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Feminist-Infused Participatory Action Research to Promote Female Students' Self- Efficacy in Mathematics

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Dedication

This dissertation is dedicated to my family who have supported me throughout my educational pursuits. To my parents, thank you for teaching me the importance of education and always believing in me, as well as your unwavering support of this process, including the thousands of pages read, hundreds of coffee runs, and infinite encouragement. To my fiancé, thank you for all that you have taken on so that I could focus on my studies and supporting me through the ups and downs of this process. To my brother, the model you have set for me and all that you have accomplished is what has pushed me to achieve new feats.

I also dedicate this dissertation to the students and educators who have inspired me. To every girl who has viewed math as a "pitch black room," this is for you. To all of the passionate teachers who I am so fortunate to work with, who pour their hearts and souls into their practice each day so that their students may have the best possible learning experiences, this is for you.

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Finally, I must acknowledge the teacher-researchers who volunteered to join me in this emancipatory work. Your dedication to your students and willingness to engage in self-reflection have made this research possible. I am so proud to call you my colleagues.

Abstract

Prompted by the manifestations of decreased levels of mathematical self-efficacy among the female students in my district, the purpose of this study was to investigate the source of self-efficacy development that was most influential among our female students and engage in praxis to combat these gender inequities. Grounded in critical feminist theory, I engaged six teacher-researchers in participatory action research through qualitative methodologies. Using questionnaires to examine the worldviews of our female students, the emergent study was guided by these voices which were previously silenced. The interventions employed were a direct result of the females' expressed mathematical experiences, leading us to target physiological states as the source of self-efficacy development. Through a series of focus groups, the team of teacher-researchers collaboratively generated, evaluated, and revised an action plan of interventions aimed at supporting female self-efficacy development in math by attending to factors that produce and exacerbate negative physiological states. The interventions employed throughout the reflexive action plan cycles included math-focused morning meetings, journaling, a coping toolkit, role model interaction, and home connections. The evolving action plan allowed us to combat the hegemonic and androcentric culture of mathematics that oppresses female self-efficacy development and limits females' access to and participation in mathematical learning.

Keywords: self-efficacy, mathematics, gender, critical feminist theory, participatory action research

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Chapter 1

Introduction

A grin spread across my face as I took a step back to scan the empty classroom, awaiting the arrival of my new students. As my eyes moved from the math tool bins I had strategically built at each table station to the 'math talk' prompts posted on the whiteboard, I nodded with satisfaction. Although I had taught math before as a fourth-grade generalist educator, moving to fifth grade for the launch of the departmentalized structure would allow me to focus solely on mathematics, reigniting a spark of passion and determination to master instruction in this field. After a summer replete with professional development institutes, readings, and lesson planning all centered around exploratory and conceptual mathematics, I was ready to embark on this journey.

With the first class underway, I tasked my students with an assignment: Draw a mathematician. While I had anticipated that students would sketch adults with the stereotypical glasses-and-lab-coat look, I was not prepared for the phenomenon that permeated my four classes, or the discussions that ensued. As I circulated the room, I observed as one female student after another drew male mathematicians. By the end of the day, 68 of the mathematicians drawn were male, even though my 86 students were equally split in terms of gender. My curiosity piqued, I asked my students what they thought was the reasoning behind this pattern. The question was met with honest reflections, such as, "Because girls are better at reading and writing, and boys are better *at math and science," and "In the world, like on TV, you really only see guys as mathematicians." These insights were shared matter-of-factly, as if such assertions did not need to be challenged or even verbalized. I suddenly realized how unprepared I was. When I had taken a step back to scan my classroom prior to the students' arrival, I did not step back far enough. I had spent the summer pouring over my lessons to ensure that I was teaching to the deep understandings my students would need to be mathematicians, but how could my female students fully invest themselves in a field in which they did not think they could ever be successful?*

In the microcosm of my fifth-grade mathematics class, divergences across genders with regard to students' beliefs about their mathematical potential were readily apparent. The mathematician-drawing activity and student insights that followed became an epiphanic moment for me. Throughout the remainder of the school year, I became more attentive to these self-perceptions, as I observed my female students hesitantly beginning their responses with, "I'm not sure if this is right," or taking passive roles in group work situations. Female students more often shut down when presented with challenging math tasks and avoided taking risks in the math classroom. The mother of one of my female students even called the school wanting to opt out of state testing because her daughter was too anxious about the math assessment. Synthesizing these observations with our class discussions at the start of the school year, I pondered how my female math students could possibly achieve at high levels if they saw themselves as lacking mathematical potential, potential that society continuously affirms their male counterparts possess.

Problem of Practice

Albert Bandura's notion of self-efficacy holds that some people believe individuals have innate ability levels that are set, while others believe ability is acquired and flexible; for those who subscribe to innate-based ideology, self-evaluations of capability influence present and future experiences (Bandura, 1993). Intertwined with cognitive, motivational, affective, and selection processes, self-efficacy influences feelings, ways of thinking, motivation, and behavior (Bandura, 1993). Low self-efficacy leads to task avoidance, decreased goal-setting, low perseverance, increased perceptions of failure, and heightened anxiety (Bandura, 1993). The self-efficacy beliefs females hold in relation to mathematics are especially important to consider given the androcentric culture of mathematics and the associated gender stereotypes that label males as being mathematically superior (Steele, 2010; Frankenstein, 1992). Not only is it possible that stereotype threat may already be negatively impacting the development of mathematical self-efficacy among the females in the context of this study, but positive self-efficacy beliefs in math are vital for females as they navigate an oppressive society beset with biases that favor males in math.

The aforementioned expressions and observations of negative self-beliefs in math among my female students were especially troubling given that our district educators explicitly teach about and promote growth mindset ideology. This notion that talents and abilities are flexible and developed through effort as opposed to innate ability stems from self-efficacy theory (Bandura, 1993; Dweck, 2017). Also serving as an instructional math coach at the time that this study was conceptualized, my classroom was actually a launching point for these mindset shifts among teachers and students, but clearly, not all students were internalizing the intended impact on mindsets and self-beliefs. There was a disconnect between the growth mindset ideology we believed we were teaching all students and the low math self-efficacy manifesting among the female population.

These inequities in mathematical experiences not only apply to the context of the present study but are also encountered at the macro level. Females in the United States are less likely than males to hold careers in the science, technology, engineering, and math (STEM) fields, with the largest gender gap appearing in the computer science and mathematical fields. These participation disparities are also visible in higher-level high school and college math courses, as well as undergraduate and graduate mathematical degree programs (Boaler, 2016; Hill, Corbett, & St. Rose, 2010). Perceptions of mathematical intelligence, acceptance of gender stereotypes, variance in self-assessment, and implicit bias, have all shown significant correlation with female disassociation from mathematics (Hill et al., 2010). Persisting stereotypes that disregard neuroscience have cultivated the perception across our society that females are less mathematically capable than males, a belief that has been internalized by female students (Jones, 2010). Therefore, addressing negative self-beliefs among female students and empowering them with the cognizance of their mathematical potential is necessary in order to reduce the threat of negative stereotypes and strengthen female engagement in mathematics, a postulate that has already begun to acquire empirical support (Jones, 2010). Bandura (1993) affirms:

> The stronger people's belief in their efficacy, the more career options they consider possible, the greater the interest they show in them, the better they

prepare themselves educationally for different occupations, and the greater their staying power and success in difficult occupational pursuits. (p. 135)

The amalgamation of the above trends and findings with respect to female math self-efficacy and females' attitudes toward and participation in mathematics presents significant implications for educators. If math self-efficacy is playing a role in the construction of inequitable educational experiences in math across our female and male students and gender disparities in the number of professionals entering the field of mathematics, then as educators, we have the responsibility to investigate what is causing this lower self-efficacy and how we can strengthen female students' positive self-efficacy beliefs in mathematics; this problem of practice is the focus of the study outlined here.

Theoretical Framework

The present study is grounded in a framework that derives from feminist, critical, social cognitive, self-efficacy, and social constructivist theories. The former two theories are enacted through their cross-section as critical feminist theory, viewing the world through critical lenses to engage in praxis toward social justice (Gannon & Davies, 2012). Self-efficacy theory, deriving from social cognitive theory, is central to the phenomenon that was investigated, describing self-beliefs of one's capabilities to succeed in a given area. Social constructivism, a theory in which the aforementioned theories are situated, holds that multiple truths exist through interactions between the individual and lived experiences in society (Merriam & Tisdell, 2016).

Feminist theory brings female perspectives to the forefront of social research, not only including females in the research process but also asking the questions that confront gender marginalization (Hesse-Biber, 2012). The emancipatory goals of feminist theory align with the aims of critical theory, seeking to promote discourse around equity and inclusion, disrupt hierarchical power structures, and bring about social change (Gannon & Davies, 2012; Hesse-Biber, 2012). This alignment takes the form of critical feminist theory, the overarching framework of the present study. Through critical feminist theory and inquiry, the present study's intent was to challenge the marginalization of female students in our society with regard to mathematics. Merriam and Tisdell (2016) purport, "In critical inquiry, the goal is to critique and challenge, to transform and empower" (p. 10). Upholding the commitment to critical feminist theory of not only interpreting social injustices but also transforming marginalizing structures (Gannon & Davies, 2012), the teacher-researchers and I, as the administrator-researcher, critically analyzed our praxis, guided by student worldviews, and took action to confront the oppression female students experience in the math field. Such reflexivity is ingrained in the tenets of feminist theory and critical theory (Gannon & Davies, 2012). As educators, and researchers, we have an obligation to be reflective in analyzing our own practices that may promote marginalization, as well as fight against injustices that occur at the macro-level. This study sought to bring about local social change by altering educational practices to promote female self-efficacy in the field of mathematics.

Through the lens of critical feminist theory, a key framework that guided the study was Bandura's self-efficacy theory, a sub-theory of social cognitive theory which emphasizes the role of human agency in behavior (Bandura, 1989). Bandura (1977) links behavior to expectations through self-efficacy theory, purporting that whether or not someone engages in and puts forth effort into an activity is highly dependent on his or her beliefs about whether or not success will be achieved. As affirmed by Bandura (1977), the four sources through which self-efficacy derives include: (a) mastery experience, the successes and failures one encounters with the activity, (b) vicarious experience, observing similar individuals perform the task and perceptions of the outcomes, (c) verbal persuasion, encouragement from others that one can succeed, and (d) physiological states, emotional arousal such as anxiousness or fear. The concept of self-efficacy as it pertains to gender and mathematics and the sources that lead to varying levels of self-efficacy were at the core of this study.

Another theoretical base influencing the study was social constructivism. Social constructivism maintains that there are multiple realities and individuals make meaning through their own interactions with society, rather than there being one truth awaiting researcher discovery (Merriam & Tisdell, 2016). This study was developed to understand self-efficacy in math from the perspectives of female students, as well as from the perspectives of math teachers. The participants' lived experiences, reflection on their self-efficacy beliefs, and interpretations of the impact of such beliefs on their interactions with society guided this research. The study was also grounded in social constructivism through the underlying approach to mathematics instruction present in the setting. The current study was initiated amidst the target district's multiyear rollout of a new mathematics curriculum and instructional approach grounded in student-centered and inquiry-based exploratory learning focused on the development of conceptual understandings through collaborative learning. The tenets of social constructivism hold that understanding and meaning in math are constructed socially (Bozkurt, 2017). Ernest (1991) further supports this framework, contending that making sense of mathematics is a "social process" because language is used as a means of transferring subjective understandings into objective ones (p. 42). Additionally, Chi and Wylie (2014) write, "Constructivism translates to instruction by encouraging a variety of learner-controlled or learner-centered activities such as discovery, hands-on, experiential, collaborative, project-based, and task-based learning" (p. 239). These tenets are woven throughout the district's new instructional framework for mathematics.

