teacher.” this belief in her ability to teach also translated to her lack of anxiety around teaching. Another example is in Hannah’s Exit Ticket 7, where she says “love talking math with my students.” This displays her lack of anxiety around teaching and her love in doing it. This intersection for teachers’ perspectives means that EPSTs will be comfortable teaching math in their classrooms. Teachers who report more positive attitudes towards math self-describe themselves as better prepared to teach math to children (Çaycı, 2011). If they are better prepared, then their students will have better outcomes.

Other EPSTs had unmatched teaching anxiety and teacher efficacy in the opposite direction, where they had high teaching anxiety and low teacher self-efficacy (3 EPSTs). These EPSTs were worried about teaching math and therefore were not confident in their abilities. One example of this is Colleen, she said that teaching math is more challenging to her in her interview. She also said that she is “worried about her math teaching abilities” (Colleen, Exit Ticket 10). This negative attitude around teaching math is so different from her attitude around learning math. Her anxieties around teaching are not content based and might be more rooted in teaching than in math itself. Even if her attitude is more about teaching, this may still affect her attitude towards teaching math and will ultimately lead to worse student outcomes.

Intersection Conclusions

In conclusion, there is a much larger spectrum of EPSTs’ mathematical dispositions when looking at all four of these constructs and understand how and why they intersect (Bosica, 2021). Prior experiences in the math environment affected all of the intersections of EPSTs' efficacies and anxieties (e.g. Bekdemir, 2010; Cornell, 1999; Finlayson, 2014). More research needs to be conducted on all four of these constructs in order to get a comprehensive understanding of how these constructs tend to interact and how those intersections affect mathematical dispositions. With this knowledge, teacher educators can start to tailor their practice to cater to the entire spectrum of dispositions and attempt to shift all of the intersections more positively.

EPSTs' Understandings for Future EPSTs

This section comes from EPSTs' responses to questions four and five of the interview protocol, which asked about where they believe their negative dispositions came from and how they would advise other EPSTs to evolve their dispositions (Appendix H). EPSTs were asked about the contributions to negative mathematical dispositions from their own perspective, as well as speculating about others' negative perspectives. Then they were asked what advice they would give to an EPST who might be experiencing a negative mathematical disposition. This section will be the precursor to the teaching design principles section because the things that EPSTs recommended to positively shift mathematical dispositions were all employed in the elementary math methods course.

EPSTs Rationale for Negative Dispositions

The largest takeaway from asking EPSTs themselves why they think EPSTs have negative dispositions was prior experiences (13 EPSTs). Prior experiences causing a negative mathematical disposition is extremely well documented in research (i.e.

Bekdemir, 2010; Cornell, 1999; Finlayson, 2014). Another reason that EPSTs thought that they themselves and other EPSTs had negative dispositions was a lack of confidence (4 EPSTs). Finlayson (2014) also confirmed that a lack of confidence can cause a negative mathematical disposition. Another reason that EPSTs reported having negative mathematical dispositions is a lack of content knowledge (3 EPSTs). Both Vinson (2001) and Bates and colleagues (2013) support the claim that content knowledge has an impact on mathematical dispositions. Two EPSTs noted that the curriculum itself was the reason that EPSTs developed negative dispositions, noting that it was very procedure-heavy. Lastly, two EPSTs explained that societal expectations were the reason that they, or other EPSTs, developed negative mathematical dispositions. Kalia said that, for her, the negative societal expectations placed on women made EPSTs develop a negative mathematical disposition. Ivy, an Asian-American EPST, said that the "cultural weight" of mathematics was why EPSTs developed negative mathematical dispositions. She went on to say that math held a place of "unearned privilege" and that is why there are so many negative feelings surrounding it. Additionally, she noted the racialized expectations of her filling the role as the myth of a model minority caused her and other EPSTs to have a negative mathematical disposition. Lastly, Ivy chimed in that her experience going to private religious school compounded all of these experiences with a negative gendered expectation. All of the societal expectations around math can affect mathematical dispositions (Trujillo & Hatfield, 1999; Karunakaran, 2020).

Advice to Evolve Negative Dispositions

This section will describe EPSTs' advice to other EPSTs who have developed a negative mathematical disposition. EPSTs themselves have experienced shifts in mathematical dispositions throughout this course and recommend the following things to future EPSTs. They believe that the methods below will improve mathematical dispositions of EPSTs. Six EPSTs reflected on the importance of re-learning the content through more creative, fun, and conceptual approaches (see teacher educator Design Principle 1). Four EPSTs mentioned asking other math teachers for support. Three EPSTs explained the importance of self-reflection (see teacher educator Design Principle 2). Two EPSTs reflected on significance of preparation for a lesson and how that can shift mathematical dispositions. Lastly, one EPST recommended that anyone struggling with a negative mathematical disposition read the Rehumanizing Math piece by Gutiérrez (2013) (see teacher educator Design Principle 4).

EPSTs had recommendations for how to support evolving negative dispositions. One of the recommendations was for EPSTs to talk to in-service teachers for additional support. That idea could be best suited for their school placements rather than their coursework. However, there is room for Dr. Brette and I to add guest speakers, or potentially to build in teacher interviews. The other recommendation that was not directly addressed in the teaching design principles below is more preparation. In future iterations of our classes, I believe that we could be more transparent with teacher preparation. We could address: how it works, how to quell tensions, how much is too much to prepare etc.

To implement more in-service teacher connections and additional time for preparation would have to come with additional course credit hours. The Association of Mathematics Teacher Educators (AMTE) recommends 21 credit hours of preparation to teach elementary math (Garner, et al., in-press). Our EPSTs received only four credit hours, falling far short of AMTE's recommendation. According to Garner and colleagues (in-press), most teacher education programs fall short of the recommendations from AMTE. We should add an additional course with some of these thrusts to make sure we meet our ESPTs where they are. Specifically, other scholars call for additional classes that explicitly focus on mathematical identity (i.e. disposition) formation so that the effects of one math methods course can persist throughout a teachers' in service years (Buck, 2022).

Teacher Educator Design Principles

These principles were created as a conclusion to this literature review in Chapter 2, and were employed in this elementary math methods class with positive results; this section revisits them. Most of the EPSTs' dispositions were positively affected by these teacher moves based on positive evolutions in both quantitative and qualitative data. Furthermore, EPSTs themselves endorsed these moves and how these principles encouraged positive evolution of their mathematical dispositions. Teacher educators should consider employing these design principles in their classrooms.

1. Create Space for EPSTs to Reflect on Their Prior Experiences

First, I would like to introduce Design Principle 1, again, from the conclusion of the literature review:

1. Teacher educators must give EPSTs the opportunity to reflect on their prior negative experiences, bringing awareness to their dispositions, and then work with ESPTs to combat them (Beilock & Maloney, 2015; Harper & Daane, 1998; Johnson & VanderSandt, 2011; Karunakaran, 2020; Kelly & Tomhave, 1985; Sloan, 2010; Wilson, 2015). Specifically, teacher educators must challenge EPSTs' preconceived dispositions and empower EPSTs to have productive mathematical dispositions (Buck, 2022; Ewart, 2022; Shilling, 2010).

Finlayson (2014) outlined the importance of self-reflection on disposition. They explained that changes in dispositions can only truly come when EPSTs know where their negative feelings come from in the first place. EPSTs benefited from the opportunity to reflect on their prior lived experiences through the math autobiography assignment (Appendix E); some EPSTs benefited more from this practice than others. EPSTs' experiences that had solidly positive experiences did not necessarily benefit from the reflective writing as much. After EPSTs take the time to write their math autobiography, they then have to take the time to grapple with how their past experiences affected their understandings of math and self in relation to math. As teacher educators, it is essential that there is discussion about why those experiences were problematic and how not to replicate the cycle of dehumanizing math. EPSTs reflecting on their prior experiences is not enough to spark shifts in disposition. However, with some teacher discourse moves that encourage discussion across shared experiences as well as not shared experiences can motivate EPSTs to see their past experiences differently.

