

Addressing Teacher Candidate Perceptions and Attitudes Toward Mathematics Through an Elementary Math Methods Course with Social Justice Pedagogy

Jennie M. Carr
Bridgewater College

Caitlin Riegel
Niagara University

Abstract

Perceptions and attitudes of math teachers have an impact on students. Research has shown teachers with negative self-efficacy can build fear, anxiety, and even negatively affect students' math achievement. This research study addresses teacher candidate perceptions and attitudes (value, self-confidence, motivation, and enjoyment) toward mathematics through an elementary math methods course with social justice pedagogy. A purposive sample of 79 teacher candidates enrolled in an elementary mathematics methods course completed the Attitudes Toward Mathematics Inventory (ATMI). The quantitative data analysis revealed statistically significant differences in teacher candidates' self-confidence, value, enjoyment, and motivation toward mathematics after completion of the elementary math methods course. The inclusion of an elementary mathematics methods course with an emphasis on social justice pedagogy in educator preparation programs can better prepare teachers to teach math, enhance teacher candidates' attitudes towards math, and positively impact future generations' attitudes towards math.

Keywords: math perceptions, teacher education, value, motivation, self-confidence, enjoyment

Education can be considered the “great equalizer for leveling the playing field in our society” (Jacobs & Perez, 2023, p. 1). With that said, it can also play a role in the marginalization of students. Specifically, if a teacher’s perceptions and personal attitude toward mathematics are negative, this can hamper not only their students’ dispositions but also their mathematical achievement (Bandura, 1993; Jackson & Leffingwell, 1999; Looney et al., 2017). This can result in an opportunity gap for marginalized students, when they are assigned to learn math from a teacher whose implicit bias against math lowers the rate of success in educational achievement. Therefore, it is critical for teacher educators to help teacher candidates formulate positive attitudes toward mathematics during their preparation programs. This research study addresses teacher candidate perceptions and attitudes (value, self-confidence, motivation, and

enjoyment) toward mathematics through an elementary math methods course that employed a social justice pedagogy. It sought to answer research questions related to the extent an elementary math methods course with a social justice pedagogy changes teacher candidates' attitudes toward mathematics and develops teacher candidates' self-confidence, value, enjoyment, and motivation in mathematics.

Literature Review

Negative attitudes toward mathematics are widespread in the United States and stem from various factors that persist across different demographics. With the potential to lead to opportunity gaps for marginalized populations it is vital that teacher candidates' preconceived notions about math are addressed during pre-service training. Experiences during their education programs can reinforce teacher candidates' math content understanding, enhance pedagogy, and foster appreciation for math. With the inclusion of social justice math pedagogy, an approach to teaching mathematics that aims to address and challenge social inequalities and injustices through mathematical education and includes "using mathematics as a tool to empower [students] and critique the status quo" (Leonard & Moore, 2014, p. 80), teacher educators can promote equal access to math content and highlight its relevance and practical applications. It is through this social justice lens that factors influencing students' attitudes and perceptions toward mathematics may be directly impacted by teacher candidates' who have value, self-confidence, motivation, and enjoyment in the subject (Leonard & Moore, 2014).

Attitudes Toward Mathematics

In the United States, having a traditionally negative disposition toward mathematics is common for adults and children (Beilock & Willingham, 2014). Negative attitudes toward math originate from a variety of sources such as parental figures, poor instruction, low mathematical

achievement, fear of failure, lack of enjoyment, and low confidence (Goodykoontz, 2009; Gutbezahl, 1995; Legg & Locker, 2009; Liew et al., 2014; Marsh, 2002). There have been many attempts over the years to identify and reduce negative feelings toward mathematics, such as strengthening math instruction, alleviating outside pressures, building classroom community, and promoting problem solving. However, negativity towards the subject persists at all age levels, genders, and ethnicities (Aydoğdu & Ayaz, 2008; Boaler, 2015; Murayama et al., 2016; Zrike & Connolly, 2015). Deficit views of mathematics are common in historically marginalized students (Valencia, 2010). Negative attitudes and perceptions start as early as elementary school and can be perpetuated throughout schooling by teachers (Beilock & Willingham, 2014). Teachers with negative self-efficacy can build fear, anxiety, and even negatively affect students' math achievement, which can be exacerbated amongst marginalized populations (Beilock et al., 2010; Gunderson et al., 2012). A negative attitude toward mathematics has been widely documented as a growing barrier for marginalized populations and poses a potential opportunity gap for all students (Geist, 2010).

Teacher candidates enter teacher education programs with lofty beliefs about school and their own personal experiences (Öçal, 2021). Öçal (2021) found teacher candidates' beliefs can change based on experiences during their Educator Preparation Program (EPP); however, Azjen (1985) and Fitzsimmons (1999) warn about the difficulties of changing teacher candidates' preconceived notions specifically about math. To begin to build positive perceptions of math, teacher candidates should have experiences throughout their EPP that reinforce their understanding of math content, strengthen their math pedagogy, and enhance their overall appreciation of math. Social justice pedagogy serves as the perfect bridge to build this

foundation, enabling equal access to the content so that mathematics knowledge can benefit all children rather than a select few (Bryk & Treismanm, 2010).

Value

For the purpose of this study, value is defined as something of importance, worth, or useful to an individual in the field of mathematics. Over three decades ago, the National Council of Teachers of Mathematics (1989) sought to prioritize teachers' and students' value of mathematics education due to its effect on perceptions and attitudes toward mathematics. Several research studies have explored and found the construct of value impacts teachers' perceptions toward mathematics (Atweh et al., 1998; Bishop, 2008), teacher candidates (Dede, 2009; Michaluk et al., 2018) and students (Fennema & Sherman, 1976; Tapia & Marsh, 2004). In order to effectively support public school students, especially marginalized students, in their understanding of the value of math education, it is essential for teacher candidates and educators to integrate pedagogy from a social justice lens to “help children investigate, identify, and react to social injustices in their community” (Easley, 2020; Gutstein & Peterson, 2005; Leonard & Moore, 2014, p. 80). This will allow students to better appreciate the value, relevance, and practical applications of math in their personal lives and communities (Gewertz, 2020).

Often policies and reform efforts in public schools see marginalized students from a deficit perspective (Stein, 2004). Similarly, elementary teachers have difficulty recognizing the value of mathematics and prefer to prioritize the socio-emotional development of students, thus further perpetuating negative attitudes toward mathematics (Blömeke, 2016; Kowalski, 2001; Lee & Ginsburg, 2007; Varol, 2013). It is important to note teacher candidates can better identify the value and importance of mathematics when they themselves personally succeed mathematically (Midgley et al., 1989; Zerpa et al., 2009). EPPs can foster a learning

environment where teacher candidates have the opportunity to make choices about their learning journey that they believe will help them to be more successful (Dell'Angelo et al., 2014; Metzger et al., 2019; Tomlinson, 2017).

Self-Confidence

Self-confidence is defined as one's confidence in their ability to learn and perform well on mathematical tasks (Fennema & Sherman, 1976). In addition to value, the National Council of Teachers of Mathematics (1989) also prioritized student's mathematical self-confidence due to its effect on student perceptions and attitudes toward mathematics. Several research studies have explored and found the construct of self-confidence impacts a teachers' perceptions toward mathematics (Kuru, 2018), teacher candidates (Norton, 2018) and students (Baird, 2019; Fennema & Sherman, 1976; Öçal, 2020; Tapia & Marsh, 2004). It is important to study the relevance of self-confidence as it is often connected to math content knowledge. Like value, teacher candidates who have more content knowledge in mathematics tend to be more self-confident (Norton, 2019). A teacher may have strong knowledge of elementary mathematics content, yet they may not have the same confidence in how to teach and communicate that concept effectively to their students.