The conception of the study was initiated by my critical analyses of gender disparities in mathematical experiences among my math students, an act that in itself aligns with critical feminist theory (Gannon & Davies, 2012). My decision to further pursue these inequities with the intent of taking action to target social injustices materializing in the classroom adheres to the critical feminist framework. The described inequities were observed through manifestations of low self-efficacy among my female students, the belief system that was investigated. Social cognitive theory, from which self-efficacy theory derives, as well as critical feminist theory, emerged from social constructivist theory, the notion that knowledge is situated within individuals' experiences and impacted by power relationships (Bandura, 1989; Hesse-Biber, 2012; Lykes & Hershberg, 2012). Upholding this ideology, the present study rejects the masculine worldviews that dominate traditional research and fail to represent the truths of those excluded from the knowledge-construction process (Hesse-Biber, 2012; Lykes & Hershberg, 2012). Rather, the study takes the form of qualitative participatory action research, placing the worldviews of the oppressed at the forefront.

Research Questions

The purpose of this study was to (a) uncover the most influential source of self-efficacy among elementary-level female students in mathematics, (b) use this knowledge to design and study the impact of gender-focused changes to the classroom-based practice of six elementary-level mathematics teachers who engaged in three cycles of participatory action research, and (c) examine my efforts to support these teachers as they engaged in collaborative inquiry focused on gender-related problems of practice.

The research question to be investigated was: *As an administrator-researcher in collaboration with teachers, how can we promote positive self-efficacy beliefs among female students in mixed-gender mathematics classes?*

The sub-questions were: *(a) What are the most influential sources of mathematics self-efficacy development among females? (b) How can teachers modify classroom practice to address common gender disparities in mathematical self-efficacy? (c) As an administrator-researcher, what methods are effective in prompting feminist-infused critical inquiry among teachers?*

If we can better understand female self-efficacy in math and implement strategies to develop positive math self-beliefs, then according to the notions of Bandura (1993), we can increase female students' effort and participation in mathematical experiences. This is our responsibility as educators, to ensure that our female and male students have the same mathematical opportunities open to them. Therefore, it is imperative that we begin this emancipatory work by strengthening our consciousness of female math experiences and the sources that are impacting their self-efficacy beliefs so that we may engage in praxis aligned with their lived experiences through targeted strategy implementation, simultaneously increasing our critical awareness as educators.

Positionality

In line with the emergent nature of action research (Herr & Anderson, 2015), from the time that I completed the first draft of this dissertation to the time that I revisited my writing for revision, the study had already changed shape. While the idea for this study first began to form when I was a classroom teacher, I have now stepped into an administrative role within the same district. This change in position required a reshaping of the study in order to maintain its authenticity. Although I no longer have a classroom of my own, abandoning the critical feminist study of female self-efficacy in mathematics would be an injustice to the students of my district. Therefore, drawing on my own classroom experiences, I aimed to engage teachers in participatory action research to uncover how our current learning environments align with macro-level systems that foster disparities in mathematical self-efficacy across genders and what interventions we could implement to develop positive math self-efficacy among our female students.

Critical feminist theory holds that all research is inherently subjective (Gannon & Davies, 2012). Reflection on one's positionality, including values, attitudes, biases, socioeconomic background, experiences, and assumptions, is viewed in feminist theory as not only necessary but increasing the objectivity of the research (Hesse-Biber, 2012). Disclosing my positionality upholds the values of feminist theory and strengthens the validity of the study in maintaining transparency (Herr & Anderson, 2015). Being female, my identities and experiences with gender and mathematics shape my connection to the participants, as well as bias my interpretations. Growing up, I developed a negative self-concept with regard to mathematics, especially in comparison to my high-achieving brother. While I would be deemed as successful based on my grades and acceptance into honors classes, these achievements were really products of my survival tactics, such as the ability to memorize formulas and procedures or relying on my brother for support. As the work became more challenging, I lost confidence in my ability to truly understand the material and saw myself in terms of the fixed mindset ideology of not being a ‘math person’ (Boaler, 2016). Although these experiences bias my interpretation, they also offer insider positionality due to my ability to connect with female participants who have also experienced low self-efficacy in math. Additionally, being an administrator within the school building afforded me another element of insider positionality; however, the power relationships in play and the reality that I am not a consistent presence in the classrooms also create outsider positionality. Throughout the study, I needed to be reflective of the role my outsider positionality may have been playing in the data collection. My position of power may have biased responses from participants, as they may have been responding in ways that they believed I would want them to.

Research Design

Guided by critical feminist theory, the teacher-researchers and I engaged in participatory action research to examine female students’ self-efficacy in mathematics. Keeping the worldviews of students and teachers at the forefront of the study, qualitative methodologies were applied throughout the data collection process, drawing on facets of constructivist grounded theory to conduct emergent analyses. Interconnections between the research design and theoretical framework for the study are presented in Figure 1.1. The research methodologies and their alignment to the theoretical framework are discussed prior to outlining specific instrumentation and data analyses applied in order to provide the necessary framework for understanding the theoretical influence on methodological decisions made.

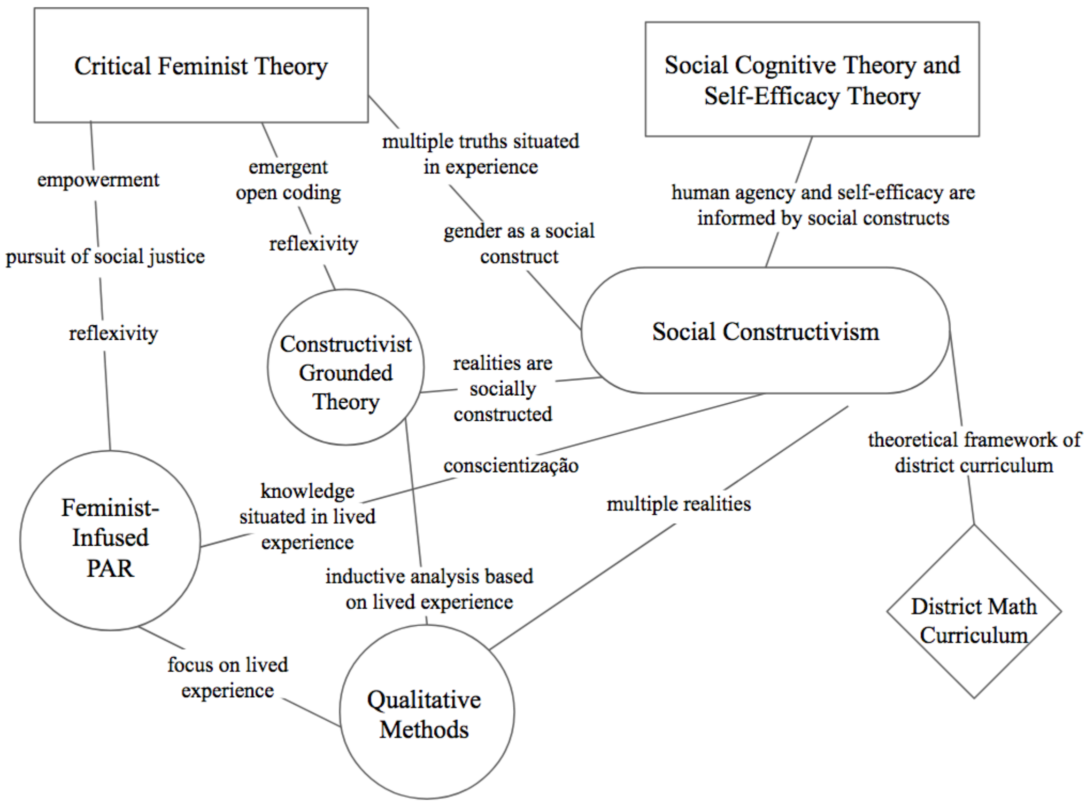

Figure 1.1 The conceptual framework is partially conveyed through the connections between the theoretical framework guiding the study and aligned methodology.

Action research grounded in the tenets of Paulo Freire seeks to unveil injustices in society and bring about social change (Herr & Anderson, 2015). Freire (1974) promulgated the importance of conscientização, or critical consciousness, in education, affirming that we must not passively receive knowledge, but rather, become critically aware of our world and the dehumanizing structures present in order to transform them. Conscientização is central to the emancipatory nature of what Lykes and Hershberg (2012) term “feminist-infused” action research and participatory action research (PAR).

Deriving from action research, PAR emphasizes collaboration among stakeholders in the setting (Herr & Anderson, 2015). Freire points to PAR as a means of inspiring reflection and critical analysis, key responsibilities of all educators (Brydon-Miller & Maguire, 2008; Freire, 2005). Through such critical consciousness, we are able to be guided toward praxis by attending to the truths of the oppressed, truths that have been socially constructed (Freire, 2005). These multiple realities are recognized through qualitative research. Aligning with the feminist and social constructivist frameworks of the study, the intent of qualitative research is to gain insight and understanding with regard to individuals' lived experiences (Merriam & Tisdell, 2016). Constructivist grounded theory, a defining application of qualitative methodology, also builds on social constructivism, as it promotes research that keeps the participants' lived experiences at the forefront of the study through inductive and emergent analyses (Charmaz, 2000).

Contextualization of the Theoretical Framework

In alignment with the responsibilities asserted by Freire and characteristics of action research, the present study was developed through reflection on my female students' self-efficacy relating to mathematics. Unlike traditional research in which the power lies with the researcher who is an outsider to the setting, through PAR, I worked collaboratively with teacher-researchers who are insiders to the setting, encouraging them to critique the social underpinnings of their practice and analyze how gender marginalization is perpetuated in a system that ignores gender disparities in math self-efficacy (Herr & Anderson, 2015). The teacher-researchers and I first analyzed the problem of practice, then developed, implemented, and revised interventions to foster female math self-efficacy, and finally reflected on the impact of such actions. This collaborative inquiry was characteristic of both critical theory and constructivist feminist research (Lykes & Hershberg, 2012). In describing feminist-infused PAR, Lykes and Hershberg (2012) affirm that "it is through relationships that participants are transformed" (p. 354). Embodying the reflexive nature of action research and critical feminist theory, the study emerged as we collaboratively moved through the cyclical research process (Gannon & Davies, 2012; Herr & Anderson, 2015; Merriam & Tisdell, 2016).