In relation to the autobiographies Dr. Brette said, “some of you are holding onto something that happened to you at [a young age] and you are still letting it affect you. You made it a defining feature of who you are and how you see yourself. Isn’t that a little weird?” Dr. Brette was insinuating that some of the EPSTs in our class were holding onto math trauma for a decade or more. As Dr. Brette when on to explain, she used the word ‘weird’ in this context to signal that she wanted the EPSTs to notice just how long they had been holding a grudge against math; that it is a bit odd to hold these feelings for so long based off of sometimes just one experience. She then went on to say, “you can let it go." In response to Dr. Brette, I chimed in although it is odd to hold onto something from so long ago, those feelings are still valid. I said that all of their experiences are valid and that you all experienced math in a racialized, gendered, and objective space and that it was all in service of the white supremacy, which naturally creates dehumanizing experiences, for some more than others. The idea of letting go of their trauma and reformulating their identities with math in a new light has the potential to have a positive impact on their potential shifts in disposition.

Some EPSTs had especially salient experiences with the math autobiographies. An example of this practice making an EPST’s disposition more positive is evident in

Exit Ticket 7: Kalia Moss explained that the ability to reflect on her past math experiences encouraged her to move past them and solidified a more positive shift in her mathematical disposition. Martha, Diana, and Ivy also spoke of how powerful the reflections– in tandem with the discussion in Session 3– were for them to shift their mathematical dispositions to be even more positive. Ivy also spoke about how important it was for her in realizing she was not alone in many of the past mathematical experiences that she had reflected on. For her, knowing her experience was not unique and that other people in the classroom that had similar experiences caused a considerable shift in her disposition. Like the 2023 study by Schanke, this reflective assignment and the subsequent discussions can positively affect efficacy and ideally mitigate anxiety. Additionally, like Buck (2022) suggests, the autobiography allowed space for students to consider their past experiences, and gave them the opportunity to consider identity reformation, which is essential in teacher education. Specifically, pointing out autobiographical themes that were shared throughout our EPSTs is how we opened up our discussion of the mathematical autobiographies. Then, we encouraged the EPSTs to chime in and talk about their experiences. After this discussion we asked them how we might be able to repair some of the harm and what they want to do in their future classrooms and what they do not want to do in their future classrooms.

In the future, Dr. Brette and I want to dive deeper into the math autobiographies by asking the EPSTs to counter the negative or dehumanizing experiences with examples that would have been more positive or rehumanizing (e.g. if someone had bad experiences with timed tests, giving examples of what a teacher might do instead). This deeper dive will be driven by the EPSTs' experiences. So, Dr. Brette and I would give examples from the next set of math autobiographies so that the experience is directly related to that group's experiences. This will encourage students to combat their negative dispositions as well as offering examples that bridge the theory to practice gap.

2. ***Build Small Group Mathematical Collaboration***

Here is Design Principle 2 from Chapter 2:

2. Teacher educators must build communities of practice that will foster shifts in disposition (Gonzalez-DeHass et al., 2017; Gresham, 2007; Harper & Daane, 1998; Karunakaran, 2020; Schanke, 2023; Shilling, 2010; Uusimaki & Nason, 2004).

EPSTs had opportunities to interact in small groups every single class session. Additionally, these small groups changed frequently and EPSTs got to interact with many of their classmates. Again, many of the EPSTs benefited from this practice.

One of the especially salient quotes about small group work was from Brenda who said "Working with small groups has been helpful in feeling more human when doing hard math." This rehumanizing experience helped Brenda's disposition to become more positive. Ivy also explained that small group collaboration allowed for a really special level of relationship-building to happen in the classroom, which encouraged her to shift her dispositions even more. Hannah also chimed in and said that working with smaller groups and discussing problems was really beneficial to her understanding of math. Both Colleen and Maggie said how important the small groups were to their participation. Colleen said being in small groups, "took the pressure off of sharing in front of the class." This decrease in pressure allowed both of them to take more space to let their dispositions evolve. Small group collaboration also made an impact on EPSTs' mathematical dispositions, though this impact was not universal and some EPSTs benefited more from this practice than others.

Some of the EPSTs benefitted more because of inherent inequities in participation. Some EPSTs took up more space in mathematical conversations. Those that naturally contributed to mathematical discussions tended to lead the conversation more often than not, which left the ESPTs who are naturally more quiet, quiet. There were issues of status in our small groups, like in most mathematical groupings. Dr. Brette and I could have done more to mitigate these status issues. I noticed mathematical leaders early on and did not intervene to encourage them to make space for others. In some groupings, there was even EPSTs actually reinforcing each other's negative dispositions. If someone stayed quiet or quickly gave up in mathematical thinking and there was another EPST who tended to do the same, they reinforced each other. If EPSTs with negative mathematical dispositions knew that an EPST with a positive disposition would always talk first and solve the task, then this made them less likely to engage. The group work did have an overall positive impact, but there were clearly instances that the groups reproduced the already outstanding mathematical social status of the EPSTs.

3. ***Give Opportunities to Do and Explore Mathematics***

Below is the third design principle from Chapter 2:

3. Teacher educators need to provide EPSTs with the opportunities to do and explore mathematics as learners and as teachers (Althauser, 2018; D'Emidio-Caston, 1993; Hill et al., 2008; Karunakaran, 2020; Schanke, 2023; Stuart & Thurlow, 2000). Specifically, teacher educators need to bridge the theory to practice gap (Ewart, 2022; Shilling, 2010).

Throughout the course, Dr. Brette and I also took the time to have EPSTs explicitly make connections between the math that they were doing and how the students in their classrooms might do and explore math. We made sure to give the EPSTs time to reflect on how EPSTs were going to take what they were learning and translate it to their own classrooms where they were teaching. The time spent to bridge this theory to practice gap by asking the EPSTs what it might look like in their classroom is extremely important.

One of the more important understandings from doing and exploring mathematics that EPSTs developed throughout this class is that it is okay to make mistakes and to be challenged while doing or teaching mathematics. Willow said in Exit ticket seven that she "no longer feels insecure when I am not understanding something." Willow also said that it was "really helpful to watch other people explain their strategies." Brenda appreciated the "space for trying new strategies." Hannah said in exit ticket seven, that doing math in this class has led her to "understand math more conceptually." Diana said in her interview that this class encouraged her to focus much more on the "exploration of math." Overall, this experience with exploratory non-traditional math deeply impacted EPSTs' mathematical dispositions (Schanke, 2023).

Relearning mathematical content is one thing, but then reflecting on how the new way of doing and knowing mathematics affects teaching and planning is an additional level. Teacher educators need to make the purpose for engaging in mathematics from the perspective of elementary students abundantly clear. Almost all of our EPSTs agreed that doing math from their students' perspectives was helpful for their learning, but some thought that it was juvenile and that they did not need to engage in math from their students' perspectives. Dr. Brette and I transparently explained how important it is to understand math from the learners' perspectives, a couple of the EPSTs still did not think it was helping them to become better teachers. As instructors, we could have had more clarity and made sure to repeat why exploring math from an elementary school standpoint is important to their learning.

4. ***Model the Classroom Environments We Want EPSTs to Create***

Lastly, here is the Design Principle 4.

> 4. Teacher educators must model the kinds of classroom environments they hope EPSTs use in their classrooms (Conrad & Tracy, 1992; Firestone et al., 2005; Gonzalez-DeHass et al., 2017; Gresham, 2007; Harper & Daane, 1998; Leavy, 2015; Karunakaran, 2020; Putney & Cass, 1998; Schanke, 2023).

For this principle, it is important that EPSTs themselves agreed that this classroom space was rehumanizing, ambitious, and equitable. Across various data points, thirteen EPSTs explicitly mentioned the word “rehumanize” when describing this class. If they did not specifically mention the word, they clearly articulated the practices that Dr. Brette and I employed in the classroom and how that made them feel like a valuable member of the community. Diana had an especially salient example of this in her Exit Ticket 7: “This class has been solely rehumanizing. I love the laughter, play, and the permission to mess up. The care for each of us as WHOLE humans is extremely palpable and appreciated.” Another example is from Tamara: “Both you and Brette were so supportive and you saw us as humans and connected with us as people” (Interview). A third example is from Willow:

> Everything about this class has been rehumanizing. I don't feel insecure when I'm not understanding something which is not typically the case. Even though a lot of the strategies we're using are really challenging for me, our small group discussions are fun and I don't dread having to learn more about them (Exit Ticket 7).