In order to communicate mathematics content to others effectively, teachers should have a higher degree of self-confidence (Kuru, 2018; Norton, 2018). Some teachers of historically marginalized populations have lower self-confidence in mathematics (Baird, 2019). It is during educator preparation that a teacher candidate builds the foundation of self-confidence (Flores, 2015). It is necessary for teacher educators to effectively model social justice pedagogies and engage in reflective discourse regarding pedagogical decision making during elementary math methods coursework for teacher candidates. This will allow teacher candidates to utilize the

modeled social justice pedagogical approaches to “engage students in contextually rich and meaningful mathematics tasks that empower students to think critically and take action in their school or community” (Leonard & Moore, 2014, p. 89; Loughran, 2006).

Motivation

Many high-quality teachers are internally motivated to excel in their teaching craft. Some teacher candidates are motivated to teach mathematics simply because they are passionate or enthusiastic about the subject matter (Bastian et al., 2022). These teachers value mathematics and desire to pass their positive attitudes and perceptions onto their students (Bastian et al., 2022). Several research studies have explored and found motivation impacts perceptions towards mathematics for teachers (Bastian et al., 2022), teacher candidates (Yildiz, 2020) and students (Fennema & Sherman, 1976 & Tapia & Marsh, 2004). One’s intrinsic motivation and enthusiasm toward teaching mathematics are positively related to a teacher’s instructional quality (Baier et al., 2019). Yildiz (2020) found motivation can also impact attitude, perceptions, behavior and recommends EPPs integrate authentic learning experiences and resources to improve teacher candidates' intrinsic motivation. Motivation and engagement can improve when teacher educators and educators utilize social justice pedagogies such as inviting students to be involved in their academic journey by including students in real-world applicable stories or word problems (Metzger et al., 2019). Additionally, when marginalized students see themselves in the content, the content becomes more relevant to them and their motivation to learn increases (Gewertz, 2020).

Enjoyment

Enjoyment, in the context of mathematics, refers to the level of pleasure or satisfaction an individual experiences when engaging with mathematical content. As previously stated, having a

traditionally negative disposition toward mathematics is common for adults and children (Beilock & Willingham, 2014). Several research studies have explored and found the construct of enjoyment can impact a teachers' perceptions toward mathematics (Blömeke, et al., 2017), teacher candidates (Michaluk et al., 2018; Peker, 2009) and students (Dowker et al., 2016; Fennema & Sherman, 1976; Panthi, 2017; Polly & Colonnese, 2021; Tapia & Marsh, 2004). Students in high poverty schools have less experienced teachers and less access to high quality resources (Duncombe, 2017). When all students have equal access to mathematics content, they have equal opportunity to enjoy and make the most of their learning experience (Panthi, 2017). The negative perceptions of teachers who do not enjoy mathematics often transfer to their interactions with children when teaching and learning mathematics (Blömeke et. al, 2017).

This dislike of mathematics has caused a crippling epidemic of math anxiety impacting nearly 60% of school-age students (Dowker et al., 2016) and even math teaching anxiety negatively impacting teacher candidates and teachers (Hadley & Dorward, 2011; Unlu et al., 2017). Lack of content knowledge, anxiety, and fear are all documented reasons as to why teacher candidates do not enjoy math, avoid higher levels of mathematics, and prefer teaching early childhood mathematical content (Lake & Kelly, 2014). A higher level of content knowledge can increase an individual's confidence in mathematics and thus make teaching and learning mathematics more enjoyable (Bastian et al., 2022). Students report finding more enjoyment in the activities selected by their teachers than the mathematical content itself (Polly & Colonnese, 2021).

Math Methods Course

Given EPPs play a pivotal role in the development of teacher candidates, there is a need to integrate an intentional focus on social justice to improve the teaching and learning for all

students (Cochran-Smith, 2010; Easley, 2020). Teachers often perpetuate inequities instead of advancing social justice and equality for all students, resulting in an implicit opportunity gap (Jacobs & Perez, 2023). It is vital in this time and space that educators see themselves as change makers who are confident enough to incorporate social justice pedagogy to create transformative teaching and learning experiences for students (Cochran-Smith; 2010; Jacobs & Perez, 2023; Easley, 2020). A teacher's beliefs, attitudes, and perceptions about mathematics impact how they see themselves as a teacher (Bandura, 1993; Cohrssen & Tayler; 2016; Gonzalez-DeHass et al., 2021; Jackson & Leffingwell, 1999; Lake & Kelly; 2014; Looney et al., 2017). Unfortunately, elementary teacher candidates have indicated higher levels of math anxiety, lower content knowledge, and lower confidence to teach mathematics than other content disciplines across the field of education (Novak & Tassel, 2017; Kelly & Timhave, 1985; Rech et al., 1993). This is problematic as negative dispositions toward mathematics can transfer to students.

According to Gay (2002) "culture is deeply embedded in any teaching" (p. 112). Teacher educators must model authentic instructional techniques that connect curriculum to students' lives and communities. (Easley, 2020). Before teacher candidates can understand others' cultural backgrounds and communities, they themselves need the opportunity to self-reflect on how value, self-confidence, encouragement, and motivation can impact teacher candidates' perceptions and attitudes toward mathematics (Martinez, 2015). In elementary mathematics methods classes with an emphasis on social justice pedagogy, teacher educators and teacher candidates can investigate personal and deep-rooted feelings towards mathematics. This opportunity can have a ripple effect by altering teacher candidates' perceptions and attitudes about mathematics, and later their elementary school students.

Theoretical Framework

This study is guided by Mezirow's (1994, 1997, 2000, 2003) transformative learning theory. Mezirow (2003) defines transformative learning for adult learners as “learning that transforms problematic frames of reference...to make them more inclusive, discriminating, open, reflective, and emotionally able to change” (p. 58). This study works to transform teacher candidates’ frames of reference (i.e., perceptions) of mathematics before they become problematic when passed down to future generations of students. This is done through integrating social justice into the elementary math methods course, which involves ensuring equal access to math content for all students and “includes the pedagogical strategies and methods teachers use, but also involves what they believe...” (Enterline, et al., 2008, p. 270). This study is grounded by the hypothesis that, through a course focused on both social justice pedagogy and frames of reference, adult learners (i.e., teacher candidates) self-confidence, value, enjoyment, and motivation toward mathematics can shift. Given “paradigms in science and mathematics” are specifically mentioned as a frame of reference that is specifically susceptible to change through transformative learning, it follows that this theory was used as a theoretical framework for this study (Mezirow, 2003, p. 59).

Methods

This research study addresses teacher candidate perceptions and attitudes (value, self-confidence, motivation, and enjoyment) toward mathematics through an elementary math methods course with social justice pedagogy. The following research questions were addressed:

To what extent, if any, does an elementary mathematics methods course with social justice pedagogy change teacher candidates’ attitudes toward mathematics?

To what extent, if any, does an elementary mathematics methods course with social justice pedagogy develop teacher candidates' self-confidence, value, enjoyment, and motivation in mathematics?

Participants

Purposive sampling was used to recruit participants from a population of teacher candidates at a small private liberal arts college in the Mid-Atlantic region of the United States. Specifically, 84 students who were enrolled in an elementary math methods class over seven consecutive spring and fall semesters were contacted and invited to participate in the study. A sample of 79 participants was recorded, including first year (8.86%), second year (69.62%), third year (18.99%), and fourth year (2.53%) students. These teacher candidates consented to be participants in the study and fully completed the pre- and post-assessment evaluating their attitude toward mathematics.