Embedded in the fundamental goals of this study was the examination of the ways in which the participants make sense of their realities: How do educators view the interplay of gender and self-efficacy in their math classes, and how do female students view their roles and abilities in relation to mathematics in our society? In qualitative research, the focus is on the emic perspective, or participant viewpoints, making this a suitable approach (Merriam & Tisdell, 2016). Drawing on social cognitive theory, this study aimed to develop an understanding of how female students form self-efficacy beliefs relating to math and how such beliefs can be improved. In order to obtain this type of data, a qualitative approach was necessary, as such interpretations cannot, or should not, be reduced to numbers and constrictive collection procedures. Contrary to traditional quantitative research, there was no set hypothesis to be tested; rather, the goal was to collect and analyze data to develop an understanding of effective practices in promoting positive math self-efficacy among females. Aligning with the characteristics of qualitative research through critical feminist theory, the study was inductive, emerging based on the responses of participants, and allowing for immediate reflexivity (Merriam & Tisdell, 2016).

Participants

The study was set in the elementary school of a K-8 district situated in an affluent suburban town in New Jersey. Criterion-based sampling methodology was used to select the teacher-participants and corresponding math classes for the study (Merriam & Tisdell, 2016). Teachers in the middle band of grades, third through fifth, who met the necessary evaluation and experience requirements, were invited to participate in the study on a volunteer basis. The target number of teacher participants was three; however, because the volunteers consisted of a mixture of general education teachers and collaborative teachers (pairs of teachers who co-teach a class of general education students and students with individualized education plans), I decided to select four classes so that there would be an equal balance between collaborative and general education classes. Since two classes were taught collaboratively, this resulted in a total of six teacher participants. The group size allowed for a variety of perspectives while also keeping the sample size small enough to form trusting relationships and obtain detailed data on teacher perspectives. One third-grade general education class, one fourth-grade general education class, one fourth-grade collaborative class, and one fifth-grade collaborative class participated in the study. Across these classes, there were 66 student participants, 31 females and 35 males.

Instruments for Data Collection

Staying true to critical feminist theory, it was essential that female student voices served as the catalyst that launched the study, while also prompting critical inquiry among the teacher-researchers. At the outset of the study, I evoked my transformational leadership leanings, specifically the sub-dimension of "intellectual stimulation" (Avci, 2015, p. 2760) to encourage teacher participants to look at their practice through a critical lens that focused on gender disparities in math self-efficacy. Keeping this lens centered on marginalized female students and reflecting on my own epiphanic experience that initiated this study, I developed an activity-based questionnaire that was administered to students, aimed at bringing to light students' self-perceptions of their capabilities in mathematics. Using both closed-ended and open-ended questions, the questionnaires examined students' "attitudes, beliefs, behaviors or experiences" (Rowley, 2014, p. 309). Rather than setting the interventions for the study *a priori*, based only on the adult perspective, the questionnaires provided vital information on female students' levels of self-efficacy in math and the sources that inform their self-efficacy development, which directly influenced the interventions to be employed. After conducting initial analyses of the student questionnaires, I asked the teacher-researchers to critically examine the data and emergent analyses.

Patterson and Johnson (2017) affirm that focus groups provide "insight into perceptions and feelings, understandings of an experience from a specific population's viewpoint, and deeper understanding of factors that influence behaviors" (p. 86). Similar to individual interviews, focus groups allow the researcher to gather participant perspectives, but such perspectives are molded by group dynamics (Mahoney, 1997). The teacher-researchers joined together in their first focus group, constructing and reflecting on their own perspectives and then, in collaboration with fellow teacher-researchers, looking across the student data and identifying patterns in levels of self-efficacy and sources of self-efficacy development surfacing as being most influential. This prompted the selection of the interventions that were employed. In a cyclical manner, characteristic of critical feminist theory (Gannon & Davies, 2012), the teachers implemented the planned interventions, reflected on the impact of the interventions, and joined together in collaborative focus groups to engage in discourse on the successes and failures of the interventions and make the necessary modifications moving forward. All focus groups were semi-structured in order to gain understandings on specific phenomena related to self-efficacy, gender, and math, while also allowing for the emergence of novel phenomena not yet identified (Merriam & Tisdell, 2016). The use of focus groups supported critical feminist inquiry, as teachers were empowered through the ability to express their insights and having those insights valued (Horn, 2015). Focus groups also allowed for the "genuine engagement and dialogue" that is essential to PAR in which stakeholders are collaborating as a form of social action (Brydon-Miller & Maguire, 2008, p. 88). All focus groups were audio-recorded, allowing for future transcription.

In addition to focus groups, I engaged the teacher-researchers in mid- and post-intervention interviews. The interviews were semi-structured, primarily utilizing open-ended questions that focused the dialogue on the goals of the study, while also allowing for follow-up questions (Brinkmann, 2013). Placing value on the perspectives of teacher-researchers, semi-structured interviews allowed me to prompt critical reflection among the teachers on the interventions they had employed and collect data on the teachers' insights pertaining to the successes and shortcomings of these interventions (Mahoney, 1997). The post-intervention interviews also supported my own reflection as an administrator-researcher on the efficacy of the study in prompting teachers' critical analyses of their practice and engagement in combating classroom inequities.

At the conclusion of the study, the students were once again administered the activity-based questionnaires in order to support educator reflection on the success of the employed interventions. Students were provided with questions relevant to the source of self-efficacy targeted, as well as reflective questions that explicitly inquired about student perceptions of the interventions.

Data Analysis

Rather than conducting research to investigate a pre-proposed theory, constructivist grounded theory seeks to build a theory for a social phenomenon emerging directly from the data collected and analyzed throughout the study (Butterfield, 2009). While the aim of the current study was not to form a general theory about self-efficacy, the study did seek to inductively develop a context-specific course of action believed to promote female math self-efficacy emerging directly from ongoing reflection on the data collected. This cyclical analysis process aligned with the tenets of constructivist grounded theory and upheld the values of critical feminist theory, maintaining a focus on the lived experiences of the oppressed and engaging in emergent reflexivity (Clarke, 2012). Utilizing a constant comparative method of emergent data analysis, the data collected through student questionnaires, focus groups, and teacher interviews were inductively coded through open coding (codes emerging directly from participant responses) and In Vivo coding (codes developed verbatim from participant responses), categorized into groups based on patterns that address the research questions, and recoded with themes (Guest, MacQueen, & Namey, 2012; Merriam & Tisdell, 2016; Saldaña, 2009). Once the themes were inductively developed, the analysis moved to a deductive nature, in which further evidence was sought out to inform the themes that had surfaced. Both inductive and deductive analyses guided the study, informing the ongoing intervention implementation and determining when to conclude the data collection process, which was signaled by saturation, or a lack of novel findings (Merriam & Tisdell, 2016).

Qualitative Validity

Without validity, research cannot achieve its ultimate goal of making a contribution to the field in which it is grounded, nor the practical setting in action research (Merriam & Tisdell, 2016). The methods of validation in this study were multifaceted. Triangulation was central to the study, as student questionnaires, teacher focus groups, and teacher interviews were all used to substantiate findings by identifying commonalities and possible areas of dissonance (Merriam & Tisdell, 2016). Implementing techniques for ensuring qualitative validity is largely a matter of ethicality; researchers have an ethical obligation to conduct their research with diligent reflection and purposeful decision-making (Merriam & Tisdell, 2016). This diligence was maintained through peer review employed throughout all stages of the study, and the use of a researcher log to document the research process and decisions made along the way (Merriam & Tisdell, 2016). In terms of external validity, the report contains thick description, detailing the study's context so that the reader may determine whether or not the findings hold relevant implications for their own settings (Merriam & Tisdell, 2016). Further ethical considerations for qualitative validity included obtaining parental consent for each student participant and affording participants the opportunity to opt out of the study at any point.

Significance of the Study

In discussing societal inequalities and the perceived absence of control over them, Pryor (1995) affirms, "Individuals are not a product just of this one overarching culture but rather of a series of subcultures nesting within each other (e.g. national, regional, social class, school and classroom)" (p. 281). Pryor (1995) suggests that educators take action to counteract societal inequities within their classrooms and schools. This ideology epitomizes critical feminist theory in action research, and mirrors the aim of this study. Herr and Anderson (2015) view action research as an effort toward social justice that occurs in contexts in which there is an imbalance of power and contradictory values. This study embraced these notions, as its intent was to empower my district's female students by combating negative self-perceptions in mathematics due to gender, a step toward overcoming female marginalization.

In my own math class and now in the classes that I oversee, female students have been subjected to inequitable educational practices in math that ignore the decreased levels of math self-efficacy among these students. These negative self-beliefs, which have surfaced through task avoidance, harmful affective responses, low perseverance, decreased risk-taking, and verbalized negative perceptions of self in relation to math, need to be addressed in order to make mathematical learning fully accessible to all students. Whether these negative self-beliefs are stemming from experiences outside of the classroom, resulting from practices inside the classroom, or influenced by an interaction of macro- and micro-levels, we as educators have the responsibility to investigate this problem, critically reflect on our practices, and engage in action to bring about gender equality in the math classroom. While the primary goal of the present study is to effect change in the local context, all individuals in the field of math education, as well as stakeholders outside the school environment, such as parental guardians, have the potential to benefit from the findings of this study in providing their female students with the same mathematical opportunities afforded to males. For those seeking to empower teachers through critical inquiry grounded in feminist theory, the use of feminist-infused PAR and methods of encouraging critique and reflection may also be of interest.

Limitations

Reflections on the limitations of the study continuously point to the element of time. In the public school system in which the study was set, a lack of time is an ongoing concern among teachers, a challenge that surfaced throughout the study as well. With regard to intervention implementation, the lengths of the action plan cycles prohibited long-term intervention implementation prior to teacher reflections. This was a constraint due to the nature of a dissertation study, but also the daunting number of tasks teachers are expected to accomplish in public school settings and non-routine events that impact instruction. At times, interventions could not be employed due to state-mandated social-emotional lessons, inclement weather resulting in delayed openings and school closings, and schoolwide assemblies. Further, while the teacher-researchers wanted to be able to gather additional student feedback on the interventions over the course of the study, this was a challenge as their daily schedules are completely filled with subject-area classes, and pressures to cover all of the state standards make it difficult to take time away from content instruction for individual conversations with students. Teacher schedules, which often include only one 40-minute prep period per day also made it challenging for teachers to have time to reflect on and revise the interventions outside of the time allotted for reflective focus groups and interviews. A further constraint of the dissertation process was that the employed interventions were disconnected from the already-established routines of the classrooms since the study began midway into the school year. Introducing such interventions at the start of the school year could have helped students to view the interventions as natural facets of the classroom environment.

Organization of the Dissertation

In the next chapter, I present a review of the literature regarding self-efficacy in mathematics in relation to gender, as well as the social constructivist, critical feminist, and social cognitive theories that were introduced here. Following the literature review, the qualitative data collection tools, which included questionnaires, focus groups, and interviews, will be outlined along with the constant comparative data analyses applied. The dissertation will then move into a presentation and discussion of the findings of the study, followed by the proposal of an action plan to be implemented in the future in targeting female students' math self-efficacy beliefs.