Additionally, although EPSTs might not have mentioned the words “ambitious and equitable,” all eighteen of them also made specific references to ambitious and equitable practices that supported them. Willow also pointed out how this class was ambitious and equitable for her by saying, “It's been really helpful to watch other people explain their strategies because I'm learning new ways to solve problems that I don't think to do myself” (Exit Ticket 7). Mary concurred about the importance of hearing new mathematical strategies, “I found through this course that there is beauty in the math process and journey. That is WAY more important than the answer.” Maggie also talked about the shift in her understanding of math to reflect a more ambitious and equitable disposition, “I used to believe that math was very analytical and left up to predetermined steps to solve problems. However, over time, I have noticed that math can actually be a creative process.” Ivy gave a fourth and final description of our rehumanizing, and ambitious, and equitable framework. She noted this as early as the Week 2 exit ticket, saying, “This course has confirmed my belief that a passionate, engaging math teacher can make content more relevant and exciting. I am seeing that there is more creativity within math instruction than I thought before.” Not only is it important that all EPSTs agreed that our practices were rehumanizing, ambitious and equitable, but these experiences have the potential to directly transfer into their future classrooms. If the EPSTs experience this rehumanizing classroom, then they might take what we modeled back into their own classrooms.

EPSTs in Their Future Classrooms

All of the above design principles can overlap or impact each other. These principles are even more powerful if they are employed at the same time, collectively. The power of reflecting on past experiences, building small groups for collaboration, giving EPSTs the opportunity to do and explore math, and modeling the classroom environment we want EPSTs to create has made an immense impact on our students. This impact influences more than just our EPSTs’ mathematical dispositions, but also the mathematical dispositions of their future students.

Throughout this course, EPSTs had the opportunity to think about what practices they will be bringing into their own classrooms and why. This is an essential part of teacher learning, where the teacher educator helps to bridge the theory-to-practice gap. It is necessary to prompt EPSTs to think about what they will employ in their own classrooms and how they plan on doing it. An additional layer of seeing if the EPSTs found the course rehumanizing, ambitious, and equitable is to see what they themselves plan to take into practice in their own classrooms.

EPSTs mentioned many rehumanizing things that they plan to take into their classrooms. The most common way they plan to teach their students is to ensure at every turn that they are breaking the cycle of negative mathematical dispositions (10 EPSTs). They do not want to teach in the ways that they were taught because they understand first-hand the damage that it can do to students. Many EPSTs also talked about the importance of the process over the answer (6 EPSTs). Some EPSTs even talked about the need to make math more creative and open-ended than the way that they were taught math (4 EPSTs). Specifically, manipulatives, low floor/high ceiling tasks, the launch explore summarize framework, multiple solution paths, and delaying the standard algorithm were very common parts of EPSTs' plans for their future classes. Two EPSTs noted the importance of student voice as a part of their lessons. Willow wants to make sure that every student feels supported, even when they might be frustrated. Tamara had a very similar sentiment and said that she wants to create an "inclusive and engaging learning environment where all my students can feel confident about their abilities, especially math." She also went on to say that discussion in math is more important than she ever thought it was before this class. Mary wants to encourage all of her students to feel their emotions, even in math class." Karly wants her students not to fear mistakes and failures. Kalla reminds herself of how important it is to continue reflecting and learning as a teacher. The most powerful quote about using methods that they were taught in fall of 2022 in elementary math methods was Colleen, she went so far as to say “Rehumanizing math is more important than the content itself." All of these EPSTs plan to implement rehumanizing, ambitious and equitable math in their classrooms, which shows the impact that this course had on the EPSTs. They want their students to be able to be a part of a classroom that fully supports their holistic selves and their mathematical selves, like the one that they were a part of in the elementary math methods course.

Potential Limitations

This study had a small quantitative sample size, under 20. For quantitative research, that number is low. Though, with the qualitative phenomenological side of my mixed-method research, Creswell and Poth (2017) argue that the number is high for phenomenological research. Around 20 participants, whose data was triangulated through quantitative and qualitative, combated this possible quantitative limitation. The sample size could not be increased because it is based off of enrollment in a specific teacher education. This sample skewed female-identifying, white, and middle class. This skew was a limitation because I was not able to collect the full range of experiences of EPSTs. There are specific people who were not captured in our class like Black, Latinè, Indigenous, or Southeast Asian; therefore some of these findings might not carry into other settings.

All of the quantitative measures that I took were self-report, which leads to the question of social desirability (Creswell & Poth, 2017). Social desirability is a form of response bias. This bias can affect how someone responds to a questionnaire because they want to be viewed favorably. An EPST might think that it is advantageous to report that they are confident in math or math teaching, even if they are not confident. EPSTs might even be more likely to say that they are confident because it was one of their instructors asking them the questions about confidence. Unfortunately, this can lead to under-reporting negative things and over-reporting positive things.

In this study, self-report data was a driving force of data collection. The autobiographical narrative, the interviews, and the quantitative measures were self-reported. Although the qualitative measures could also have elements of social desirability, the mixed methods triangulation should combat the potential downfall. A second line of defense was keeping the questions in all of the measures as neutral and unbiased as possible. Furthermore, the in class recording data over 10 weeks did confirm much of what the EPSTs reported.

My close involvement in the data collection process shaped the results of this study. The ESPTs were my students. I desperately wanted them to be successful teachers, and I cared about their whole beings. Because I cared for them and hoped for their success, I attempted to implement a rehumanizing, ambitious, and equitable teaching framework alongside Dr. Brette. My bias did affect the data analysis as I am one of the instruments used in data collection. I understood the data through a lens of strong hopes and desires for productive shifts in dispositions , which might have made certain data more central to this dissertation than others. I combated this through critical self-reflection, data triangulation, and a profound description of my own and students' lived experiences. I attempted to show all iterations of the evolution of mathematical dispositions, not just the positive ones.

I have been a part of this institution as a student, instructor, and staff member since 2019. I have been teaching in this program since 2020 and foster deep care for the students and the institution. I know this institution, my co-instructor, and this course very well. To be rooted in the community where you are conducting research is more powerful than to parachute into a different community. The potential perception of this limitation was combated through my co-teacher looking at the codes and themes, my participants corroborating their responses and lived experiences through member checking, and multiple data sources. With these processes in mind, I used verbatim descriptions of the EPSTs' experiences wherever possible. I also attempted to keep meticulous records of my data collection and analyses. Both of these strengthened reliability and validity.

The most significant limitation is that a foundational past study has shown that the effect of a math methods course on EPSTs' dispositions might be seen at the end of the course, but the teachers might not retain these effects (Gresham, 2017). The shifts in disposition that our EPSTs have experienced might decrease or even disappear over time. They might have additional influences outside of our classroom that cause them to regress into a more negative disposition. They also might not have the support of people like Dr. Brette and me, reminding them that they can continue to be mathematicians. In Gresham's (2017) study, she followed preservice teachers in their classrooms for the five subsequent years and some of the teachers saw an increase in their math anxiety throughout their years of teaching. Gresham (2007) attributed this to a lack of continuing professional development for in-service teachers and the in-service teachers' need to hide their real emotions surrounding math. Although this was not a feasible timeline to continue to collect data, future scholarship on longitudinal studies are desperately needed.

I am not able to say that the potential shifts in disposition are permanent in this current study. In a follow-up study I could measure the EPSTs' dispositions at a later point in their teacher education program to see if the evolution of their dispositions did stick with them and were not a short term change. I would follow these EPSTs throughout their first year teaching and see if the evolved dispositions stuck.

Areas for Future Research

This field needs more longitudinal studies across the entirety of teacher education programs on all four constructs of mathematical disposition (math teacher efficacy, math self-efficacy, math anxiety, and math teaching anxiety). Even though no past longitudinal studies have studied all four constructs, there were studies that looked at one or two of these constructs. Jong and Hodges (2015) found the most robust differences in EPSTs' mathematical disposition throughout a teacher education program to be right after a methods course. Mongillo (2016) found similar longitudinal findings; the first of two methods courses resulted in EPSTs having a much larger positive shift in efficacy than the second course. Additionally, Vacc and Bright (1999) found that EPSTs' beliefs changed significantly after their math methods course. There are no longitudinal studies that look at all four constructs, but the ones that look at some of the constructs have shown the most significant shift in mathematical disposition to be the methods course —

further supporting my shorter-term research around a single course. I still believe that a more longitudinal study would be a powerful addition.