Design and Data Collection

The elementary math methods course selected for this research study intentionally focused on positively building teacher candidates' perceptions and attitudes toward mathematics in the areas of value, self-confidence, motivation, and enjoyment through social justice pedagogy. The integration of social justice math pedagogy took the form of the teacher educator taking significant time to build relationships with teacher candidates. During the first week of the course, one of the first course assignments is a 1:1 meeting with the teacher educator. The goal of the meeting is to get to know the teacher candidate on a personal level, to better understand their background, goals, interests, experiences, learning preferences, and concerns. This self-awareness helps the teacher educator to integrate students' interests and preferences throughout the course (Tomlinson, 2017). For example, if there are teacher candidates who love football, the teacher educator can integrate recent NFL scores into computation-based word problems or if a

teacher educator is aware their student recently lost their favorite grandmother, they may be able to provide alternative assignments while the student attends the funeral.

Additionally, instead of waiting until the end of the semester on the course evaluation, the teacher educator included modified electronic course evaluations and check-ins throughout the course at week three and the midterm point to offer teacher candidates the opportunity to share any concerns or successes. This also gave the teacher educator the chance to make adjustments to better meet the individual needs of each student.

During class, the teacher educator strived to create a positive classroom community with a safe learning environment for all teacher candidates where they could be honest, take academic and emotional risks and engage in critical discussions (Brown, 2004; Capper et al., 2006; Dell'Angelo, 2014; Martinez, 2015; Young et al., 2006). The teacher educator collaboratively developed positive classroom norms and regularly practiced productive math talks, which have been shown to provide a “prioritization of sense making, engaged learners, and create a safe space for mathematical discourse” (Boaler, 2015; Saylor & Walton, 2018, p. 348). Teacher candidates were given the opportunity to self-reflect on the value, self-confidence, encouragement, and motivation of their own perceptions and attitudes toward mathematics in an effort to gain self-awareness (Martinez, 2015). Using social justice pedagogical strategies, the teacher educator worked to reduce student math anxiety throughout the elementary math methods course by incorporating regular group work, promoting communication amongst teacher candidates, displaying a positive and growth mindset about math amongst students by building on mistakes, incorporating problem solving and exploring mathematics through interactive games, concrete and virtual manipulatives (Boaler, 2015).

The integration of social justice math pedagogy also took the form of the teacher educator integrating real-world problems, manipulatives, and multiple methods for solving from various cultural backgrounds (Dell'Angelo, 2014; Ruppert et al., 2022; Yu et al., 2021). The teacher educator was explicit about how the modeled instructional strategies and methods could be applied in real teaching and learning scenarios (Cite et al., 2017). Teacher candidates debriefed regularly about their value and effectiveness (Loughran, 2006).

Although there is an overall decline in college enrollment, various racial/ethnic groups continue to be represented in higher education population (National Center for Education Statistics, 2023), suggesting the traditional one-size-fits-all lecture and summative exam may not be appropriate (Smith & Chesnutt, 2021). To support the learning needs of all teacher candidates, every course assignment in the math methods course was differentiated, creating a personalized learner-centered experience for each teacher candidate. Teacher candidates had the opportunity to choose the assignment option that best met their learning needs or propose an alternative assignment further creating agency and independence (Hagerman & Porath, 2018; Tomlinson, 2017).

It is important to develop authentic meaningful assessments where teacher candidates have the opportunity to apply their knowledge for real audiences outside the classroom (Dell'Angelo, 2014). The signature course assignment was a blended math mentorship experience in which teacher candidates provided virtual and in-person tutoring to second graders in a 1:1 or 1:2 setting (Carr & May, 2021). Teacher candidates read scholarly articles related to building relationships, math anxiety, self-esteem, motivation, and encouragement throughout the semester to prepare for their mentoring experiences. Mentoring elementary students offers teacher candidates unique perspectives and experiences with teaching math, including assessing

learning, analyzing student work, differentiating instruction, and providing remedial support. Additionally, the mentorship provides an opportunity for teacher candidates' to work on aspects of their classroom management, communication, and relationship building. analyzed student performance and utilized instructional research-based strategies weekly with their mentee. This authentic mentorship experience allowed for the teacher candidates to practice and implement what they learned throughout the course. At the end of the course, as part of the capstone experience, teacher candidates designed a differentiated interest-based mathematics lesson focused on one math skill for their mentee (Tomlinson, 2017). Teacher candidates were motivated to integrate concrete manipulatives in their lesson plans based on personally seeing their value. Students who have participated in mentorship programs with teacher candidates in EPPs have documented increased achievement (Elburn et al, 2017), deeper critical thinking skills (Nelson et al., 2017), strengthen relationship building through improved communication (Ferguson et al, 2021) motivation, self-efficacy, and self-confidence (Fogg-Rogers et al., 2017; Hollingsworth & Knight-McKenna, 2018), changed attitudes (Coller & Kou, 2014; Hastings et al., 2015), and reduced anxiety (Page-Gould et al., 2008).

Data Analysis

This research study addressed teacher candidate perceptions and attitudes (value, self-confidence, motivation, and enjoyment) toward mathematics through an elementary math methods course with social justice pedagogy. This study sought to answer research questions related to the extent an elementary math methods course with social justice pedagogy changes teacher candidates' attitudes toward mathematics and develop teacher candidates' self-confidence, value, enjoyment, and motivation in mathematics.

Likert-type scales are frequently utilized to measure attitudes toward mathematics (Code et al., 2016; Femmen & Sherman, 1976). The Attitudes Towards Mathematics Inventory (ATMI), demonstrated to be a valid and reliable inventory used with both K-12 and collegiate populations, was selected as the data collection instrument for this quantitative study (Afari, 2013; Majeed et al., 2013; Tapia, & Marsh, 2000, 2002, 2004). The ATMI is a 40-question self-assessment with five-point Likert scale positive and negative items ranging from 1 (strongly disagree) to 5 (strongly agree) (see Figure 1). The ATMI contains four subcomponents, including self-confidence (15 questions), value (10 questions), enjoyment (10 questions), and motivation (5 questions).

Figure 1

ATMI Sample Items

Mathematics is a very worthwhile and necessary subject.
I want to develop my mathematical skills.
I get a great deal of satisfaction out of solving a mathematics problem.
Mathematics helps develop the mind and teaches a person to think.
Mathematics is important in everyday life.

Participating teacher candidates completed the ATMI during the first week of classes (pre-assessment). Following a 15-week elementary mathematics methods course designed in part to develop appropriate mathematics attitudes, students were asked to complete the ATMI again (post-assessment). Multiple paired sample t-tests were conducted comparing the means for the four subscales and the total score for the ATMI. Significant differences were evaluated to determine if an elementary mathematics methods course changed teacher candidates' overall attitude toward mathematics, and if so, in what way (e.g., self-confidence, value, enjoyment, and/or motivation). For the second research question, descriptive statistics were employed using Likert scale item responses from the ATMI post-assessment. Specifically, the average scores for

individual items within each of the four subscales were calculated. Given the inventory included both positive and negative items, reverse scoring was applied where appropriate before analysis.

Findings

In an effort to answer the first research question, multiple paired sample t-tests were conducted comparing the means for self-confidence, value, enjoyment, motivation, and total scores on the ATMI. A significant difference was found in each construct of the ATMI, as well as on the total score. Regardless of what year participants were in during their undergraduate program, results indicated a significant difference in overall attitude toward mathematics before and after taking an elementary mathematics methods course, with teacher candidates expressing higher self-confidence, value, enjoyment, and motivation in mathematics after taking the course (see Table 1).