Glossary of Terms

Action research: research conducted in a systematic and cyclical format to solve a problem identified in one's own setting (Herr & Anderson, 2015)

Conscientização: notion of critical consciousness promoted by Freire (1974)

Constant comparative analysis: emergent form of data analysis in which data are cyclically coded and themes are derived from the coded data (Hewitt-Taylor, 2001))

Constructivist grounded theory: making sense through the investigation of individuals' underlying perspectives developed through social experience (Charmaz, 2000)

Critical inquiry: reflective research intended to challenge societal structures that embody an imbalance of power (Herr & Anderson, 2015)

Criterion-based sampling: purposive sampling methodology (Merriam & Tisdell, 2016)

Feminist-infused participatory action research (PAR): research at the local level in which those with direct ties to the problem of practice examine marginalizing structures and engage in praxis to combat these structures (Hesse-Biber, 2012)

Feminist theory: a research paradigm focusing on the lived experiences of marginalized populations and transformation in pursuit of social justice (Hesse-Biber, 2012; Lykes & Hershberg, 2012)

Fixed mindset: the belief that intelligence and abilities are fixed (Dweck, 2006)

Freire: theorist and activist who promoted emancipatory research and praxis, informing future critical and feminist inquiry (Herr & Anderson, 2015; Hesse-Biber, 2012)

Growth mindset: the belief that intelligence and abilities are flexible (Dweck, 2006)

Qualitative methods: research methods describing subjective interpretations of the natural environment (Merriam & Tisdell, 2016)

Self-efficacy: one's perceived beliefs about his or her capabilities (Bandura, 1977)

Social cognitive theory: the notion that self-beliefs, such as self-efficacy, significantly influence human agency (Bandura, 1986)

Social constructivism: the theory that there are multiple realities and individuals make meaning through social experience (Bozkurt, 2017)

Transformational leadership: style of leadership in which the collective group is inspired to pursue shared goals (Avci, 2015).

Chapter 2

Literature Review

The identification of problematic gender disparities with regard to mathematical self-efficacy in the local context prompted the present study. Task avoidance, low perseverance, passive behaviors, negative affective responses, and negative self-beliefs in math among female students, as well as a deficit view of their gender in relation to math, demonstrated the current inequities in mathematical experiences across genders as well as implications for future math participation. The study was therefore conceptualized to critically examine female mathematical self-efficacy and the sources that are most influential in the development of math self-efficacy beliefs among females in order to engage in praxis, identifying and employing modifications to classroom practice that strengthen female self-efficacy in math. The following research question guided the study: *As an administrator-researcher in collaboration with teachers, how can we promote positive self-efficacy beliefs among female students in mixed-gender mathematics classes?* The sub-questions are: *(a) What are the most influential sources of mathematics self-efficacy development among females? (b) How can teachers modify classroom practice to address common gender disparities in mathematical self-efficacy? (c) As an administrator-researcher, what methods are effective in prompting feminist-infused critical inquiry among teachers?*

There often lies a gap between the theoretical and practical, between empirically supported findings and daily classroom instruction. In order to address the manifestations of low self-efficacy in the math classroom, it is necessary to first examine the theoretical framework in which the study is grounded and the theoretical paradigms from which the notion of self-efficacy emerged, reviewing historical and current collections of research on these ideologies. This allows for informed decision-making about methods and interventions to employ, upholding the tenets of the theories that drive the study, as well as avoiding praxis already proven ineffective or damaging and building upon findings that have resulted in positive outcomes. Reviewing the current state of literature enables researchers to develop a deeper understanding and historical perspective of the topic and identify gaps in the present base of knowledge (Machi & McEvoy, 2016). The process for developing the literature review began with reflections on the theoretical framework of the study and historical research pertaining to the worldviews on which these theories are predicated. Included in this research was a thorough analysis of the conceptualization of the theory of self-efficacy, as postulated by Albert Bandura (1977), followed by an examination of contemporary application of self-efficacy theory. The sources of self-efficacy defined by Bandura (1977) provided a framework for conducting searches on recent as well as landmark studies. The literature reviewed throughout these stages was collected through the use of the University of South Carolina PASCAL catalog, Education Source, ERIC, Google Scholar, and the technique of 'citation chasing' in examining the works cited by reviewed authors. Mendeley served as the tool for organizing this literature. Throughout the collection process, I annotated the texts, noting key points and findings, as well as research methods that held implications for the study. I then sorted these annotations based on connecting themes using an Excel spreadsheet.

Because the problem of practice and purpose of the study center directly on a theoretical concept, self-efficacy, an iterative approach was used in the organization of the literature review. The review begins with a general examination of the problem of practice followed by a discussion of the theoretical framework in which the research questions, methodology, and analyses were grounded. The framework is heavily based in the seminal works of Bandura given the study's focus on the notion of self-efficacy and its continued relevance today as originally conceptualized. After delineating the theoretical framework for the study and providing a thorough analysis of the concept of self-efficacy and its sources that guided the study, the review will then trace self-efficacy theory to its current revitalization under growth mindset ideology. Having established the necessary background information on self-efficacy theory, the review will then cycle back to the problem of practice, outlining a detailed synthesis of self-efficacy research relevant to math and gender codified by the established sources of self-efficacy development.

Problem of Practice

In 1972, Title IX was enacted, prohibiting gender discrimination in federally-funded organizations. Societal privileges previously designated for males, including coursework in science, technology, engineering, and mathematics (STEM), were now offered to females, and experiences typically labeled as female were made available to males (Zittleman, 2007). Ten years later, Sally Ride became the first American female to fly in space, and in 2014, Harvard graduate, Maryam Mirzakhani, secured her place as the first woman to be awarded the Fields Medal, the highest possible mathematical accolade. While female advancements in the STEM fields have been attained over the last half-century, significant gender disparities remain. Historically, imbalances in gender representation in the field of mathematics have been attributed to biological capability; however, recent shifts in achievement, as well as studies on cognitive development and affective influences, have exposed the fallacies of such rationale (Steele, 2010).

National and global trends and findings in regard to female participation in and beliefs toward mathematics, from educational settings to the workforce, identify significant short- and long-term effects. In 2014, women made up only 25% of professionals in computer and mathematical occupations, a decrease in representation from 1993 when females made up 30% of this population, and from 1960 to 2000, the representation of females in engineering, a math-driven field, increased only marginally from 1% to 11% (Hill et al., 2010; Jones, 2010; US Department of Labor, 2015). As a measure of leadership, power, and voice in the field, Topaz and Sen (2016) found that across 435 mathematical science journals investigated, only 8.7% of the editors were female. These disproportionate figures are not unique to the workforce and research field, but rather, present in students' schooling, surfacing as early as elementary school. A 2009 survey indicated that 5% of females, ages eight to 17, expressed interest in a career in engineering, in comparison to 24% of their male counterparts (Engineering image, 2009). By high school, fewer females enroll in advanced mathematics courses or take advanced placement exams in math (Hill et al., 2010; Jones, 2010). These trends continue into higher education, with female undergraduates pursuing STEM degrees at a disproportionately lower rate than males, and females comprising only 27% of the population of mathematics doctoral students in 2013, a decrease since 2004 (Boaler, 2016; Hill et al., 2010).

Although the gap in mathematical participation across genders persists with minimal reduction, gaps in achievement have begun to close. In 1980, among high-performing students who were administered the Scholastic Aptitude Test at age 13, a score of 700 or above in math was achieved at a 13:1 male to female ratio; in 2010, this ratio contracted to 3:1 (Hill et al., 2010). Further, while the 2012 Programme for International Student Assessment (PISA) and 2015 Trends in International Mathematics and Science Study (TIMSS) convey that males outperform females in math in the United States, these findings are not consistent across participating countries (OECD, 2014; NCES, 2016). In high-performing countries such as Finland, Singapore, and Shanghai-China, females achieve scores equal to or higher than male peers (OECD, 2014; OECD, 2015; NCES, 2016). These findings suggest that gender differences in achievement are not grounded in biological factors, but rather, sociocultural. There has been evidence pointing to a deficit in females' visuospatial skills linked with lower performance; however, it is unknown whether this gap is biological or environmental in nature, and instruction targeting these skills has proven successful in filling in visuospatial gaps, negating the supposition that these are innate skills unique to the male population (Jones, 2010).

Advancements in neuroplasticity further support this notion that gender gaps in mathematics are not due to a biological inferiority in math capabilities. In 2010, Patricia Wolfe asserted, "We've learned more about the brain and how it functions in the past three decades than in all recorded history" (p. 3). Contrary to previously held tenets, breakthroughs in technology, such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), have enabled researchers to prove that the brain is not fixed, but rather, is continuously restructured by environmental influences (Aldrich, 2013; Boaler, 2016; Wolfe, 2010). In fact, the brain is the only organ that is shaped by environmental factors (Wolfe, 2006). These revelations challenge the common misconception that some people are 'math people,' as well as the stereotype that males are biologically better at math. Scholars have found that about 95% of the population, regardless of gender, is able to achieve success in math at high levels (Boaler, 2016). Therefore, we must switch our attention to outside factors resulting in gender disparities in the field.

Whereas assumptions regarding biological math capabilities have proven inconsistent and flawed in accounting for perpetual gender differences in mathematics, recent studies focused on females' self-beliefs and attitudes toward mathematics have displayed a connection to their participation, as well as achievement, in mathematics. Studies show that females hold fixed mindset beliefs about STEM subjects and decreased self-efficacy beliefs in comparison to males (Boaler, 2016; Falco, Summers, & Bauman, 2010; OECD, 2015). On the 2012 PISA, a significant gender gap in self-efficacy existed across STEM fields, with females expressing lower self-efficacy beliefs than males, with the greatest gap appearing in mathematics (OECD, 2015). It is not only the students who hold these deficient views. Because math is a subject in which 'giftedness,' a flawed belief, is valued, educators are more likely to hold stereotypical views about who belongs in the field (Boaler, 2016; Frankenstein, 1992). Self-efficacy beliefs in mathematics hold profound implications for learning, as decreased self-beliefs negatively impact math interest, participation, and achievement (Gonida & Leondari, 2011; OECD, 2015; Ross, Bruce, & Scott, 2012). Across Organisation for Economic Co-operation and Development (OECD) countries, self-efficacy beliefs are associated with a 49-point differential in performance across genders, equated with one half to one full year of math learning (OECD, 2015). However, when efficacy beliefs and anxiety are controlled for, the achievement gap between genders disappears (OECD, 2015). Further, female self-efficacy in mathematics has been found to decrease as students move up in grade levels (Banjong, 2014). As educators, we have the opportunity and responsibility to take action in countering the growth of these debilitating beliefs among female students and promoting female participation in mathematics.

The impetus for the study presented here derives from the self-beliefs and attitudes toward mathematics that manifested among a cohort of fifth-grade students. After gender biases were revealed through an activity in which students were asked to draw mathematicians, the subsequent conversations led to verbal expressions of negative self-beliefs and misconceptions regarding female capabilities in mathematics compounded by the affirmation of such beliefs through the lack of female representation in the media and throughout history. The influence of these perceptions on female students was observed through consistent hesitation and self-doubt in presenting mathematical thinking, a tendency to avoid math tasks or give up prematurely, and the exhibition of reticent behaviors in mixed-gender group-work situations. Not only were these patterns presenting in my fifth-grade classes, but when I engaged in discourse on this phenomenon with educators across grade levels in the K-8 district, they verbalized similar findings among their female students. Upon reflection, these teachers expressed that their female students were less likely to take on mathematical challenges and leadership roles in collaborative work, often saying, “I don’t get it,” as soon as they were presented with a task, and demonstrated negative emotional responses more often than males, such as crying or exhibiting panicked facial expressions. These insights triggered concern for the equity in educational opportunities being afforded to female and male students.