A second area for future research, is following EPSTs into classrooms to see how their mathematical disposition follows them into actual teaching. Jao (2017) found that some teachers are still unsure how to apply their knowledge that they learned in teacher education. Some EPSTs had high efficacy in planning tasks but did not have high efficacy in implementing them (Yurekli et al., 2020). Although right after the course concluded many EPSTs said that they planned on implementing aspects of the rehumanizing, ambitious and equitable frameworks in their classrooms, they might not be able to or might not hold onto that belief long after the end of the course. A study that looks at how EPSTs bring their teacher education content — specifically, their elementary math methods content — into their classrooms would be an incredibly influential study for both teacher educators and K-12 researchers.

A third area for future research is better understanding the sensitivity of the quantitative tool versus some of the qualitative responses from EPSTs. Though some of the quantitative responses from EPSTs may not have dramatically shifted, their qualitative responses did dramatically shift. EPSTs with lower quantitative shifts still shoed a completely different understanding of self in relation to math and math teaching by the end of the course, which begs for further research.

A fourth area for future research is updating the quantitative measures. These measures are older and could use newer options with more teacher education nuances. Specifically, the math anxiety measure and the math self-efficacy measures were based in questions that were set in a traditional math classroom. They were based in participants responding to content based questions as if they were students. There is room for additional math anxiety and math self-efficacy measures that consider the nuance of what math anxiety looks like in a content teacher education course, or a math methods teacher education course. There is room for new measures to gain an understanding into more nuanced versions of learners' anxieties and beliefs situated in teacher education.

Conclusions

All eighteen EPSTs had different dispositions across the four constructs as they were coming into the elementary math methods course (RQ1). They all evolved in different ways as they went through the course. All EPSTs evolved into having much more positive mathematical dispositions around doing and teaching math, some statistically significantly so, some less so. Though, at the end of the course some EPSTs were more anxious or worried about their ability to be successful math teachers because of how much they realized they would have to re-learn content and apply new pedagogical strategies in the classroom (RQ2). The intersections among constructs truly paints how complex and nuanced mathematical dispositions are. More research should be done looking at how all of these constructs interact. There is no one-size-fits-all approach to helping EPSTs' dispositions evolve, but there are design principles that will encourage each EPST to grapple with their preconceived notions of what it means to do and teach mathematics. Through the self-study lens, I believe Dr. Brette and I successfully implemented the conceptual framework of rehumanizing and ambitious math because the EPSTs resoundingly agreed (RQ3). We consistently reiterated the course, took feedback from EPSTs, and discussed how we could teach the course better, which all supported EPSTs' in evolving their mathematical dispositions.

This research was important for the math teacher education sphere of research. This work contributed a new unit of analysis in multiple ways. I created a new conceptual framework through the combination of rehumanizing, ambitious and equitable math. I applied both of these frameworks to an innovative space of higher education; when they were previously only applied to the K-12 space. Another layer of innovation is rooted in this course being a graduate course; much teacher education research is rooted in the undergraduate space. Additionally, this research furthered mathematical disposition scholarship by combining math teaching anxiety, math anxiety, math self-efficacy, and math teacher self-efficacy, which has never been done before. Lastly, the most important contribution of this work is the new design principles for math teacher education that affect EPSTs' mathematical dispositions, which cycles all the way through how they teach their students. This work will make the K-5 classroom a more rehumanizing, equitable, and ambitious space for young mathematicians to thrive.

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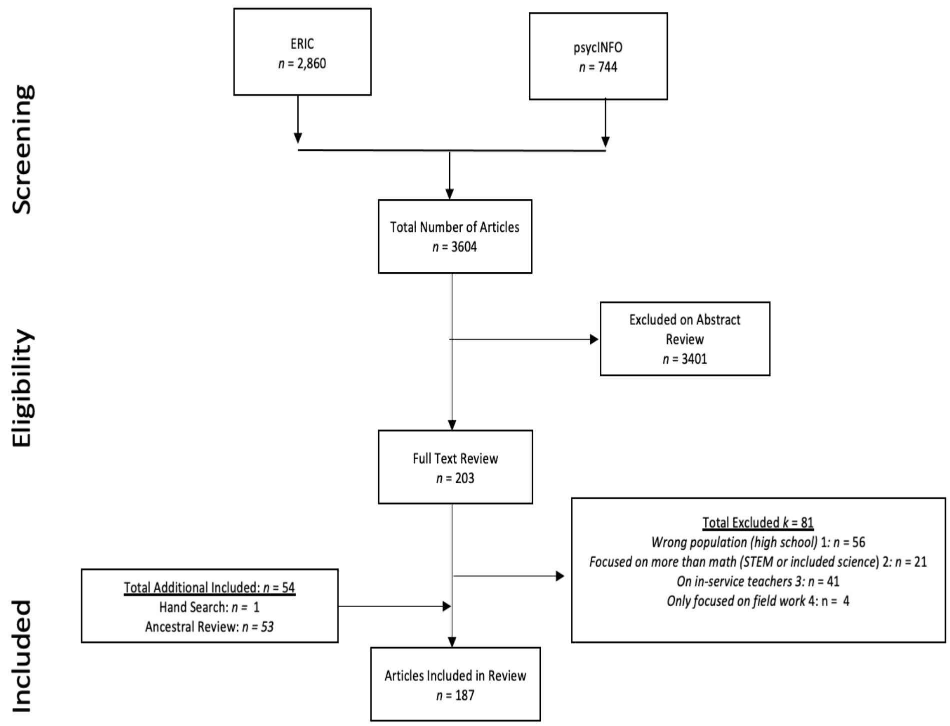
Appendices

Appendix A: Hand Search Excel Sheet

Note: if they have no number, it is only one reading from said journal.

	A	B	C
1	Australian Journal of Teacher Education	2	
2	Gender and Education		
3	International Journal of Assessment Tools in Education	2	
4	Educational Research Quarterly		
5	Journal of Education and Learning		
6	Journal of Mathematics Teacher Education	3	There were 95 results in the last 3 years. None of them fit my inclusion criteria.
7	Teaching Children Mathematics		
8	Adults Learning Mathematics		
9	SRATE Journal		
10	School Science and Mathematics	8	There were 137 results in the last 3 years. From this additional hand search, I decided to take a look at a review of research in mathematical content courses, although I am not studying a content course, my course does include content. So, I wanted to make sure that within Hart, Auslander, Carothers, and Chestnutt's (2018) review there was not any additional information that I might have missed.
11	Educational Studies in Mathematics		
12	Alberta Journal of Educational Research		
13	Teachers and Teaching: Theory and Practice		
14	Issues in the Undergraduate Mathematics Preparation of School Teachers	6	There were 20 results in the last 3 years. Only one was relevant and I already reviewed it. Otherwise, these articles focused on specific content areas or content courses, niether of which is included in my study.
15	Teaching Education	2	
16	Childhood Education		
17	North American Chapter of the International Group for the Psychology of Mathematics Education		
18	Journal of Latinos and Education		
19	Cogent Education		
20	Learning and Individual Differences		
21	Early Childhood Education Journal		
22	Journal of Classroom Interaction		
23	International Journal of Humanities Social Sciences and Education (IJHSSE)		
24	International Journal for Mathematics Teaching and Learning		
25	Action in Teacher Education		
26	Journal of Curriculum Studies		
27	Educational Research		
28	Mathematics Teacher		
29	International Journal of Science and Mathematics Education		
30	The Mathematics Enthusiast		
31	European Journal of Science and Mathematics Education		
32	International Electronic Journal of Elementary Education		
33	Education	2	
34	Teaching in Higher Education		
35	Academic Therapy		
36	World Journal of Education		
37	Networks: An Online Journal for Teacher Research		
38	Participatory Educational Research		
39	International Education Studies		
40	College Student Journal		
41	Journal of Urban Learning, Teaching, and Research		
42	Mathematics Education Research Journal		
43	Educational Forum		
44	Mathematics Teacher Education and Development	2	
45	Mathematics Teaching in the Middle School		
46	Journal of Instructional Psychology		
47	Higher Education Studies		
48	Journal for Research in Mathematics Education		
49	Journal of Technology Education		
50	For the Learning of Mathematics		
51	Mathematics Education Research Group of Australasia	3	
52	Journal of Education for Teaching: International Research and Pedagogy		