A significant difference in self-confidence was found ($t(78) = -4.179, p < .001$). The mean on the pre-assessment was significantly lower ($m = 46.41, sd = 14.16$) than the mean on the post-assessment ($m = 50.49, sd = 12.31$). A significant difference in value was also found ($t(78) = -3.656, p < .001$). The mean on the pre-assessment was significantly lower ($m = 39.05, sd = 4.66$) than the mean on the post-assessment ($m = 41.37, sd = 5.23$). A significant difference in enjoyment was found ($t(78) = -4.375, p < .001$). The mean on the pre-assessment was significantly lower ($m = 31.71, sd = 8.17$) than the mean on the post-assessment ($m = 33.90, sd = 7.75$). Additionally, a significant difference in motivation was found ($t(78) = -3.105, p < .001$). The mean on the pre-assessment was significantly lower ($m = 13.87, sd = 3.99$) than the mean on the post-assessment ($m = 14.86, sd = 3.92$). It follows that a significant difference in total score on ATMI was found ($t(78) = -5.079, p < .001$). The mean on the pre-assessment was significantly lower ($m = 131.04, sd = 27.22$) than the mean on the post-assessment ($m = 140.62,$

sd = 25.37). These results suggest that an elementary math methods course delivered with social justice pedagogy has the potential to improve teacher candidates' attitudes and perceptions towards mathematics.

Table 1

Paired Sample t-test of Pre and Post scores for Self-confidence, Value, Enjoyment, Motivation, and Total on ATMI

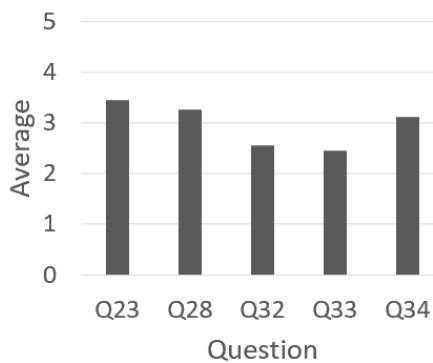
Score	Variable	n	Mean	Std. Dev.	t-values	df	p
Self-confidence	Pre	158	46.41	14.16	-4.179	78	**
	Post	158	50.49	12.31			
Value	Pre	158	39.05	4.66	-3.656	78	**
	Post	158	41.37	5.23			
Enjoyment	Pre	158	31.71	8.17	-4.375	78	**
	Post	158	33.90	7.75			
Motivation	Pre	158	13.87	3.99	-3.105	78	**
	Post	158	14.86	3.92			
Total	Pre	158	131.04	27.22	-5.079	78	**
	Post	158	140.62	25.37			

** $p < .001$

Although the course demonstrated potential to change teacher candidates' attitudes towards mathematics, the question remains to what extent the course *developed* self-confidence, value, enjoyment, and motivation in mathematics. Figures 2-5 suggest that the largest area for growth for elementary mathematics methods courses was in developing a motivation for mathematics within teacher candidates (see Figure 2). All questions addressing the subscale of motivation averaged below a 4, with 40% of the questions averaging below a 3 in agreement. The math methods course facilitated transformative learning (see Table 1), however there is still room to improve upon the motivation to learn mathematics so that future generations of students gain the motivation required to continually practice and grasp mathematical concepts (e.g., problem solving, critical thinking, relationships, etc.).

Figure 2

Average for Motivation ATMI Questions



Both the subscales of developing self-confidence in mathematics (see Figure 3) and developing an enjoyment for mathematics (see Figure 4) within teacher candidates indicated room for growth as well. All questions addressing self-confidence averaged below a 4 and all but one enjoyment question averaged below a 4. Self-confidence questions (13.33%) and enjoyment questions (10%) each had a small percentage of their questions averaging below a 3 in agreement. Much like with teacher candidates' motivation to learn math, transformative learning

within math methods can continue to enhance a teacher candidates' willingness to change their perceptions towards their own ability to learn math and enjoyment for the subject in an effort to pass these positive perceptions down to future generations.

Figure 3

Average for Self-confidence ATMI Questions

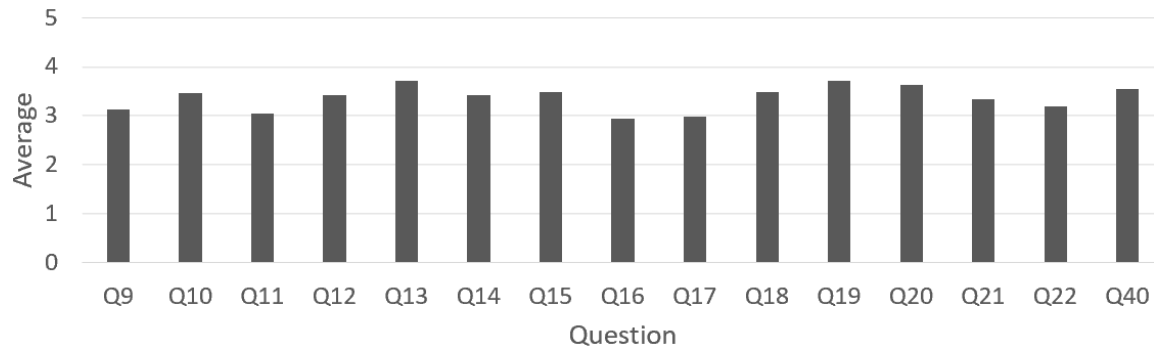
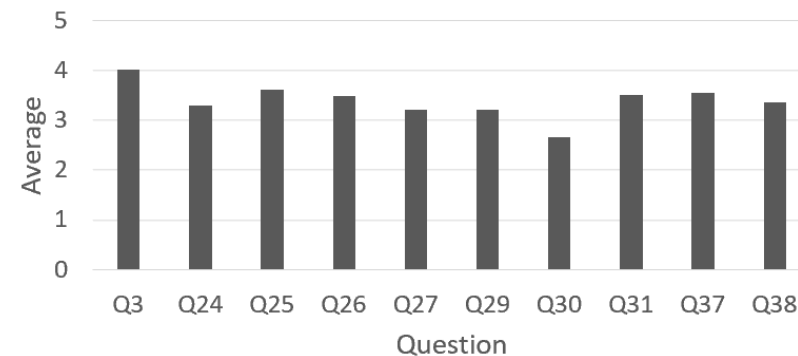


Figure 4

Average for Enjoyment ATMI Questions

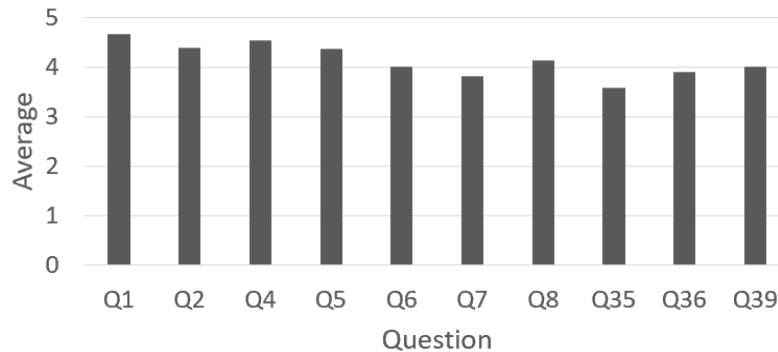


The area in which elementary mathematics methods courses seem to excel is in developing a value for mathematics within teacher candidates (see Figure 5). The majority of questions addressing the subscale of value averaged above a 4, with only 30% of the questions averaging below a 4, but still above a 3 in agreement. Although many may argue against the value of mathematics (e.g., $a^2 + b^2 = c^2$) in everyday life, it appears elementary mathematics methods courses promote an attitude towards mathematics that includes seeing the value within building

critical thinking, logical reasoning, problem-solving ability, etc. Results suggest transformative learning is occurring successfully within the math methods course, allowing teacher candidates to increase their value towards mathematics.