Paulo Freire (2005) writes, “Our job is not exhausted in the teaching of math, geography, syntax, history. Our job implies that we teach these subjects with sobriety and competence, but it also requires our involvement in and dedication to overcome social injustice” (p. 104). To ignore the role of mindsets in mathematics classrooms and the impediment of low self-efficacy among female students results in our failure to achieve both our secondary responsibility of teaching mathematical content and our primary responsibility of promoting social justice, as posited by Freire (2005). Female students must be afforded mathematical opportunity equal to that of males, and if self-beliefs are hindering this opportunity, we have the duty to act on this inequity. This study endeavored to bring female math self-efficacy to the forefront of educators’ minds and discourse among educators in the setting of the study. Through critical inquiry grounded in feminist theory, the cadre of teacher-researchers participating in the study, and I, as an administrator-researcher, explored the nature of mathematical self-efficacy across genders and the success of interventions implemented to promote positive self-beliefs. The outcomes of the study hold valuable implications for all district stakeholders, including educators, students, and parents. Findings presenting the levels of success of the instructional strategies employed will better equip educators in the setting to uphold the ideals of Freire in educating all students with conceptual competency and engaging in social action designed to promote gender equity by disrupting practices that hinder females' success in the field of mathematics. Enacting interventions determined to be effective in promoting positive math self-efficacy among females will serve to remove or reduce the negative influences that cultivate a female tendency to disassociate from mathematics, thereby, making female students more available to mathematical learning, increasing the likelihood of future participation in the field, and improving achievement, which has been positively linked to mindsets (Boaler, 2016).

Theoretical Framework

In describing revisions to his conceptualization of a worldview, Sire (2015) writes that "a worldview is not just a set of basic concepts but a fundamental orientation of the heart" (p. 14). The present study originated from my own views of the current state of education experienced by my female students. Thus, the theoretical framework for the study, which captures the worldview through which the research is planned, conducted, and analyzed (Grant & Osanloo, 2014), derives initially from the values held within my heart and is further developed through intellectual deliberation. Aligning with the views of Freire (2005), I believe that education should be, at its core, a means of social action, providing all individuals with equitable opportunities in the face of societal injustices, a belief system which led to my critical reflection on the inequities present in my math classes. These commonalities between my values and those of Freire (1974/2005) led me to the concept of conscientização and critical theory. Although Freire is often criticized for being blind to the masculine dominance of his writings, his work still guides emancipatory praxis, influences feminist theory, and is revered by feminist leaders (hooks, 1994; Lykes & Hershberg, 2012). Given the focus of the current research on female emancipation, the combination of the ideologies of Freire, critical theory, and feminist theory under the framework of critical feminist theory became the driving theoretical background for the study, as described below. This framework led to the methodological decisions to employ participatory action research drawing on constructivist grounded theory. Given the focus on female self-efficacy, social cognitive theory and the paradigm from which social cognitive theory derives, social constructivism, inherently influenced the development and execution of the study. These theories are outlined below, as well as the evolution of self-efficacy theory to mindset theory, the lens through which these concepts of self-beliefs are currently viewed by staff and students in the context of the study.

Critical Feminist PAR Influenced by Constructivist Grounded Theory

In a society that assumes the superiority of men, oppressing women and their capacities, emancipatory research through critical feminist theory is necessary to examine and challenge dynamics of power, privilege, and inequity, and hopefully, inspire others to take action (Charmaz, 2017; Gannon & Davies, 2012; Merriam & Tisdell, 2016). Challenging traditional research that excluded the voices of females, feminist theory emerged with the goal of breaking down the barriers that prevent marginalized voices from being heard (Hesse-Biber, 2012). Aligning with these aims, the present study sought to not only shed light on debilitating female self-beliefs in math, but also to uncover why these beliefs exist and how to remove the classroom structures that promote them, as well as critique the damaging influences beyond the classroom walls. Placing critical qualitative inquiry in contemporary society, Denzin (2016) professes that “we are no longer called to just *interpret* the world," but rather, "we are called to *change* the world and to change it in ways that resist injustice while celebrating freedom and full, inclusive, participatory democracy" (p. 9). Herein lies the intersection between critical theory and feminist theory; those belonging to the critical feminist paradigm view their roles as moving beyond interpreting injustices to transforming the oppressive systems that produce such injustices: emancipation through human agency (Gannon & Davies, 2012). Denzin (2016) specifically cites education, employment, and economy as areas of life fraught with injustice and requiring critical qualitative inquiry. In the present society, females are not afforded the same educational opportunities as males due to sociocultural barriers, which then hinders female entrance into the STEM workforce, a sector of employment with growing opportunity and higher average pay than the non-STEM professions (Jones, 2010). Since women are rarely represented in the current STEM workforce, the views and needs of women are also underrepresented in STEM advancements (Jones, 2010). Because female attitudes toward math are influenced by systemic structures and reproduce those same gender inequities, self-efficacy must not be viewed individualistically, but as an interaction between the individual and societal structures. Feminist theory and critical theory share this view of knowledge as being situated in societal experience and power relations (Charmaz, 2017; Hesse-Biber, 2012).

Educators have a civic duty to promote social justice (Freire, 2005); action research is a means of this pursuit (Herr & Anderson, 2015). Freire, who purported that education is a platform for social action and educators have the responsibility to critically analyze their practice, sparked a critique of traditional research that was later pursued by those who subscribed to the critical theory and feminist paradigms (Freire, 2005; Herr &

Anderson, 2015). Freire affirmed the collaborative nature of PAR as a means of attaining critical consciousness through the social construction of understanding (Brydon-Miller & Maguire, 2008; Freire, 1974/2005). The PAR approach that guided the study derives from feminist theory seeking to give a voice to oppressed populations who had previously been unrepresented in academic research (Herr & Anderson, 2015). Aligning with feminist theory, the aim of this study was to empower students and teachers to be critical of the role that societal structures, including education, has played in the hindrance of mathematical opportunity for females (Cahill, Cerecer, & Bradley, 2010). Our cadre of researchers upheld the values of feminist theory through a “praxis of care and solidarity” toward social action that directly impacted and continues to impact the daily lived experiences of students (Cahill et al., 2010, p. 408).

Constructivist grounded theory upholds the same promise of social justice that critical theory and feminist theory center on, and PAR seeks to pursue, embodying a social perspective that acknowledges both human agency and environmental influence (Charmaz, 2017; Gannon & Davies, 2012). As opposed to objectionist grounded theory, constructivist grounded theory is built on the valuing of participant feelings, how those feelings were developed, and how they affect future interaction with the world (Charmaz, 2000). This notion parallels social cognitive theory and its derivative, self-efficacy theory, making components of the framework a natural fit for the study. Constructivist grounded theory emphasizes an emergent and flexible approach aligned with critical feminist theory, promoting openness to true critique and inquiry through communication and collaboration rather than reestablishing familiar interpretations, which are beset with societal influence (Charmaz, 2017). Such values are ingrained in this study. Through

PAR, interventions and further inquiry were directly guided by discourse and collaboration among teacher-researchers and student perspectives expressed through qualitative methods. As we critiqued our own practices based on the belief systems expressed by students and observations of the manifestations of these beliefs in the classroom, we engaged in self-conscious reflection and analysis. This reflexivity was further supported through emergent data analyses guided by open and In Vivo coding (Saldaña, 2009). Proponents of constructivist grounded theory and critical feminist theory affirm that this genuine reflexivity is essential to engaging in social action (Charmaz, 2017; Gannon & Davies, 2012).

Social Cognitive Theory Situated in Social Constructivism

When Albert Bandura entered the field of psychology in the mid 1900s, behaviorism ruled the discipline (2011). Although numerous textbooks continue to classify Bandura as a behaviorist, this is a label that Bandura himself rejected, as behaviorism, especially radical behaviorism, fails to account for the influence of human agency and social interaction (Bandura, 1999; Pajares & Schunk, 2002; Simon, 1999). Behaviorist views remove human agency from performance, placing the determination of human action on past or current external stimuli, a tenet refuted by Bandura who affirms that humans and human interaction play integral self-regulatory roles in behavior (Bandura, 1999; Simon, 1999). Therefore, the present study aligns with the views of scholars who situate Bandura's work in the constructivist paradigm. While influenced by prior ideologies, Piaget is viewed as the originator of constructivism (Airasian & Walsh, 1997; Palincsar, 1998; Simon, 1999). Piaget purports that humans construct knowledge through a need to reach cognitive balance between previously held schemata and novel environmental influence (Airasian & Walsh, 1997; Palincsar, 1998; Simon, 1999). Building on this theory, Vygotsky (2005) emphasizes the social component of constructivism, placing a heightened importance on teachers as facilitators in the construction of knowledge through the Zone of Proximal Development (ZPD) (Palincsar, 1998; Simon, 1999). Both Piaget (1979) and Vygotsky (2011) highlight the role of self-regulation in learning and behavior. In describing the interaction between the individual and the environment, Bandura (1999) asserts that humans:

> construct thoughts about future courses of action to suit ever-changing situations, assess their likely functional value, organize and deploy strategically the selected options, evaluate the adequacy of their thinking based on the effects which their actions produce and make whatever changes may be necessary. (p. 23)

Bandura (1999) goes on to describe the learning process, involving "exploratory activities, verbal instruction, and innovative cognitive syntheses of acquired knowledge" used in the "construction of complex patterns of behavior" (p. 24). Aligning with constructivist ideology, Bandura (1999) emphasizes environmental influence on knowledge construction, which informs self-regulatory behavior.

Challenging the human agency models of autonomous agency, that humans act independently of their environment, and mechanical agency, that environment is the key determiner of all human action, Bandura (1989) professes the model of emergent interactive agency. This framework is at the heart of Bandura's social cognitive theory which holds that human agency is guided by interaction of self-influence and societal factors (Bandura, 1989). Bandura (1989) describes a system of triadic reciprocal causation to capture the interaction of behavior, personal influences (cognitive, affective, biological), and environmental factors. Affirming triadic reciprocal causation, Bandura (1989) suggests that any research on human behavior must include an analysis of self-influence. The component of social cognitive theory that Bandura (1977/1989/1999) purports has the greatest impact on human agency is self-efficacy.

Self-Efficacy

Self-efficacy, or the beliefs an individual holds about her ability to achieve success in performing a given behavior, impacts action initiation, as well as coping mechanisms, perseverance, and resiliency when challenges arise during the attempted execution of the target behavior (Bandura, 1977). Therefore, an individual's construction of her environment, specifically which experiences to engage in and for how long, are directly impacted by the self-efficacy beliefs held in relation to such experiences (Bandura, 1977). Self-efficacy beliefs materialize through cognitive, motivational, affective, and selection processes (Bandura, 1993). These four domains of human agency interact in a self-fulfilling prophecy (Pajares & Schunk, 2002). Goal-setting and future engagement in an activity are determined through the cognitive and motivational influences of one's attribution of potential failures or successes to innate ability versus effort, self-evaluation of current and future attainment, and outcome expectancy (Bandura, 1977/1993). This goal-setting and experience-selection process is further compounded by the level of perceived threat (Bandura, 1993). Low self-efficacy results in increased stress and anxiety, as well as a decrease in perceived ability to cope with these affective barriers, making the environment more threatening, especially when social implications are present (Bandura, 1993). If the individual selects avoidance of the environment, the threat of failure is removed, thereby reinforcing the avoidance behavior.