Appendix B: Summary of Literature Review Method



Appendix C: Research Informed Consent

Consent to Participate in Research

Study Title: *Mathematical Dispositions of Elementary Preservice Math Teachers*

Principal Investigator: *Doctoral Candidate in Curriculum & Instruction and Co-instructor Christine Hood M.S. in Secondary Mathematics Education*

Faculty Sponsor: ***Dr.*** *Brette Garner Ph.D. Assistant Professor in Teaching and Learning Sciences*

Study Site: *DU MCE classroom*

You are being asked to participate in a research study. Your participation in this research study is voluntary and you do not have to participate. This document contains important information about this study and what to expect if you decide to participate. Please consider the information carefully. Feel free to ask questions before making your decision whether or not to participate.

The purpose of this form is to provide you information that may affect your decision as to whether or not you may want to participate in this research study. The person performing the research will describe the study to you and answer all of your questions. Please read the information below and ask any questions you might have before deciding whether or not to give your permission to take part. If you decide to be involved in this study, this form will be used to record your permission.

This research study will take place during regular classroom activities; however, if you do not want to participate, your data will not be included. There will also be an additional optional interview that will be conducted outside of regular classroom activities. Your grades will not be affected by the study.

You are being asked to participate in this study because you are an elementary preservice teacher enrolled in a mathematics methods course.

<u>Purpose</u>

If you participate in this research study, you will be invited to participate in class and course assignments just like you would without the study. I will be taking informal observations and analytic memos throughout the course, neither of which require any additional work on your part. You will also be asked to participate in a semi-structured interview that will take about an hour at the end of the ten week course. Your autobiographical assignment will be used in tandem with the quantitative questionnaire, which will take about 15 minutes for a pretest. Your interview and an additional quantitative questionnaire, which will take 15 minutes, will be used as posttest data. If you choose to participate, you may refuse to answer any question in the questionnaire or the interview. If you decide not to participate in the study you will not have to take the two questionnaires and you will not participate in the end of course interview.

Educational records will be accessed. Your autobiographical assignment that you submit for this course will be accessed to provide additional qualitative data for pretest data. Additionally, informal observations and classroom recordings will be accessed for data to explain both the instructors and the students' lived experiences during the course. Only Dr. Brette Garner and Christine Hood, co-instructors, will access this data.

Risks or Discomforts
There are no expected risks to you as a result of participating in this study. There may be risks involved from taking part in this study that are not known to researchers at this time.

Benefits
The benefits which may reasonably be expected to result from this study are an improved mathematical disposition, which can encourage you to be a better student in graduate school and make you a more effective and confident teacher.. We cannot and do not guarantee or promise that you will receive any benefits from this study. Your decision whether or not to participate in this study will not affect your grades.

Confidentiality of Information

All information collected about you during the course of this study will be kept confidential and password protected. You will be identified in the research records by a number.

When the results of this research are published or discussed in conferences, no information will be included that would reveal your identity.

Videos of class and your interview will be used for research or educational purposes, your identity will be protected or disguised. The tapes will be destroyed at the conclusion of this study. You have the right to review or edit the tapes at any time. Only Dr. Brette Garner and I, Christine Hood, will have access to the tapes. Your personal identity will be disguised with a blurred face filter.

Limits to confidentiality

Before you begin, please note that the data you provide may be collected and used by Qualtrics as per its privacy agreement. This research is only for U.S. residents over the age of 18. Please be mindful to respond in private and through a secured Internet connection for your privacy. Your confidentiality will be maintained to the degree permitted by the technology used. Specifically, no guarantees can be made regarding the interception of data sent via the Internet by any third parties.

Your name will not be used in any report. Identifiable research data will be encrypted and password protected.

Your responses will be assigned a code number. The list connecting your name to this code will be kept in an encrypted and password protected file. Only the research team will have access to the file. When the study is completed and the data have been analyzed, the list will be destroyed.

With your permission, I would like to videotape class so that I can best garner your lived experiences in class. Additionally, with your permission, the subsequent interviews will also be videotaped so that I can make an accurate transcript. Once I have made the transcript, I will erase the recordings. Your name will not be in the transcript or my notes. Once I have completed the study, the course recordings will be erased as well.

Because of the nature of the data, it may be possible to deduce your identity; however, there will be no attempt to do so and your data will be reported in a way that will not identify you.

Information that may identify you may be used for future research for future published research studies, outside of this dissertation, without additional consent.

The information that you provide in the study will be handled confidentially. However, there may be circumstances where this information must be released or shared as required by law. Representatives from the University of Denver may also review the research records for monitoring purposes.

Government or university staff sometimes review studies such as this one to make sure they are being done safely and legally. If a review of this study takes place, your records may be examined. The reviewers will protect your privacy. The study records will not be used to put you at legal risk of harm.

Data Sharing

De-identified data from this study may be shared with the research community at large to advance science and health. We will remove or code any personal information (e.g., your name, date of birth) that could identify you before files are shared with other researchers to ensure that, by current scientific standards and known methods, no one will be able to identify you from the information or samples we share. Despite these measures, we cannot guarantee anonymity of your personal data.

Consent to video / audio recording / photography solely for purposes of this research

This study involves video/audio recording, and/or photography. If you do not agree to be recorded, you can still take part in the study.

_____ YES, I agree to be video/audio recorded/photographed.

_____ NO, I do not agree to be video/audio recorded/photographed.

Consent for Accessing Education Records

Education records used by this research project are education records as defined and protected by Family Educational Rights and Privacy Act (FERPA). FERPA is a federal law that protects the privacy of student education records. Your consent gives the researcher permission to access the records identified above for research purposes.

____ **YES**, I give permission to the researcher to access my education records for this research project.

____ **NO**, I do not give permission to the researcher to access my education records for this research project.

Questions

For questions, concerns, or complaints about the study you may contact Christine Hood at the following phone number 641-691-6165 or email Christine.hood@du.edu. You can contact her Faculty Sponsor at Brette.Garner@du.edu.

If you are not satisfied with how this study is being conducted, or if you have any concerns, complaints, or general questions about the research or your rights as a participant, please contact the University of Denver (DU) Institutional Review Board to speak to someone independent of the research team at 303-871-2121 or email at IRBAdmin@du.edu.

Signing the consent form

I have read (or someone has read to me) this form, and I am aware that I am being asked to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to participate in this study.

I am not giving up any legal rights by signing this form. I will be given a copy of this form**.**

Printed name of subject		Signature of subject		Date

Please take all the time you need to read through this document and decide whether you would like to participate in this research study.

If you decide to participate, your completion of the research procedures indicates your consent. Please keep this form for your records.

Appendix D: Quantitative Mathematical Dispositions Questionnaire

Start of Block: Intro

Introduction We are asking every person who is an elementary preservice teacher in the University of Denver's Teacher Education Preparation Program to complete this survey.

Please understand your participation is voluntary. You can decide not to participate. If you decide to participate, you have the right to withdraw and discontinue participation at any time. If you decide to participate, please complete the following survey. This survey will take about 15 minutes. In each survey, you will be asked to answer questions about your overall sense of confidence in doing math, in teaching math, and how effective you believe yourself to be as a math teacher. Your responses will be anonymous. Please feel free to ask Christine Hood questions regarding this study. You can contact her at Christine.hood@du.edu. Her Advisor on this project can be contacted at Brette.Garner@du.edu If have any concerns, complaints, or general questions about the research or your rights as a participant, please contact the University of Denver (DU) Institutional Review Board to speak to someone independent of the research team at (303) 871-2121, or email at IRBAdmin@du.edu. Survey results data from this study may be shared with the research community at large to advance science and health. Thank you for your time. Sincerely, Christine Hood, Doctoral candidate at Morgridge College of Education in Curriculum & Instruction at the University of Denver

Implied Consent By clicking the link below, I confirm that I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement, and possible risks and inconveniences have been explained to my satisfaction. I understand that I can discontinue participation at any time. My consent also indicates that I am at least 18 years of age. [Please feel free to print a copy of this consent form.]