Figure 5

Average for Value ATMI Questions



Results suggest that elementary math methods courses impact teacher candidates' attitudes towards mathematics. Specifically, results indicate a difference in overall attitude toward mathematics before and after taking an elementary mathematics methods course with social justice pedagogy, with teacher candidates expressing higher self-confidence, value, enjoyment, and motivation in mathematics after taking the course. These results provide a lens to understand the extent to which such an elementary mathematics methods course can positively impact teacher candidates' perceptions and attitudes towards math and can be used to better inform the role of teacher educators in fostering positive attitudes towards mathematics.

Discussion

EPPs are designed to provide teacher candidates with a wealth of comprehensive experiences to prepare them for their future students. This preparation regularly includes content coursework, pedagogy course work, and clinical experiences (Walsh et al., 2022). Content courses heavily focus on learning the content (e.g., number sense, computation and estimation,

etc.), while pedagogy courses focus on methods, strategies, and approaches used in teaching (Cochran-Smith, 2010). The combination of these courses is meant to ensure that teacher candidates have both the knowledge base to teach the subject(s) as well as the knowledge base for teaching to the learning standards. An element not often covered within EPP coursework is the perceptions and attitudes toward the content they will be teaching.

This study works to transform teacher candidates' frame of reference (i.e., perceptions) of mathematics before they become problematic when passed down to future generations of students (Mezirow, 2003). Although teacher candidate perceptions and attitudes toward math have received attention in the past, this is the first study to address concerns through social justice pedagogy in a math methods course, which "includes the pedagogical strategies and methods teachers use, but also involves what they believe..." (Enterline, et al., 2008, p. 270; Fachrudin et al., 2019; Hourigan et al., 2016; Jong & Hodges, 2015; Kesicioglu, 2015; Russo et al., 2021). Using social justice pedagogy in a math methods course can help teacher candidates see the value in connecting students, content, and pedagogy and foster equitable learning environments to support all students (Creasey et al., 2016; Gorski, 2017). Teacher educators must be self-aware of not only the mathematics content, but their own implicit perceptions and the way these may marginalize students and/or impact their opportunity to learn and experience success within the content (D'Urso et al., 2023; Lee et al., 2017).

The teacher educator of the math methodology course strived to engage learners by creating a learner-centered safe learning environment, where students felt a strong community and belonging (Brown, 2004; Capper et al., 2006; Dell'Angelo, 2014; Hagerman & Porath, 2018; Martinez, 2015; Ruppert et al., 2022); a space where learners could take risks, develop individual agency and voice (Yu et al., 2021) through differentiation (Tomlinson, 2017). Teacher

candidates had exposure to use a variety of math physical and virtual manipulatives in class to solve elementary mathematics standards-based problems. Teacher candidates appeared to enjoy exploring the manipulatives as many of them self-reported never utilizing rekenreks, base 10 blocks, geoboards, ten frames, fraction bars, or number mats in their academic career: an unfortunate commonality in teacher candidates' year-to-year. Through these intentional choices, teacher candidates were able to self-reflect on their own perceptions and attitudes including self-confidence, value, enjoyment, and motivation toward mathematics.

EPPs have the opportunity to support teacher candidates providing evidence-based mathematics instruction through social justice pedagogy (Cochran-Smith, 2010; Jacobs & Perez, 2023). If math methodology classes are only about math content, ways of instruction, and demo lessons, we are missing an opportunity to build a support system for teacher candidates and close an opportunity gap related to math education. If methodology courses utilize social justice pedagogical connections, they will naturally provide an intentional focus on perceptions and attitudes of math. This could assist teacher candidates to be more self-aware of not only their value, self-confidence, motivation, and enjoyment of mathematics but how they will impact the perceptions and attitudes of their future students (Bandura, 1993; Jackson & Leffingwell, 1999; Looney et al., 2017). Understanding and incorporating students' attitudes, perceptions, experiences, and views can inform a teacher's efforts to increase instructional and learning opportunities for all students (Rittle-Johnson, 2020). The research study results suggest that the inclusion of a math methods course with social justice pedagogy can help bridge the opportunity gap to enhance teacher candidate's self-confidence, value, enjoyment, and motivation in the field of mathematics.

Implications

The field of mathematics is plagued by perpetuated cultural and societal beliefs, including assumptions of difficulty and inherited bias that the content is too hard, too boring, and/or not practical to learn. These often result in students harboring negative dispositions toward mathematics, as well as a lack of interest in-demand science technology engineering and mathematics careers (Leyva et al., 2022). Teacher candidates are preparing to teach students who may hold these negative attitudes and are not exempt from harboring these attitudes themselves. Negative attitudes and perception toward mathematics may be heightened among historically marginalized populations. Teachers often perpetuate inequities intentionally or unintentionally (Jacobs & Perez, 2023). Teachers serving historically marginalized children are “often teaching against the grain because of institutionalized racism, inadequate resources, punitive accountability, and prescriptive curricula” (Roegman, 2020, p. 161).

It is vital in this time and space that educators see themselves as change makers who are confident to incorporate social justice pedagogy to create transformative teaching and learning experiences for all students (Cochran-Smith; 2010; Easley, 2020; Jacobs & Perez, 2023). EPPs can assist teacher candidates to identify negative attitudes and offer equitable opportunities for all their students by focusing on building relationships, creating a safe classroom community, and implementing real-world assessments. Creating an environment where teacher candidates feel safe to take academic risks can help to improve their self-confidence in mathematics. Encouraging agency and independence through allowing candidates to choose between differentiated assessments that still meet the learning outcomes (Hagerman & Porath, 2018; Tomlinson, 2017). Providing students with a choice and a voice in their academic journey can help them to see the value, increase their motivation and enjoyment in mathematics. The results

of this study suggest that the inclusion of an elementary mathematics methods course with social justice pedagogy can provide a support system that fosters teaching and learning experiences for teacher candidates to develop and strengthen self-confidence, value, enjoyment, and motivation in mathematics. This may not only change teacher candidates' attitudes towards mathematics but may also positively impact future generations of students who will learn from these prospective educators.

Limitations and Future Research

There is a need for additional research studies which focus on teacher candidates' attitudes toward mathematics. Negative attitudes, such as low self-confidence, lack of value, enjoyment, and motivation toward mathematics needs to be minimized amongst educators and all students, especially those marginalized populations. Teacher candidates' quickly transition into educators in the classroom whose perceptions and attitudes toward mathematics can directly influence their future public school students' attitudes toward mathematics (Bandura, 1993; Jackson & Leffingwell, 1999; Looney et al., 2017). This study has a very low n, meaning it is difficult to draw conclusions from the data with a small sample size. A clear weakness of this design is its minimal internal validity, controlling only for selection of subject and experimental mortality and lack of external validity. The findings raise several questions that could be addressed in future research. Future research could focus specifically on which elementary mathematics course objectives or social justice pedagogies including topical lectures, activities, or assignments that impact self-confidence, value, motivation, and enjoyment. Additionally, future researchers could follow the candidates into their student teaching experiences or even their first year of teaching to see what experiences during candidates' EPP left a lasting impact on their perceptions and attitudes toward mathematics.