If the individual does decide to engage in the experience even with low self-efficacy, which is less likely, these efficacy beliefs continue to manifest through cognitive and affective processes (Bandura, 1977/1993). Visualizations of failure and exaggerated feelings of stress, anxiety, and threat hinder the activation of necessary knowledge and maintenance of task-focus (Bandura, 1989/1993). Higher-order thought processes including analysis, decision-making, and problem-solving, which are critical to mathematics, are severely diminished under the debilitating agency of self-doubt (Bandura, 1989; Pajares, 1996). Thus, the initial damaging self-beliefs are fulfilled (Pajares, 1996).

Before continuing, it is important to note that self-efficacy does not work in isolation (Bandura, 1977). Belief in ability alone does not result in the intended outcome. Self-efficacy must be accompanied by effort and appropriate tools and/or approaches to learning (Bandura, 1977; Boaler, 2016; Dweck, 2006). Bandura (1977) also asserts the significance of incentive, as belief in one's capability and appropriate learning strategies could result in the desired behavior, but action toward the target behavior will only be employed if there is a reason to do so.

There are three dimensions of self-efficacy that must be considered when evaluating the impact, or potential impact, of self-beliefs: magnitude, generality, and strength (Bandura, 1977; Pajares, 1996). Magnitude refers to the interaction between the level of challenge of the task and the self-efficacy beliefs (Bandura, 1977). For example, one student may possess low self-efficacy beliefs when presented with math tasks of moderate difficulty, whereas another student may be plagued with low self-efficacy only when they are presented with tasks of high difficulty. The extent of permeation of a self-efficacy belief is described as its generality (Bandura, 1977). If self-efficacy beliefs are tied to specific situations or tasks, they have low generality; those that span across entire content areas or schooling in general have high generality. The strength of self-efficacy beliefs holds significant implications for interventions. While weak self-efficacy beliefs can be more easily altered, strong self-efficacy beliefs will likely require multiple intervention experiences (Bandura, 1977). It should be pointed out that weak or strong self-efficacy beliefs can be positive or negative (Bandura, 1977). If a student holds weak, positive beliefs, she may take on challenges but quickly change her mindset when faced with failure, resulting in decreased self-efficacy. If a student holds weak, negative beliefs, there is a greater likelihood that interventions will be successful in altering these perceptions than if she possessed strong, negative beliefs.

Sources of self-efficacy. Up to this point, we have examined the nature of the presentation of self-efficacy beliefs in human agency. Shifting to the development of self-efficacy beliefs, we will now explore the four sources that cultivate them, which will lay the groundwork for the present study: mastery experience, vicarious experience, verbal persuasion, and physiological states (Bandura, 1977). It can be a challenge to discern these four sources of development, as their interconnection often results in an inability to separate active factors. Further, there exists overlap between sources that develop self-efficacy beliefs and the resulting outcomes of those beliefs, as is the case with mastery experience and physiological states.

Mastery experience. Competency expectation is directly influenced by performance experiences, which are believed to be the strongest source informing efficacy beliefs (Bandura, 1977). Successful mastery experiences tend to improve conceptions of capability, whereas failure experiences tend to foster the opposite beliefs. These self-conceptions connect with ego identity described by Erikson (1980), one's self-evaluation of effectively meeting the necessary steps toward becoming an accepted member of society. Erikson (1980) affirms that children's ego identity can only be fundamentally impacted by "real accomplishment" or "achievement that has meaning in their culture" (p. 95). While mastery experience is often identified as the strongest source of efficacy development across genders and racial groups (Usher & Pajares, 2006), the impact and strength of mastery experiences are variable. Strong positive self-efficacy is less likely to be reduced by occasions of struggle and failure, but strong negative self-efficacy beliefs will require multiple successes to disconfirm the pre-established beliefs (Bandura, 1977). The ideal mastery experiences in improving self-efficacy are those in which the individual exerts effort toward, remains persistent in, and successfully copes with a challenging task, eventually leading to success (Bandura, 1989; Maddux, 2009). Such situations promote resiliency and future positive beliefs in the face of challenge. When an individual overcomes low self-efficacy in contexts that present challenges and perceived threats, the gained self-efficacy beliefs may be generalized to situations beyond the current context, even to environments and tasks that are highly dissimilar (Bandura, 1977). While Bandura (1977) asserts that students should be provided with extended exposure to tasks, rather than intermittent sessions, in order to increase the likelihood of attaining success before removing focus from the task, Bandura and Schunk (1981) and Pajares (2003) have also found that short-term goals with scaffolding toward mastery, such as in the ZPD approach, support the development of positive self-efficacy beliefs through mini-successes. In addressing low self-efficacy beliefs, modeling and additional supports to prevent failure should be applied to ensure success, engaging the student in disconfirming experience by allowing them to experience success in a situation they thought they were incapable of mastering (Bandura, 1977). Following initial success, these scaffolds should then be slowly removed to promote independent self-efficacy (Bandura, 1977).

Vicarious experience. Though often not as strong as mastery experience, observing others achieve a task promotes the belief within an individual that she too can reach success (Bandura, 1977). These symbolic experiences are more beneficial if the observed person needed to put in persistent effort; otherwise, the observer may attribute the viewed success to innate ability (Bandura, 1977). Models of performance absent of mistakes, such as teacher modeling, can result in increased self-doubt on the part of the student when she makes a mistake carrying out the same or a similar task (Pajares & Schunk, 2002). On the other hand, observing others struggle with a task, such as peers, is correlated with enhanced perceptions of one's own capability and higher performance on analogous tasks (Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016; Pajares & Schunk, 2002). The utilization of coping behaviors throughout modeled perseverance also helps to reduce the threat of aversive feelings and emotional arousal on the part of the observer (Bandura, 1977). Attribution of observed success to innate ability can also be decreased by having multiple models demonstrating success with the same target behavior (Bandura, 1977). Holding strong implications in the current study, the degree of influence of the model being observed is positively correlated with the perceived similarity to the model (Bandura, 1977). This notion suggests that vicarious experience in math is low for female students due to the lack of individuals similar to them, i.e. women, represented in the field, as alluded to by the students in the aforementioned vignette.

Verbal persuasion. Social persuasion, or the suggestion that one can accomplish a set goal, positively affects the level of effort put into the experience and improves self-efficacy beliefs, especially among females (Bandura, 1977; Usher & Pajares, 2006). Since children are not yet adept at accurately judging their own successes, Pajares (as interviewed by Madewell & Shaughnessy, 2003) purports that they look to adults for confirmation; these adults therefore have the capacity to improve or damage flexible beliefs of achievement and capability. Pajares professes, "We tend to become the sort of person we believe others believe us to be" (as cited in Madewell & Shaughnessy, 2003, p. 390). Providing students with messages that their abilities and intelligences can be developed curtails negative stereotypes that tell them otherwise (Good, Rattan, & Dweck, 2012). However, since verbal persuasion is indirect, it holds weaker influence on efficacy than mastery experience (Bandura, 1977). If the individual has already experienced failure with the task, she is less likely to be receptive of positive suggestion (Bandura, 1977). Further, if proper supports are not in place, as outlined under mastery experience, the experience may lead to failure, which will discredit the social persuasion (Bandura, 1977).

Physiological states. While affective processes are influenced by self-efficacy, they also serve as information sources that produce varying levels of self-efficacy (Bandura, 1977). Above, we explored the fallacies of attributing decreased female math self-efficacy and entrance into math-focused educational pathways and careers to biological differences between females and males in terms of mathematical capability;

however, this does not exclude all biological factors from possibly inducing these self-concept and participation disparities. When individuals experience situations in which they are struggling to meet the target objective, emotional arousal in the form of stress and anxiety forms an exaggerated view of the threat of the situation (Bandura, 1977). This exaggerated level of threat may also be prompted by prior negative experiences related to the target behavior (Bandura, 1989). Emotional arousal and increased perceptions of threat lead to physiological responses triggered by the amygdala (Wolfe, 2006). This fight-or-flight response leads to cognitive abilities being overpowered by emotional arousal, impairing rational thought and problem-solving skills (Wolfe, 2006). Since these physiological states hinder cognitive functioning, performance is often lowered, thereby preventing mastery experience and decreasing self-efficacy (Bandura, 1977; Bandura, 1989). In a cyclical format, emotional responses to a situation lead to decreased perceptions of one's capability to succeed, lowering self-efficacy beliefs and stimulating further feelings of stress and anxiety, which inhibits performance (Schunk & DiBenedetto, 2016). Fear of failure may also lead to avoidance, which prevents further mastery experience (Bandura, 1977). On the other hand, being in a calm state allows the individual to access and apply cognitive abilities and produces more positive feelings of self-efficacy (Maddux, 2009; Wolfe, 2006). Interrelated is the individual's coping efficacy. A stressful situation is not avoided because it will produce anxiety alone, but because the individual does not believe she will be able to cope with that anxiety and exert control over the perceived threats (Bandura, 1977/1989). Desensitization to experiences that produce negative emotional arousal can be realized through mastery and/or vicarious experience, with the former producing stronger results (Bandura, 1977).

These disconfirming experiences lead the individual to see that the aversive perceptions are unwarranted. Additionally, teaching coping mechanisms enables individuals to overcome stress and anxiety, improving performance and coping efficacy, and in turn self-efficacy (Bandura, 1977/1989).

From self-efficacy to growth mindset. Though the name Albert Bandura and the roots of self-efficacy may not be commonly known among contemporary educators, the modern unconscious celebrations of Bandura's work through ideologies such as growth mindset (Dweck, 2006) are spreading across American schools. And, with advancements in neuroscience pointing to self-efficacy as an instrumental factor in gender disparities in math (Maguire et al., 2006), scholars have begun to examine these connections and spark a mathematical revolution (Boaler, 2016). Bandura's conceptualization of self-efficacy in 1977 changed the landscape of research on human behavior and motivation. With his focus on self-systems and human agency, Bandura (1977/1986) challenged previously accepted behaviorist views that placed the human in a passive role, responding to external stimuli without any self-regulation. At 92 years of age, Bandura (2017a/2017b) remains the distinguished voice of self-efficacy and social cognitive theories, with publications on moral agency through social cognitive theory released in the last year. While Bandura remains the most prominent figure in self-efficacy and social cognitive studies, researchers have applied and confirmed the effects of self-efficacy across domains, including smoking and pain regulation (Pajares & Schunk, 2002). Perhaps the domain with the greatest implications, education has been a central focus of self-efficacy research. A meta-analysis conducted by Multon, Brown, and Lent (1991) demonstrated consistent findings across studies that applied self-efficacy to academics and career paths, that these self-beliefs are positively correlated with perseverance and success and significantly influence choice in academic and career pursuits. In 2000, Zimmerman, who had previously collaborated with Bandura in 1994, identifying a positive correlation between self-efficacy and student achievement and goal-setting in writing, built upon the theory of self-efficacy, developing a self-regulated learning model. Zimmerman (2000) highlighted the power of self-efficacy beliefs and task analysis in the forethought stage of learning, which then guides performance and self-reflection.