○ I agree to participate

○ I decline to participate

End of Block: Intro

Start of Block: AMAS

AMAS Directions Please indicate your level of anxiety with the following statements. Imagine yourself in the context of a college-level mathematics course.

AMAS Q1 Having to use the tables in the back of a math book.

	Low (1)	Some (2)	Moderate (3)	Quite a Bit (4)	High (5)
Level of Anxiety	○	○	○	○	○

AMAS Q2 Thinking about an upcoming math test 1 day before.

	Low (1)	Some (2)	Moderate (3)	Quite a Bit (4)	High (5)
Level of Anxiety	○	○	○	○	○

AMAS Q3 Watching a teacher work an algebraic equation on the board.

	Low (1)	Some (2)	Moderate (3)	Quite a Bit (4)	High (5)
Level of Anxiety	○	○	○	○	○

AMAS Q4 Taking an examination in a math course.

	Low (1)	Some (2)	Moderate (3)	Quite a Bit (4)	High (5)
Level of Anxiety	○	○	○	○	○

AMAS Q5 Being given a homework assignment of many difficult problems that is due the next class meeting.

	Low (1)	Some (2)	Moderate (3)	Quite a Bit (4)	High (5)
Level of Anxiety	◯	◯	◯	◯	◯

AMAS Q6 Listening to a lecture in math class.

	Low (1)	Some (2)	Moderate (3)	Quite a Bit (4)	High (5)
Level of Anxiety	◯	◯	◯	◯	◯

AMAS Q7 Listening to another student explain a math formula.

	Low (1)	Some (2)	Moderate (3)	Quite a Bit (4)	High (5)
Level of Anxiety	◯	◯	◯	◯	◯

AMAS Q8 Being given a "pop" quiz in math class.

	Low (1)	Some (2)	Moderate (3)	Quite a Bit (4)	High (5)
Level of Anxiety	◯	◯	◯	◯	◯

AMAS Q9 Starting a new chapter in a math book.

	Low (1)	Some (2)	Moderate (3)	Quite a Bit (4)	High (5)
Level of Anxiety	○	○	○	○	○

End of Block: AMAS

Start of Block: AM-TCHAS

AM-TCHAS Directions Please indicate the frequency on the following statements.

AM-TCHAS Q1 I'm afraid other teachers will think I'm incompetent at teaching my students math.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q2 I anticipate I will feel anxious when preparing math lessons.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q3 I feel sure I can be a good math teacher.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q4 I feel uncertain about my ability to improvise in the math classroom.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q5 I feel at ease when I am being observed by my university supervisor while teaching a math lesson.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q6 I feel I will be less competent in the math classroom than other preservice teachers in my teacher preparation.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q7 I am afraid I will forget everything I know when I get in front of a class to teach a math lesson.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q8 I would feel calm and collected even when a student asks me a math question I couldn't answer.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q9 I feel less well prepared for teaching math than other preservice teachers in my program.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q10 I would feel edgy and nervous if a student's parent observed a math lesson in my classroom.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q11 I'm afraid students won't follow my math instruction.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q12 I feel certain about my ability to keep the class interested during a math lesson.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q13 I feel comfortable speaking about math in front of a group.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q14 I am afraid to speak up about math among other teachers.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q15 I would feel calm if the principal informed me they were coming to my math class to observe.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q16 I would find it difficult to admit that I don't know the answer to a math question that a student asked.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q17 Even if I had trouble answering a student's math question, I would find it easy to concentrate on the rest of class.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q18 I will have a feeling of uncertainty with how to present math information in the classroom.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

AM-TCHAS Q19 The thought of math coming up at parent teacher conferences makes me feel panicky.

	Never (1)	Infrequent (2)	Occasionally (3)	Frequently (4)	Always (5)
Level of Frequency	○	○	○	○	○

End of Block: AM-TCHAS

Start of Block: MSES-R

MSES-R Directions Please indicate your level of confidence with the following statements. *NOTE* you are not answering the questions, just rating how confident you are in your ability to answer them.

MSES-R Q1 In a certain triangle, the shortest side is 6 inches. The longest side is twice as long as the shortest side, and the third side is 3.4 inches shorter than the longest side. What is the sum of the three sides in inches?

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q2 About how many times larger than 614,360 is 30,668,000?

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q3 There are three numbers. The second is twice the first and the first is one-third of the other number. Their sum is 48. Find the largest number.

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q4 Five points are on a line. T is next to G. K is next to H. C is next to T. H is next to G. Determine the positions of the points along the line.

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q5 If y = 9 + x/5, find x when y = 10.

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q6 A baseball player got two hits for three times at bat. This could be represented by 2/3. Which decimal would most closely represent this?

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q7 If P = M + N, then which of the following will be true? a. N = P – M b. P - N = M c. N + M = P

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q8 The hands of a clock form an obtuse angle at _____ o'clock.

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q9 Bridget buys a packet containing 9-cent and 13-cent stamps for $2.65. If there are 25 stamps in the packet, how many are 13-cent stamps?

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q10 On a certain map, 7/8 inch represents 200 miles. How far apart are two towns whose distance apart on the map is 3 1/2 inches?

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q11 Fred's bill for some household supplies was $13.64. If he paid for the items with a $20 bill, how much change should he receive?

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q12 Some people suggest that the following formula be used to determine the average weight for children between the ages of 1 and 7: W = 17 + 5A where W is the weight in pounds and A is the child's age in years. According to this formula, for each year older a child gets, should his weight become more or less, and by how much?

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q13 Five spelling tests are to be given to Mary's class. Each test has a value of 25 points. Mary's average for the first four tests is 15. What is the highest possible average she can have on all five tests? 14. 3 4/5 - 1/2 = ______

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q14 14. 3 4/5 - 1/2 = ______

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q15 In an auditorium, the chairs are usually arranged so that there are rows and y seats in a row. For a popular speaker, an extra row is added, and an extra seat is added to every row. Thus, there are x + 1 rows and y + 1 seats in each row, and there will be (x + 1) and (y + 1) seats in the auditorium. Multiply (x + 1) (y + 1).

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q16 A ferris wheel measures 80 feet in circumference. The distance on the circle between two of the seats is 10 feet. Find the measure in degrees of the central angle SOT whose rays support the two seats.

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q17 Set up the problem to be done to find the number asked for in the expression "six less than twice 4 5/6"?

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

MSES-R Q18 The two triangles shown on the right are similar. Thus, the corresponding sides are proportional, and AC / BD = XZ / YZ If AC = 1.7, BC = 2, and XZ = 5.1, find YZ.

	Not at all (1)	Somewhat confident (2)	Moderately Confident (3)	Quite Confident (4)	Completely Confident (5)
Level of Confidence	○	○	○	○	○

End of Block: MSES-R

Start of Block: AM-TSES

AM-TSES Directions Please indicate the level of influence that you feel over the following questions.

AM-TSES Q1 How much can you do to motivate students who show low interest in math school work?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q2 How much can you do to motivate students who show low interest in math school work?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q3 How much can you do to get students to believe they can do well in math school work?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q4 To what extent can you craft good questions for your students in math class?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q5 To what extent can you craft good questions for your students in math class?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q6 To what extent can you craft good questions for your students in math class?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q7 How well can you establish an inclusive classroom management environment with a group of students in math class?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q8 How much can you use a variety of assessment strategies in math class?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q9 To what extent can you provide an alternative explanation of example when students are confused in math?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q10 How much can you assist their families in helping their children do well in math?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

AM-TSES Q11 How well can you implement alternative strategies in your math classroom?

	Nothing (1)	Very Little (2)	Some Influence (3)	Quite a bit (4)	A Great Deal (5)
Level of Influence	○	○	○	○	○

End of Block: AM-TSES

Start of Block: Additional data

Q1 What is your name?