Conclusion

The results of this study suggest that including social justice pedagogy in elementary math methods courses may create a supportive environment which enhances the teaching and learning experiences of teacher candidates, leading to improved value, motivation, self-confidence, and enjoyment toward mathematics. After teacher candidates graduate and acquire their own students, their perceptions and attitudes toward mathematics can directly influence their future students' attitudes toward mathematics (Bandura, 1993; Jackson & Leffingwell, 1999; Looney et al., 2017). It is necessary for EPPs to actively allocate time to improve teacher candidates' dispositions in an effort to address perpetuated cultural and society beliefs about mathematics for teacher candidates turned educators and their students.

References

- Afari, E. (2013). Examining the factorial validity of the attitudes towards mathematics inventory (ATMI) in the United Arab Emirates: Confirmatory factor analysis. *The Mathematics Educator, 15*(1), 121-135.
- Atweh, B., Bleicher, R. E., & Cooper, T. J. (1998). The construction of the social context of mathematics classrooms: A sociolinguistic analysis. *Journal for Research in Mathematics Education, 29*(1), 63-82. <https://doi.org/10.2307/749718>
- Aydoğdu, M., & Ayaz, M. F. (2008). The importance of problem solving in mathematics curriculum. *Physical Sciences, 3*(4), 538-545.
- Azjen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl & J. Beckmann (Eds.), *Action – control: From cognition to behavior* (pp. 11-39). Heidelberg: Springer.
- Baier, F., Decker, A., Voss, T., Kleickmann, T., Klusmann, U., & Kunter, M. (2019). What makes a good teacher? the relative importance of mathematics teachers' cognitive ability, personality, knowledge, beliefs, and motivation for instructional quality. *British Journal of Educational Psychology, 89*(4), 767-786. <https://doi.org/10.1111/bjep.12256>

- Baird, C.L., Keene, J.R., (2019). Closing the gender gap in math confidence: Gender and race/ethnic similarities and difference in the effects of academic achievements among high math achievement. *International Journal of Gender, Science, and Technology*, 10(3) 378-410.
- Bastian, K., Kaiser, G., Meyer, D., Schwarz, B., & König, J. (2022). Teacher noticing and its growth toward expertise: an expert–novice comparison with pre-service and in-service secondary mathematics teachers. *Educational Studies in Mathematics*, 110(2), 205–232. <https://doi.org/10.1007/s10649-021-10128-y>
- Bishop, A.J. (2008). Values in mathematics and science education: Similarities and differences. *The Montana Mathematics Enthusiast*, 5(1), 47-57. Bishop, A.J. (2008b). Teachers' mathematical values for developing mathematical thinking in classrooms: Theory, Research and Policy. *The Mathematics Educator*, 11(1/2), 79-88.
- Boaler, J. (2015). *Mathematical mindsets* [EPUB]. Jossey Bass Wiley.
- Blömeke, S., Thiel, O., & Jenßen, L. (2019;2018;). Before, during, and after examination: Development of prospective preschool teachers' mathematics-related enjoyment and self-efficacy. *Scandinavian Journal of Educational Research*, 63(4), 506-519. <https://doi.org/10.1080/00313831.2017.1402368>
- Brown, K. (2005). Transformative adult learning strategies: Assessing the impact on pre-service administrators' beliefs. *Educational Considerations*, 32(2), 17–26.
- Bryk, A.S. & Treisman, U. (2010). Make math a gateway, not a gatekeeper. *The Chronicle of Higher Education*.
- Capper, C. A., Theoharis, G., & Sebastian, J. (2006). Toward a framework for preparing leaders for social justice. *Journal of Educational Administration*, 44(3), 209–224.
- Carr, J.M. & May, T. (2021). Connecting, collaborating, and cultivating their relationship with Christ: The journal and resources utilized by two school leaders. *Christian Educators Journal*.
- Cite, S., Lee, E., Menon, D., & Hanuscin, D. L. (2017). Learning from rookie mistakes: Critical incidents in developing pedagogical content knowledge for teaching science to teachers. *Studying Teacher Education*, 13(3), 275-293. <https://doi.org/10.1080/17425964.2017.1366306>
- Cochran-Smith, M. (2010). Toward a Theory of Teacher Education for Social Justice. In: Hargreaves, A., Lieberman, A., Fullan, M., Hopkins, D. (eds) *Second International Handbook of Educational Change*. Springer International Handbooks of Education, vol 23. Springer, Dordrecht. https://doi.org/10.1007/978-90-481-2660-6_27

- Code, W., Merchant, S., Maciejewski, W., Thomas, M., & Lo, J. (2016). The Mathematics Attitudes and Perceptions Survey: An instrument to assess expert-like views and dispositions among undergraduate mathematics students. *International Journal of Mathematical Education in Science and Technology*, 47(6), 917-937.
<http://dx.doi.org/10.1080/0020739X.2015.1133854>
- Cohrssen, C., & Tayler, C. (2016). Early childhood mathematics: A pilot study in preservice teacher education. *Journal of Early Childhood Teacher Education*, 37(1), 25-40.
- Coller, R.J. & Kuo, A.A. (2014). Youth development through mentorship: a Los Angeles school-based mentorship program among Latino children. *Journal of Community Health*. 316-321.
- Cooney, T. J. (2001). Considering the paradoxes, perils, and purposes of conceptualizing teacher development. In F. Lin, & T. J. Cooney (Eds.), *Making sense of mathematics teacher education* (pp. 9–31).
- Creasey, G., Mays, J., Lee, R., & D’Santiago, V. (2016). A survey to assess barriers to urban teaching careers. *Urban Education* (Beverly Hills, Calif.), 51(7), 748-769.
<https://doi.org/10.1177/0042085914549359>
- Dede, Y. (2009). Turkish preservice mathematics teachers’ mathematical values: Positivist and constructivist values. *Scientific Research and Essays*, 4(11), 1229-1235
- Dell’Angelo, T. (2014). Creating classrooms for social justice. *Edutopia*.
<https://www.edutopia.org/blog/creating-classrooms-for-social-justice-tabitha-dellangelo>
- Duncombe, C. (2017). Unequal opportunities: Fewer resource, wore outcomes for students in schools with concentrated poverty. *The Commonwealth Institute*.
- D’Urso, Maynard, A., Petruccelli, I., Di Domenico, A., & Fasolo, M. (2023). Developing Inclusivity from Within: Advancing Our Understanding of How Teachers’ Personality Characters Impact Ethnic Prejudice and Homophobic Attitudes. *Sexuality Research & Social Policy: Journal of NSRC*. <https://doi.org/10.1007/s13178-022-00788-7>
- Easley, J. (2020). Educator preparation programs lead the way for racial and social justice for all. *Diverse Issues in Higher Education*.
<https://www.diverseeducation.com/demographics/african-american/article/15108195/educator-preparation-programs-lead-the-way-for-racial-and-social-justice-for-all>
- Elburn, S. J., Cooper, M. A., & Conners, K. J. (2017). Salisbury University and Snow Hill Elementary: Creating and Sustaining a Rural Title I PDS Partnership. *School-University Partnerships*, 10(2), 3-7.