Shortly after Bandura formulated self-efficacy theory, Carol Dweck (2017), who had also been studying systems of self in relation to attribution and motivation, began working with Mary Bandura, daughter of Albert Bandura, on Mary's dissertation in the mid-1980s. Their examination of differences in perceptions of ability, specifically the need for validation of ability in certain situations and the drive to improve ability in others, led to the development of mindset theories (Dweck, 2017). Dweck (2017) posited that individuals possess varying beliefs about the plasticity of intelligence, talents, and abilities. Those who believe intelligence, talents, and abilities are innately defined, commonly referred to as a fixed mindset, tend to avoid challenges, view failure as an indicator of natural inability, and give up easily (Dweck, 2017). In contrast, those who believe intelligence, talents, and abilities are flexible and developed through effort, commonly referred to as a growth mindset, seek out challenges, attribute failure to a lack of effort, and demonstrate increased perseverance and resilience (Dweck, 2017). Looking at the work of Bandura, we can see clear connections between self-efficacy theory and Dweck's mindset theory. Bandura (1977/1986/1993/2006) identified self-efficacy as the beliefs one holds about his or her capability in achieving a target goal and the most significant component of human agency. The implications of self-efficacy theorized by Bandura (1977/1986/1993/2006) include impacts on task selection, motivation, goal-setting, exerted effort, perseverance, resilience, anxiety and stress, and performance. Bandura (2006) asserts, "Efficacy beliefs affect whether individuals think optimistically or pessimistically, in self-enhancing or self-debilitating ways" (p. 170). As growth versus fixed mindset notions have permeated educational settings in recent years, the ideologies and language of mindset theory are readily observable in the district in which the study took place. Self-efficacy in the context of the study was viewed in connection to mindset theory.

From Theory to Practice: A Reexamination of the Problem of Practice

Current research surrounding students' self-beliefs in mathematics validates the tenets of Bandura (1977), as clear connections can be drawn to the sources of self-efficacy he had outlined. The studies presented below are categorized into these sources in order to provide a more detailed analysis of the roots of self-efficacy beliefs. However, the intersections between sources sometimes result in overlaps across categories that the studies can be placed into. For the purposes of this literature review, studies have been placed into single best-fit categories where there was a clear source that was examined or presenting as most influential, but there are also cases in which two sources are used as the lens of analysis.

Mastery experience. Mastery experience was identified by Bandura (1977) as the greatest determiner of self-efficacy. Bandura (1977) also realized that actual success was not the influential factor, but rather, individuals' self-evaluations of their success. Studies conducted by Falco, Summers, and Bauman (2010) and Gonida and Leondari (2011) both conveyed inaccurate self-evaluations among females in regard to mathematics. Falco et al. (2010) led a study in which a school counselor implemented interventions to improve math self-efficacy and attitudes among 153 students. The population of the K-8 district in which the study took place closely resembles that of the present study with a predominantly white affluent student body (Falco et al., 2010). While the results of the intervention will be discussed below, the pre-assessment data also held crucial information (Falco et al., 2010). Although no significant difference was found in math performance across genders, there was a significant difference in estimations of ability; female students underestimated math capacities and male students overestimated (Falco et al., 2010). Similarly, Gonida and Leondari (2011) conducted a study aimed at determining gender differences in the accuracy of ability estimations in math and ELA and the impact on motivation. Gonida and Leondari (2011) provided questionnaires to 6,110 ninth- and tenth-grade students to gauge self-efficacy, interest, persistence, achievement goals, and social goals in each subject. Achievement levels in math and ELA were also measured through school records (Gonida & Leondari, 2011). The study revealed that female students significantly underestimated their math abilities in comparison to males, even though females' school records demonstrated higher achievement, while males overestimated their math skills (Gonida & Leondari, 2011). Overestimators and those who accurately estimated their achievement levels (accurates) both communicated higher mastery goals and interest levels in math, ELA, and both subjects combined (Gonida & Leondari, 2011). In comparing the two, accurates did display higher interest levels and mastery goals than overestimators (Gonida & Leondari, 2011). These findings support Bandura's claims that positive beliefs in one's capabilities correlate with higher interest and goal-setting (Gonida & Leondari, 2011); however, Bandura (1986) also asserted that self-efficacy beliefs are most powerful when they are slightly higher than actual capability. More research is necessary to determine the ideal level of overestimation beliefs (Gonida & Leondari, 2011). Gonida and Leondari (2011) also found that while those who overestimated capabilities in both subjects expressed higher mastery goals and persistence than single-subject overestimators, underestimation of one subject was enough to produce the same lack of perseverance and decreased goal-setting as those who underrated their abilities in both subjects. Therefore, inaccurate negative perceptions were more powerful than inaccurate positive perceptions (Gonida & Leondari, 2011).

The results of the studies by Falco et al. (2010) and Gonida and Leondari (2011) suggest that in order to increase interest and future goal-setting in mathematics, thereby heightening participation, we need to target both actual performance and self-evaluations of performance among female students. Ross et al. (2012) suggest the use of rubrics to help students self-evaluate their achievements in mathematics rather than relying solely on general perceptions after engagement in tasks, which are biased due to environmental forces. Detailed rubrics with specific task-dependent indicators of achievement would allow females to accurately judge their performance rather than underestimating achievement. In fostering experiences for all students to experience task-mastery, the use of scaffolded activities promoted by Boaler (2016) allows learners at diverse stages of math skills to access the task and experience success. These tasks, referred to as 'low-floor-high-ceiling,' begin with lower entry points necessary for the task but at a level all students in the class can master, and then increase in complexity as students progress through the stages (Boaler, 2016). While this approach connects to the constructivist notion of the zone of proximal development (ZPD) posed by Vygotsky (2017), as the students are guided to push beyond their current levels of understanding through social interaction, the scaffolded tasks differ from the concept of ZPD in that there is greater emphasis on exploratory learning, trial-and-error, and peer collaboration, rather than a reliance on teacher modeling to be imitated by students (Boaler, 2016). This approach allows for a balance of both successful experience and appropriate challenge. In the study conducted by Falco et al. (2010), the interventions employed by the school counselor targeted time-management, goal-setting, mathematics study skills, and help-seeking skills. These interventions improved females' mathematics performance, attitudes, and self-efficacy, growing at a higher rate than males in the group and participants in a control group without interventions (Falco et al., 2010). Paired with self-evaluation tools to elicit accurate judgments of ability and low-floor-high-ceiling task structures, these curricular interventions hold encouraging implications for enhancing female math self-efficacy.

Vicarious Experience and Verbal Persuasion: Stereotype Threat. Though not viewed as being as powerful as mastery experience, Bandura (1977) recognized vicarious experience as a second source of information in developing positive or negative self-efficacy beliefs, affirming that witnessing others achieve success in a task builds one's own perception of capability with the task, especially when the characteristics of the observer and performer are similar. This is especially relevant in mathematics, a field in which there is a lack of female models serving as symbols of success (Hill et al., 2010; Jones, 2010). Bandura (1977) also presented verbal persuasion, or the messages received from others, as a source of self-efficacy development. Gender biases in mathematics form through a socialization process (Harro, 2013). From birth, we continuously receive messages about the "rules, roles, and assumptions" (Harro, 2013, p. 48) pertaining to our identities, such as being female versus male (a dualistic view) (Coman, 2016; Emolu, 2014). These messages are transmitted to us through observations in our primary and secondary discourses and the macro-level society (vicarious experience), as well as through direct communication about what we are good at and where we belong (verbal persuasion) (Harro, 2013). Through this process, we receive stereotyped beliefs that lead to internalized oppression, becoming "our own oppressors from within" (Harro, 2013, p. 50). Negative self-efficacy beliefs serve the purpose of internalized oppression, hindering our attainment of opportunities and privileges that we have been socialized into believing we do not have the capacity for. In studies on the socialization processes that have influenced decreased female self-efficacy in mathematics, it is often not possible to separate sources of vicarious experiences from verbal persuasion since, as mentioned above, this inculcation begins at birth. Therefore, these sources are analyzed together in this literature review.

Steele (2010) conducted a study in which male and female students of equal ability attending the University of Michigan were given a challenging math test. She found that even though the two gender groups had equal math skills, the females underperformed on the test (Steele, 2010). Seeking to uncover the cause of this discrepancy, Steele (2010) developed a second experiment to test her hypothesis that the gender stigma imposed by society about what females are and are not good at played a role in decreasing their performance. In the control group, the experiment was carried out in the same manner as the initial study (Steele, 2010). In the experimental group, Steele (2010) acknowledged the reality that people often believe females are weaker than males in math. However, since she believed that trying to convince the participants that this was not true would fail to discount the pervasive beliefs held throughout our society, Steele (2010) instead explained that for the particular test the participants were about to take, this belief was not true and “women always do as well as men” (Steele, 2010, p, 37). In contrast to females in the control group who continued to underperform, females in the experimental group whose biased self-perceptions based on gender were removed, performed at the same level as males of equal math ability (Steele, 2010). This confirmed the impact of stereotyped beliefs based on gender and the resulting decreased self-efficacy on mathematics performance, but it also confirmed that the threat of stereotypes received through socialization could be reduced or eliminated (Steele, 2010).

While Steele (2010) used direct intervention to target explicit stereotypes held by students, it is essential that we also attend to implicit biases. In a study developed by Cvencek, Meltzoff, and Greenwald (2011), societally-imposed gender stereotypes in math were examined through implicit and explicit measures among 247 elementary students in the United States. Self-report was used to investigate more explicit gender stereotypes in math through which participants were shown images of males and females and asked to decide which person liked math more (Cvencek et al., 2011). Implicit stereotypes were assessed through an association test in which words were sorted into categories of “boy-math,” “girl-reading,” “boy-reading,” and “girl-math” (Cvencek et al., 2011). Explicit and implicit measures were also used to determine the degree to which the participant associated with the male versus female gender. The results showed that the gender stereotypes pertaining to math held by adults are also found among elementary school students. Females identified with math to a lesser extent than males, and the female gender was associated with math to a lesser extent than male; this was true for both explicit and implicit measures (Cvencek et al., 2011). Galdi, Cadinu, and Tomasetto (2014) also studied the impact of gender stereotypes in math at implicit and explicit levels. First-grade students were split into two groups, one in which they were asked to color pictures that were stereotype-consistent and one in which they were provided with pictures to color that were stereotype-inconsistent (Galdi et al., 2014). Coloring in pictures of boys successfully solving math problems led to an increased automatic association between males and math and decreased female math performance; whereas, coloring in pictures of girls successfully solving math problems led to an increased automatic association between females and math and improved female math performance (Galdi et al., 2014). These findings support Bandura's notion of vicarious experience that observing those similar to you achieve success results in increased perceptions of one's own capability to achieve success (Bandura, 1977). Given that the students in the study did not express explicit stereotype-consistent beliefs, this study shows the essentiality of attending to implicit gender stereotypes that could be influencing students' self-efficacy and performance at a subconscious level (Galdi et al., 2014).