____

Q2 What is your email?

____

Q3 How old are you?

____

Q4 What was your college major?

____

Q5 What was the highest level of math you have completed?

____

Q6 How long ago was the most recent math course you took?

____

Consent: Do you want to participate in the whole study throughout your elementary math methods course?

○ Yes

○ No

Skip To: Q74 If you want to participate in the whole study throughout your elementary math methods course? = Yes

Q74 Consent to video / audio recording / photography solely for purposes of this research This study involves video/audio recording, and/or photography. If you do not agree to be recorded, you can still take part in the study.

○ Yes, I agree to be video/audio recorded/photographed.

○ No, I do not agree to be video/audio recorded/photographed.

Skip To: Consent form If Consent to video / audio recording / photography solely for purposes of this research This study... = Yes, I agree to be video/audio recorded/photographed.

Consent form <u>Hood DU informed consent</u>

Consent for Accessing Education Records Education records used by this research project are education records as defined and protected by Family Educational Rights and Privacy Act (FERPA). FERPA is a federal law that protects the privacy of student education records. Your consent gives the researcher permission to access the records identified above for research purposes.

○ Yes, I give permission to the researcher to access my education records for this research project.

○ No, I do not give permission to the researcher to access my education records for this research project.

End of Block: Additional data

Appendix E: Mathematics Autobiography

Submit via Canvas.

In this first reflection in Elementary Math Methods, I want to get to know you a little bit more. In particular, I want to learn about the influences and experiences that shaped your mathematics learning. Use the focus questions below to help you write your story. Feel free to describe other things that influenced your interest and experience in learning mathematics.

Focus questions

- **How does doing mathematics make you feel?** Are you confident in your abilities? How would you describe your relationship with math? (Math anxiety and self-efficacy)
- **How does the idea of teaching mathematics make you feel?** Are you confident in your teaching abilities? (math teaching anxiety and math teacher self-efficacy)
- **What was learning mathematics like for you in school?** For instance, did you find math to be easy or challenging? Why? Did you always feel the same way about it? Why?
- **Were most students in your math classes of the same ethnicity, race, gender, or linguistic or socioeconomic background as you?** Be specific in your identification of yourself and others.

- **What specific experiences affected your mathematics learning?** For example, did a particular person, event, or math topic get you interested in or turn you away from math? What types of instruction or experiences with instruction made learning math easier or harder for you?
- **How did your interest in math vary as you went through school?** Consider your math experiences as you moved through elementary, middle, and high school, as well as college.
- **How was your mathematics learning supported at home and in your community?** Did you do any math activities outside of school (for example, in sports, hobbies, or games)? In what ways were you like or different from the other students in your math classes in this respect?
- **How has math affected your career path?** Include the selection of your undergraduate major and your choice of profession.

  Conclusion
- **How do your experiences in learning math shape your views about teaching mathematics to children and your future classroom teaching practices?**

Requirements

Your reflection should be about **3-5 pages, double-spaced, 10-12pt font**.

Page guidelines do not include title page, references, etc.

Title page is optional

You do not need an abstract

If there are particular books or readings that resonate with your personal narrative, feel free to cite them — but **citations are not required** for this reflection.

If you do include citations, please use APA style

- The focus questions are intended to help you generate ideas to craft your story. **You do not need to address all of the focus questions**, but consider each of them carefully. You may write about things that are important to your story, even if not covered in the focus questions.
- **You DO need to address the conclusion question** at the end of your autobiography.

  Rubric

Criteria	**Weight**	**Excellent (5)**	**Satisfactory (3-4)**	**Needs Revision (1-2)**
Coherence	**1**	Your reflection is coherently written, is logical, and comprehensible.	Your reflection could be more coherent, could make more sense or could be more comprehensible.	Your reflection lacks coherence, is difficult to follow and is not comprehensible.

Content	**2**	You explore your narrative in some depth and creative insights are demonstrated.	You could explore your narrative in more depth or demonstrate more creative insights.	You could explore your narrative in more depth and demonstrate more creative insights.

Appendix F: Analytic Memo Template

ANALYTIC MEMO TEMPLATE	
Date:	
Session #:	
Pedagogical Objectives:	
Practical Objectives:	
Mathematical Objectives:	
Manipulatives:	

Topics	Pre-Planning (strengths, tensions, or opportunities)	Post-Debrief (critical reflection and action step development to improve instruction)
Math Journals?		
Pedagogical Materials?		
Doing math as a student?		
Doing math as a teacher?		
Pedagogical strategies?		
Rehumanizing?		
Ambitious?		
Miscellaneous?		

Appendix G: Interview Protocol

Semi-Structured Interview Protocol (Billups, 2021, p. 50-51).

Title of the Project: Rehumanizing Elementary Math Education			
Date:		**Time and Place:**	
Interviewer: Christine Hood		**Interviewee:**	

Thank you very much for coming today. The purpose of this study is to look into the mathematical dispositions of EPSTs through a lens of efficacy and anxiety. The responses you give today will be transcribed and I will be looking over them to pick out key themes that emerge from our conversation. Before conclusions are gathered from the data collected, I will be in contact with you to make sure any comments or feelings that emerge from this data are accurate to what you were trying to convey. Your identity will be kept confidential. This interview will be recorded and is expected to take approximately one hour. When you are ready we can begin.

Questions:
1. Thinking about yourself as a student, how would you describe your relationship with mathematics? *Purpose: How they feel about themselves as a mathematician. (Mathematics Anxiety / Math Self-Efficacy).*

Probe 1a. **(Rehumanizing and Ambitious & Equitable Math)** Did this methods course encourage any shifts in your relationship with mathematics from your perspective as a student? If so, can you describe them?

Probe 1b. **(Mathematics Anxiety)** Are there any feelings of anxiety that arise when you think about doing math as a student? If so, can you describe them?

Probe 1c. **(Mathematics Self-Efficacy)** Do you believe your efforts will be effective in solving challenging math problems?

1d. (**Overall Disposition**) Is there anything that gets in the way of you being successful as a mathematics learner? If so, can you try to describe what gets in the way?

2. Thinking about yourself as a future full-time elementary teacher, how would you describe your relationship with teaching mathematics? *Purpose: How they feel about themselves as a mathematics teacher. (Mathematics Teaching Anxiety / Math teacher self-efficacy).*

Probe 2a. **(Rehumanizing and Ambitious & Equitable Math)** Did the course encourage any shifts in your understanding of your relationship with math teaching? If so, can you describe them?

Probe 2b. **(Mathematics Teaching Anxiety)** Are there any feelings of anxiety that arise when you think about teaching math? If so, can you describe them?

Probe 2c. **(Mathematics Teacher Self-Efficacy)** Do you believe your efforts will be effective in teaching a math class?

Probe 2d. (**Overall Disposition**) Is there anything that gets in the way of being successful as a mathematics teacher? If so, can you try to describe what gets in the way?

3. Do you think your relationship with mathematics will affect your teaching and therefore your students? Why or why not? Please elaborate on what ways you think your relationship will have an impact. *Purpose: Looking at their view of how their personal relationship with mathematics will come across in their teaching. (Mathematics Teaching Anxiety / Mathematics Teacher Self-Efficacy).*

4. What specific actions will you take as a mathematics teacher after going through this course? *Purpose: Understanding their takeaways from the course and what they plan to do in their own classrooms. (Mathematics Teacher Self-Efficacy).*

- 5a. (**Math teacher self-efficacy**) How do you feel about your abilities to take those actions?
-5b. (**Math teacher self-efficacy**) How prepared do you feel to teach elementary mathematics?

5. What do you think contributes to negative mathematical dispositions in preservice teachers? *Purpose: Looking at their viewpoint on potential sociocultural issues with mathematics and preservice teachers. (Mathematics Anxiety / Mathematics Teaching Anxiety).*

6. What advice would you give to a preservice teacher who is experiencing anxiety or a lack of confidence in teaching or learning math? *Purpose: How do they view a* *solution to negative mathematical dispositions? Gives a deeper look to what they believe to be the problem.*

7. Is there anything else you would like to add about your personal disposition towards math? *Purpose: A "catch all" question at the end to see if I missed anything and to let the interviewee discuss anything that came up during the discussion that they felt to be important.*

Thank you and follow up reminder

Researcher script: Thank you for your time and your insights on math teaching anxiety, math anxiety, math self-efficacy, and math teacher self-efficacy after a rehumanizing math methods course. I will follow up with you to complete a member-checking exercise to verify my notes of our session.