- Enterline, S., Cochran-Smith, M., Ludlow, L. H., & Mitescu, E. (2008). Learning to teach for social justice: Measuring change in the beliefs of teacher candidates. *The New Educator*, 4(4), 267-290.
- Fachrudin, A. D., Widadah, S., & Kusumawati, I. B. (2019). Pre-service mathematics teachers' knowledge, beliefs, and attitude toward using PISA-based problems in mathematics education. *Journal of Physics. Conference Series*, 1200(1), 12013. <https://doi.org/10.1088/1742-6596/1200/1/012013>
- Fennema, E., & Sherman, J. A. (1976). Mathematics Attitudes Scales: Instruments Designed to Measure Attitudes toward the Learning of Mathematics by Females and Males. *Journal for Research in Mathematics Education*, 7(5), 324–326. <https://doi.org/10.2307/748467>
- Ferguson, L. J., Girolami, T., Thorstad, R., Rodgers, C. D., & Humbert, M. L. (2021). "that's what the program is all about... building relationships": Exploring experiences in an urban offering of the indigenous youth mentorship program in Canada. *International Journal of Environmental Research and Public Health*, 18(2), 733. <https://doi.org/10.3390/ijerph18020733>
- Fitzsimmons, G. E. (1999). Values, vocational education and mathematics: Linking research with practice. Paper presented at the 7th Annual International Conference on Post-Compulsory Education and Training, Brisbane, Australia.
- Flores, I. M. (2015). Developing preservice teachers' self-efficacy through field-based science teaching practice with elementary students. *Research in Higher Education Journal*, 27.
- Fogg-Rogers, L., Lewis, F., & Edmonds, J. (2017). Paired peer learning through engineering education outreach. *European Journal of Engineering Education*, 42(1), 75-90.
- Gay, G. (2002). *Culturally responsive teaching: theory, research and practice*. New York: Teachers Press.
- Geist, E. (2010). The anti-anxiety curriculum: Combating math anxiety in the classroom. *Journal of Instructional Psychology*, 37(1), 24.
- Gewertz, C. (2020, December 2). Teaching Math Through a Social Justice Lens. *Education Week*, 40(15), 14. https://link.gale.com/apps/doc/A644695972/BIC?u=vic_liberty&sid=summon&xid=d8e6d07c
- Goodykoontz, E. (2009). *Factors that affect college students' attitudes toward mathematics*. http://sigmaa.maa.org/rume/crume2009/Goodykoontz_LONG.pdf

- Gonzalez-DeHass, A. R., Furner, J. M., Vásquez-Colina, M. D., & Morris, J. D. (2021). Achievement goals as predictors of female pre-service elementary school teachers' self-efficacy for learning math in a methods course. *Journal of Early Childhood Teacher Education*, 1-20. <https://doi.org/10.1080/10901027.2021.1955052>
- Gorski, P.C. (2014). *Reaching and teaching students in poverty: Strategies for easing the opportunity gap*. New York: Teachers College Press.
- Gunderson, E. A., Ramirez, G., Levine, S. C., & Beilock, S. L. (2012). New directions for research on the role of parents and teachers in the development of gender-related math attitudes: Response to commentaries. *Sex Roles*, 66(3-4), 191-196. <https://doi.org/10.1007/s11199-011-0100-8>
- Hadley, K. M. & Dorward, J. (2011). The relationship among elementary teachers' mathematics anxiety, mathematics instructional practices, and student mathematics achievement. *Journal of Curriculum and Instruction (JoCI)*, 5(2), 27-44.
- Hagerman, D., & Porath, S. (2018). The possibilities of teaching for, with, and about social justice in a public middle school. *Middle School Journal*, 49(5), 26-34. <https://doi.org/10.1080/00940771.2018.1509561>
- Hollingsworth, H. L., & Knight-McKenna, M. (2018). "I am now confident": academic service-learning as a context for addressing math anxiety in preservice teachers. *Journal of Early Childhood Teacher Education*, 39(4), 312-327
- Hourigan, M., Leavy, A. M., & Carroll, C. (2016). 'Come in with an open mind': Changing attitudes towards mathematics in primary teacher education. *Educational Research (Windsor)*, 58(3), 319-346. <https://doi.org/10.1080/00131881.2016.1200340>
- Jackson, C. D., & Leffingwell, R. J. (1999). The role of instructors in creating math anxiety in students from kindergarten through college. *Mathematics Teacher*, 92(7), 583– 586.
- Jacobs, J., & Perez, J. I. (2023). A qualitative meta synthesis of teacher educator self-studies on social justice: Articulating a social justice pedagogy. *Teaching and Teacher Education*, 123, 103994. <https://doi.org/10.1016/j.tate.2022.103994>
- Jong, C., & Hodges, T. E. (2015). Assessing attitudes toward mathematics across teacher education contexts. *Journal of Mathematics Teacher Education*, 18(5), 407-425. <https://doi.org/10.1007/s10857-015-9319-6>
- Leonard, J., & Moore, C. M. (2014). Learning to enact social justice pedagogy in mathematics classrooms. *Action in Teacher Education*, 36(1), 76-95.
- Kelly, W.P., & Tomhave, W.K. (1985). A study of math anxiety/math avoidance in preservice elementary teachers. *Arithmetic Teacher*, 32, 51-53.

- Kowalski, K., Pretti-Frontczak, K., & Johnson, L. (2001). Preschool teachers' beliefs concerning the importance of various developmental skills and abilities. *Journal of Research in Childhood Education, 16*, 5–14
- Kuru, O. (2018). Analysis of classroom teaching candidates' speaking self-efficacy in terms of different variables. *International Journal of Education & Literacy Studies, 6*(3), 76-83. <https://doi.org/10.7575/aiac.ijels.v.6n.3p.76>
- Lake, V. E., & Kelly, L. (2014). Female preservice teachers and mathematics: Anxiety, beliefs, and stereotypes. *Journal of Early Childhood Teacher Education, 35*(3), 262–275. doi:10.1080/10901027.2014.936071
- Lee, J. S., & Ginsburg, H. P. (2007). Preschool teachers' beliefs about appropriate early literacy and mathematics education for low- and middle-socioeconomic status children. *Early Education and Development, 18*(1), 111–143.
- Leyva, E., Walkington, C., Perera, H., & Bernacki, M. (2022). Making mathematics relevant: An examination of student interest in mathematics, interest in STEM careers, and perceived relevance. *International Journal of Research in Undergraduate Mathematics Education, 8*(3), 612-641. <https://doi.org/10.1007/s40753-021-00159-4>
- Liew, J., Lench, H.C., Kao, G., Yeh, Y-C., K, O. (2014). Avoidance temperament and social-evaluative threat in college students' math performance: A mediation model of math and test anxiety. *Anxiety, Stress, & Coping: An International Journal, 27*, 650-661.
- Loughran, J. (2006). *Developing a pedagogy of teacher education: Understanding teaching and learning about teaching*. Taylor & Francis.
- Majeed, A. A., Darmawan, I. G. N., & Lynch, P. (2013). A confirmatory factor analysis of attitudes toward mathematics inventory (ATMI). *The Mathematics Educator, 15*(1), 121-135.
- Martinez, M. A. (2015). Engaging aspiring educational leaders in self-reflection regarding race and privilege. *Reflective Practice, 16*(6), 765-776. <https://doi.org/10.1080/14623943.2015.1095727>
- Mezirow, J. (1994). Understanding transformation theory. *Adult Education Quarterly, 44*(4), 222-232.
- Mezirow, J. (1997). Transformative learning: Theory to practice. In P. Cranton (Ed.), *Transformative learning in action: Insights from practice – New directions for adult and continuing education*, No. 74 (pp. 5-12). Jossey-Bass.
- Mezirow, J. (2000). *Learning as transformation: Critical perspectives on a theory in progress*. Jossey-Bass.