Appendix H: Member Checking Email

Hey ____,

Here is a member-checking chart about your experience in elementary math methods. This is not an exhaustive list of all of the data that I have collected, but it is the most salient data for my research!

Below you will see an Excel workbook with your initials. In this workbook you will see an interpretation of the three phases of data (before, during, and after). This interpretation is a couple sentences and is arguably the most important part of the file. Below that interpretation you will see the data sources and your particular raw results from those sources.

Do you feel like this interpretation and salient data points captured your experience? If so, please let me know. If not, please let me know what I missed so that I can add that information into my dissertation. Either way, I look forward to hearing back from you.

Hope this quarter is off to a good start!

PS if you do not respond within a week's time (Feb 10th) I will assume that I captured your experience in the course.

Best,

Christine

Appendix I: Member Checking Document

1. Summary of My Interpretations of Where Your Mathematical Dispositions Started Before the Course:	
Data Source:	**Results:**
1. Quantitative: Pre-Questionnaire Scores	Out of 5.00
Math Anxiety: Anxiety around DOING math*	
Math Teaching Anxiety: Anxiety around TEACHING math*	
*Math Self-Efficacy**: Confidence in your ability to DO math*	
*Math Teacher Self-Efficacy**: Confidence in your ability to TEACH math*	
2. Qualitative: Math Autobiography:	
*The higher the more negative disposition	
** The higher the a more positive dispostion	

2. Summary of My Interpretations of What Happened During the Course with Your Mathematical Dispositions:	
RAW DATA	
Data Source:	**Results:**
3. Qualitative: Exit Tickets	
~ By Session's Exit Ticket # (ET 2= Exit ticket from week 2)	
4. Qualitative: Course Video:	
~ By Session # (S2 = Week 2's class session)	

3. Summary of My Interpretations of Where you Ended Up with Your Mathematical Dispositions:	

Data Source:	**Results:**
5. Quantitative: Post-Questionnaire Scores	Out of 5.00
Math Anxiety:*	
Math Teaching Anxiety:*	
*Math Self-Efficacy**:*	
*Math Teacher Self-Efficacy**:*	
6. Qualitative: Semi-Structured Interview:	

Appendix J: Exit Tickets 2, 4, 7, & 10

Exit Ticket for Week 2

Please fill this out before leaving class on 9.19

1. What is your name?

2. After the first two course sessions, what are some of your takeaways from learning math as a student? What about learning how to teach math as a teacher?

3. Has your concept of a "good math student" shifted throughout these first two weeks of the course? What about your concept of a "good math teacher"?

Week 4 Exit Ticket Fall 2022

Please fill this out before leaving class 10.3

1. Name (optional, but helpful)

2. What's going well so far? What should we keep doing?

3. What's not working well for you? What should we try doing instead?

4. What questions do you have about teaching? What do you want us to be sure to make time foi the next few weeks?

Exit Ticket for Week 7

Please fill this out before leaving class on 10.24

1. What is your name? (optional, but helpful)

2. What have been some salient moments (shift or solidification) for your mathematical mindset i class?

   Note: this can be related to teaching math or learning math

3. Some of you have started to (or will soon start to) lead math lessons in your placement.

   What are some of your feelings surrounding lead-teaching a math lesson?

Math Methods Course Evaluation

Bonus questions—to ask a few things that the generic evaluation doesn't, and to help make this class better for future TEP students!

1. What's your name? (Optional, but helpful)

____

2. How confident are you in your understanding of elementary math content?

Mark only one oval.

	1	2	3	4	5	
Not	◯	◯	◯	◯	◯	Very confident

3. How prepared to you feel to teach elementary math?

Mark only one oval.

	1	2	3	4	5	
Not	◯	◯	◯	◯	◯	Very prepared

Looking back on the course

This set of questions is about the course in general — they will help us improve the next iteration of the course

Week 4: Oct 3	What kinds of tasks or problems are important for good math teaching? How do students develop understandings of shape and space?	Yeh et al. (2017): Task-Rich Environments ❋ Chapter 3: Teaching through Problem Solving Chapter 19: Geometric Thinking and Geometric Concepts	Identify cognitive demand of tasks Identify groupworthy tasks Describe conceptual development of geometric concepts	Sunday 10/2: Math Journal #4
Week 5: Oct 10	How do standards and big mathematical ideas develop over time? How do students develop understandings of fractions and measurement?	Chapter 14: Developing Fraction Concepts Chapter 18: Developing Measurement Concepts Progressions for the CCSS, Fractions — Grades 3-5	Analyze the progression of Common Core standards across multiple grade levels. Describe conceptual development of fractions and measurement concepts.	Sunday 10/9: Math Journal #5 **Monday 10/10: Video Analysis due**
Week 6: Oct 17	How do teachers maintain the cognitive demand of rich tasks? What strategies do students use to add and subtract?	Chapter 4: Planning in the Problem-Based Classroom Chapter 11: Developing Strategies for Addition and Subtraction Computation Chapter 15: Developing Fraction Operations (Addition/Subtraction)	Identify and understand relationships among addition and subtraction strategies for fractions and whole numbers. Describe strategies for maintaining the cognitive demand of a task	Sunday 10/16: Math Journal #6 **Monday 10/17: Lesson plan draft due**
Week 7: Oct 24	How can teachers support conceptual learning through discourse? What strategies do students use to multiply and divide?	Yeh et al. (2017): Discourse-Rich Environments ❋ Chapter 12: Developing Strategies for Multiplication and Division Computation Chapter 15: Developing Fraction Operations (Multiplication and Division)	Identify and plan strategies to press for conceptual thinking. Identify and understand relationships among multiplication and division strategies for fractions and whole numbers.	Sunday 10/23: Math Journal #7

Week 8: Oct 31	What language demands do math lessons place on students? How do students develop understanding of decimals and percents?	Aguirre & Bunch (2012): What's language got to do with it? ❋ Chapter 16: Developing Decimal and Percent Concepts and Decimal Computation	Identify linguistic demands of a math lesson and ways to support students to meet those demands Describe conceptual development of rational numbers.	Sunday 10/30: Math Journal #8 ***Peer feedback in class***
Week 9: Nov 7	How do we know what students know? How do students develop an understanding of algebraic reasoning?	Chapter 5: Creating Assessments for Learning Chapter 13: Algebraic Thinking, Equations, and Functions	Identify and create examples of formative and summative assessments Describe conceptual development of algebraic thinking	Sunday 11/6: Math Journal #9
Week 10: Nov 14	How can elementary students model meaningful mathematics contexts? How do students develop understanding of ratios and proportions?	Suh et al (2018): Every Penny Counts ❋ Chapter 17: Ratios, Proportions, and Proportional Reasoning	Understand mathematical modeling in elementary settings Describe conceptual development of proportional reasoning	Sunday 11/13: Math Journal #10
Exam week	**Lesson Plan Paper due Nov 21** (submit on Canvas)			

4. What have been your favorite readings, classes, and activities?

5. What have been your least favorite readings, classes, and activities?

6. What's extra? What do you wish we hadn't talked about (or talked about less)?

7. What's missing? What do you wish we had talked about (or talked about more)?

8. If you want me to know one thing about your experience in class this quarter, what would it be‘

9. If you could change one thing about our class this quarter, what would it be?

Manipulatives question

We started handing out manipulatives bags during remote teaching — and this is the first year that we've been consistently in-person since the Before Times™

I still want y'all to have access to manipulatives — e.g., for math journals or if you have to zoom in to class but I also don't want to burden y'all with dragging them back and forth.

I'm wondering if still makes sense to send bags home with each of you, or if it's better/easier for me to bri manipulatives to class when we need them.

10. If we were going to re-do this quarter, would you want to take home a bag?

Mark only one oval.

- Yes — I like the option of having manipulatives at home
- No — I can use them in-person (or use virtual ones for math journals)
- Other: ____________