- Mezirow, J. (2003). Transformative learning as discourse. *Journal of Transformative Education*, 1(1), 58-63.
- Midgley, C., Feldlaufer, H., & Eccles, J. S. (1989). Student/teacher relations and attitudes toward mathematics before and after the transition to junior high school. *Child Development*, 60(4), 981-992. <https://doi.org/10.2307/1131038>
- Michaluk, L., Stoiko, R., Stewart, G., & Stewart, J. (2018). Beliefs and attitudes about science and mathematics in pre-service elementary teachers, STEM, and non-STEM majors in undergraduate physics courses. *Journal of Science Education and Technology*, 27(2), 99-113. <https://doi.org/10.1007/s10956-017-9711-3>
- Murayama, K., Pekrun, R., Suzuki, M., Marsh, H. W., & Lichtenfeld, S. (2016). Don't aim too high for your kids: Parental over aspiration undermines students' learning in mathematics. *Journal of Personality and Social Psychology*, 111(5), 766-779. <https://doi.org/10.1037/pspp0000079>
- National Council of Teachers of Mathematics (NCTM). (1989). *Curriculum and evaluation standards for school mathematics*. National Council of Teachers of Mathematics.
- National Center for Education Statistics. (2023). *College enrollment rates*. <https://nces.ed.gov/programs/coe/indicator/cpb>
- Nelson, K., Sabel, J., Forbes, C., Grandgenett, N., Tapprich, W., & Cutucache, C. (2017). How do undergraduate STEM mentors reflect upon their mentoring experiences in an outreach program engaging K-8 youth? *International Journal of STEM Education*, 4(1), 1-13.
- Novak, E., & Tassell, J. L. (2017). Studying preservice teacher math anxiety and mathematics performance in geometry, word, and non-word problem solving. *Learning and Individual Differences*, 54, 20-29.
- Norton, S. (2019). Middle school mathematics pre-service teachers' content knowledge, confidence and self-efficacy. *Teacher Development*, 23(5), 529-548. <https://doi.org/10.1080/13664530.2019.1668840>
- Öçal, T. (2021). 'I remembered this mathematics course because.': How unforgettable mathematics experiences of pre-service early childhood teachers are related to their beliefs. *International Journal of Mathematical Education in Science and Technology*, 52(2), 282-298. <https://doi.org/10.1080/0020739X.2020.1861349>
- Page-Gould E, Mendoza-Denton R, Tropp LR. (2008). With a little help from my cross- group friend: reducing anxiety in intergroup contexts through cross-group friendship. *Journal of Personality and Social Psychology*. 95(5):1080–1094. doi: 10.1037/0022-3514.95.5.1080
- Panthi, R.M., Luitel, B.C., Belbase, S. (2017). Teachers' perception of social justice in mathematics education. <https://files.eric.ed.gov/fulltext/ED573753.pdf>

- Peker, M. (2009b). Pre-service teachers' teaching anxiety about mathematics and Their learning styles. *Eurasia Journal of Mathematics, Science & Technology Education*, 5(4), 335-345.
- Polly, D., & Colonnese, M. W. (2022). Developing elementary education candidates' skills to elicit and interpret student thinking through a mathematics tutoring clinical experience. *Early Childhood Education Journal*, 50(3), 435-444. <https://doi.org/10.1007/s10643-021-01152-x>
- Rech, J., Hartzell, J., & Tephens, L. (1993). Comparisons of mathematical competencies and attitudes of elementary education majors with established norms of a general college population. *School Science and Mathematics*, 93(3), 141-145.
- Rittle-Johnson, B., Farran, D.C., Durkin, K.L. (2020). Marginalized students' perspectives on instructional strategies in middle school mathematics classrooms. *The Journal of Experimental Education*. 89(4) 569-586. <https://doi.org/10.1080/00220973.2020.1728513>
- Roegman, R., Goodwin, A.L., Lee, C.C., (2020). Social justice-oriented teacher preparation in political contexts. *International Journal of Qualitative Studies in Education*. 34(2) 145-167.
- Russo, J., Bobis, J., Downton, A., Feng, M., Hughes, S., Livy, S., McCormick, M., & Sullivan, P. (2021). Characteristics of high enjoyment teachers of mathematics in primary schools. *Mathematics Education Research Journal*, 1-21. <https://doi.org/10.1007/s13394-021-00372-z>
- Ruppert, N. B., Coleman, B., Pinter, H., Johnson, D. T., Rector, M., & Diaz, C. (2022). Culturally sustaining practices for middle level mathematics teachers. *Education Sciences*, 12(12), 910. <https://doi.org/10.3390/educsci12120910>
- Saylor, L. L., & Walton, J. B. (2018). Creating a math-talk learning community with preservice teachers. *School Science and Mathematics*, 118(8), 348-357.
- Stein, S. J. (2004). *The culture of education policy*. Teachers College Press.
- Tapia, M., & Marsh, G. (2000). *Attitudes toward mathematics instruments: An investigation with middle school students*. Paper presented at the annual meeting of the Mid-South Educational Research Association, Bowling Green, Kentucky.
- Tapia, M., & Marsh, G. (2002). *Confirmatory factor analysis of the attitudes toward mathematics inventory*. Paper presented at the annual meeting of the Mid-South Educational Research Association, Chattanooga, Tennessee.
- Tapia, M., & Marsh, G. (2004). An instrument to measure mathematics attitudes. *Academic Exchange Quarterly*, 8(2), 1-8.

- Thiel, O. (2010). Teachers' attitudes towards mathematics in early childhood education. *European Early Childhood Education Research Journal*, 18(1), 105-115. <https://doi.org/10.1080/13502930903520090>
- Tomlinson, C.A. (2017). *How to differentiate instruction in an academic diverse classroom*. (3rd Ed.). ASCD: Alexandria, VA.
- Unlu, M., Ertekin, E. & Dilmac, B. (2017). Predicting relationships between mathematics anxiety, mathematics teaching anxiety, self-efficacy beliefs towards mathematics and mathematics teaching. *International Journal of Research in Education and Science (IJRES)*, 3(2), 636- 645. DOI: 10.21890/ijres.328096
- Varol, F. (2013). What they believe and what they do. *European Early Childhood Education Research Journal*, 21(4), 541–552.
- Walsh, K., Drake, G., & Holston, S. (2022). *Teacher prep review: Preparation for teaching elementary mathematics*. National Council on Teacher Quality. https://www.nctq.org/dmsView/NCTQ_Teacher_Prep_Review_Preparation_for_Teaching_Elementary_Mathematics_2022.
- Yıldız, A., Baltacı, S. & Kartal, B. (2020). Examining the relationship between pre-service mathematics teachers' mathematical thinking level and attitude towards mathematics courses. *Acta Didactica Napocensia*, 13(2), 256-270, <https://doi-org.ezproxy.liberty.edu/0.24193/adn.13.2.17>
- Young, M., Mountford, M., & Skrla, L. (2006). Infusing gender and diversity issues into educational leadership programs: Transformational learning and resistance. *Journal of Educational Administration*, 44(3), 264–277
- Yu, M. V. B., Liu, Y., Soto-Lara, S., Puente, K., Carranza, P., Pantano, A., & Simpkins, S. D. (2021). Culturally responsive practices: Insights from a High-Quality math afterschool program serving underprivileged Latinx youth. *American Journal of Community Psychology*, 68(3-4), 323-339. <https://doi.org/10.1002/ajcp.12518>
- Zerpa, C., Kajander, A., & Van Barneveld, C. (2009). Factors that impact preservice teachers' growth in conceptual mathematical knowledge during a mathematics methods course. *International Electronic Journal of Mathematics Education*, 4(2), 57-76.
- Zrike, S., & Connolly, C. (2015). Problem solvers: Teacher leader teams with content specialists to strengthen math instruction. *The Journal of Staff Development*, 36(1), 20.