Harro (2013) writes that the stereotypical messages are "woven into every structural thread of the fabric of our culture," such as television, Internet, newspapers, language, and music (p. 49). Bandura extended his original notions about the power of models to influence self-perception beliefs to acknowledge the increased "symbolic environment" made possible through technological advances (as cited in Psychological

Science, 2013, 18:06). Bond (2016) examined the influence of one of these sources on female elementary students' STEM perceptions: television. Students were placed into a stereotype, counter-stereotype, or control group (Bond, 2016). Students in the stereotype group watched clips of television shows depicting stereotypical roles of males and females in relation to STEM, those in the counter-stereotype group watched clips of television shows in which females were portrayed in scientist roles, and participants in the control group were not exposed to television clips (Bond, 2016). After the treatment exposure, or non-exposure for the control group, students completed a questionnaire pertaining to math and science self-efficacy, career interests, and perceptions of scientists through a scientist-drawing activity (Bond, 2016). Students who were exposed to the stereotype-consistent television clips were more likely to select stereotypical careers and draw male scientists (Bond, 2016). The study did not display significant differences between the control and counter-stereotype groups, but 75% of the females in the counter-stereotype group drew female scientists, and 65% in the control group drew female scientists (Bond, 2016). Bond (2016) contends that the lack of influence of the counter-stereotype clips may have been due to the limited exposure to the treatment, as cultivation theory suggests the need for multiple exposures to effect change. Further, no significant difference was found in self-efficacy beliefs between the three groups; however, implicit self-efficacy beliefs were not assessed (Bond, 2016). The study was also limited in that it did not examine how media affects boys' perceptions of females in math, which can impact classroom dynamics (Bond, 2016).

The results of these studies on stereotypical beliefs internalized through social experience, including vicarious experience and verbal persuasion, and their impact on self-perceptions in math set the groundwork for investigations into how these sources affect learning in the setting of the present study and what interventions could be employed to counter these beliefs if these sources were determined to be the most influential. While we cannot safeguard our students from negative influences received outside the classroom, we have the responsibility to guide students to critically analyze these influences and employ methods of countering stereotypical beliefs in the classroom.

Verbal Persuasion: Teachers, Parents, and Peers. After measuring self-reports of self-efficacy, attitudes toward math, science, and technology, and perceived support from teachers, parents, and peers among 1,552 students in fifth grade through high school, Rice, Barth, Guadagno, Smith, and McCallum (2013) found that higher levels of support from peers, parents, and teachers were positively correlated with self-efficacy beliefs and attitudes toward math and science. Further, females' attitudes toward math were more significantly impacted by perceived support than was evident for males. While this study conveys the impact of support systems on female self-perceptions in regard to math, studies measuring beliefs of those individuals who are integral to these support systems display problematic biased viewpoints. In exploring the presence of attribution bias among educators, Espinoza, Arêas da Luz Fontes, and Arms-Chavez (2013) found a significant difference between teachers' attributions of students' successes and failures across genders, perceiving male success as ability-based to a greater degree than female success and male failure as being effort-based to a greater degree than female failure. It is likely that such views are conveyed to students through feedback about their performance, which would reinforce the impact of societal stereotypes on math self-efficacy through verbal persuasion. However, interventions employed by Espinoza et al.

(2013) point to the possibility of being able to alter these viewpoints among educators. Espinoza et al. (2013) exposed teachers to professional development on the incremental theory of brain development or learning styles. Though it was hypothesized that only the former group would demonstrate a change in attribution bias, changes were evident in both groups, indicating that any reflection on processes of learning could correct attribution bias (Espinoza et al., 2013). Teachers did express increased effort attributions to male successes, as opposed to innate ability, but surprisingly, they also decreased effort attributions made to female successes (Espinoza et al., 2013). The educators increased effort attributions made to female failures, but again unexpectedly, they decreased effort attributions made to male failures (Espinoza et al., 2013). While further research is necessary to examine why effort attributions were decreased in certain cases, this study gives us hope that inaccurate attribution biases can be reduced or eliminated (Espinoza et al., 2013).

Parents, too, have been shown to hold biased views of the capabilities of their sons and daughters based on gender. A parent survey included in the 2012 PISA depicted that parents hold higher expectations for their sons to enter STEM fields than their daughters, regardless of performance levels (OECD, 2015). Moffatt, Anderson, Anderson, and Shapiro (2009) conducted a study in which they analyzed the language and gestures parents displayed while playing a board game with their preschool sons and daughters in determining their constructions of their children's capabilities in mathematics. This analysis demonstrated that parents were more likely to engage their sons in performing the mathematical processes used in the game than their daughters, prompted sons to carry out mathematical procedures at a rate twice as often as they did for daughters, and engaged in executive autonomy (performing the math silently or without including the child) more frequently with daughters (Moffat et al., 2009). Not only do these behaviors send varying messages to children dependent on gender about their capabilities in math, but males are also provided with increased skill practice and resulting mastery experience, which as we have already explored, increases self-efficacy.

Although the influence of peer support on math self-perceptions has not been as heavily researched, Leaper, Farkas, and Brown (2012) found that peer support in math and science had a significant and positive influence on math and science motivation among middle and high school students. This presents another element of verbal persuasion to explore in the current study, in addition to the impact of verbal persuasion affected by parent and teacher bias. Not only was the impact of these sources examined, but also possible interventions, such as education on the incremental intelligence theory (Espinoza et al., 2013). If verbal persuasion was determined to be an influential factor in math self-efficacy development among females, these findings and knowledge of prior interventions would allow educators in the district to leverage social persuasion as a force to promote positive math self-efficacy among female students, rather than perpetuating its possible negative implications.

Physiological States. Bandura (1989) continuously cites a proverb in discussions of stress and anxiety in relation to social cognitive theory: “You cannot prevent the birds of worry and care from flying over your head. But you can stop them from building a nest in your head” (p. 1177). Not only is math anxiety a product of low self-efficacy, but it is also a source (Bandura, 1977/1986). Mathematics is a subject in which mistakes are frequent and necessary, such as in trial-and-error problem-solving approaches, yet due to the perfectionist culture of our society, students often fear mistakes, increasing their anxiety and task-avoidance (Boaler, 2016; OECD, 2015). This product-focused approach to mathematics that equates aptitude with error-free solutions further perpetuates the association of anxiety with math, and because males are already viewed as being innately superior in math, this increased math anxiety is more damaging to females (Frankenstein, 1992). Another misconception promoted by the societally-developed hegemonic and competitive culture of mathematics is that individuals who are strong at mathematics are also fast in mathematics problem-solving and computation (Boaler, 2016; Frankenstein, 1992). Classroom practices, such as basic facts assessments, are often associated with time, which significantly increases anxiety among students, especially females (Boaler, 2016). In the majority of OECD countries, including the United States, females reported higher levels of math anxiety, which is correlated with lower performance (and therefore decreased mastery experience) (OECD, 2015). These higher levels of math-anxiety have been correlated with negative self-efficacy beliefs (Griggs, Rimm-Kaufman, Merritt, & Patton, 2013).

A possible rationale for these gender disparities in negative physiological states in math has been the impact of stereotype threat. Stereotype threat can produce negative physiological reactions, such as increased blood pressure, to situations in which one is inculcated to believe through societal influences that she should not be successful (Hill et al., 2010). As males are commonly thought to be more successful in math than females, simple allusions to gender, such as asking individuals to circle their gender before beginning an assessment, can further elicit this stereotype threat (Dowker, Sarkar, & Looi, 2016; Hill et al., 2010; Steele, 2010). Teacher anxiety has also been proposed as a potential cause of increased female anxiety in mathematics. After studying levels of math anxiety among 17 female math teachers and the gender-stereotypical beliefs and performance of their students, Beilock, Gunderson, Ramirez, and Levine (2009) found that increased math anxiety expressed by female teachers was correlated with lower female student achievement and stronger gender-stereotypical math beliefs among female students, trends that were not present at the start of the school year. These findings suggest an intersection between math anxiety held by female teachers and the vicarious experience presented to students that confirm gender stereotypes. However, as described above, observing models perceived to be similar to oneself persevere through mathematical struggle and mistakes can strengthen perceptions of self-capability (Bandura, 1977; Lin-Siegler, Ahn, Chen, Fang, & Luna-Lucero, 2016; Pajares & Schunk, 2002).

Griggs et al. (2013) explored the potential of a common instructional approach, *Responsive Classroom*, to decrease students' math anxiety and increase math self-efficacy. The *Responsive Classroom* approach focuses on fostering supportive learning environments in which students feel safe to take risks with encouragement from their peers (Griggs et al., 2013). Unfortunately, the study did not show a significant increase in math-self-efficacy as a result of the implementation of *Responsive Classroom*; however, there was a significant difference in the strength of the relationship between math anxiety and self-efficacy between classrooms that used *Responsive Classroom* and those that did not (Griggs et al., 2013). Therefore, techniques that build a sense of classroom community and support among peers may help to alleviate the effects of math anxiety, but further intervention is required to attend to additional sources of self-efficacy.

Drawing on modern technology, Schaeffer, Rozek, Berkowitz, Levine, and Beilock (2018) conducted a longitudinal study with 587 first-grade students in which they sought to decrease the connection between parents' math anxiety and the lower achievement of their children. The employed intervention was the nightly use of a math app called 'Bedtime Math.' Schaeffer et al. (2018) found that not only did the app decrease the impact of parent math anxiety on student achievement, but that this influence remained even two years after the usage of the math app was ended. Additional interventions that have been found successful in helping students to overcome negative physiological states associated with mathematics are the use of bibliotherapy, or literature that desensitizes mathematics, breathing techniques, positive self-talk, and journaling (Furner & Duffy, 2002; Tobias,1987). Negative physiological states in math and students' perceived abilities to overcome these states served as a source of self-efficacy explored in the current study. Providing the teacher-researchers with a review of the physiological interventions outlined above allowed the educators to make informed decisions about the actions to employ in their classrooms.

Summary

Bandura (1977/1986) professes that the experiences one chooses to engage in or avoid, such as educational and career pursuits, are determined by the self-belief systems the individual holds regarding her potential success in the given experience, referred to as self-efficacy. At the time of its conceptualization, self-efficacy theory was groundbreaking as it challenged previous behaviorist views that failed to acknowledge the role of human agency in behavior (Bandura, 1999; Simon, 1999). Today, self-efficacy theory and its revitalization through growth mindset ideology (Dweck, 2006) hold significant implications in regard to gender disparities in mathematics, as biological explanations of mathematical capability have proven to be flawed and sociocultural forces in the environment have emerged as influential factors in fostering gender differences. The present study utilized the four sources of self-efficacy purported by Bandura (1977), mastery experience, vicarious experience, verbal persuasion, and physiological states, as lenses for analysis in examining how self-efficacy beliefs among students in the setting of study are developed and what interventions can be employed to increase self-efficacy beliefs among females. These goals were targeted through feminist-infused PAR and critical feminist theory, using qualitative methodology drawing on the tenets of constructivist grounded theory. The study empowered teacher-researchers and student participants to critically analyze the views they hold, societal influences, and educational practices that produce gender disparities, striving collaboratively to break free from oppressive systems and move toward equitable mathematical opportunity across genders.

Chapter 3

Research Design and Methods

The development of the methodology used in the present study centered on the aim of critically examining female self-efficacy in math in order to engage in praxis toward equitable learning opportunities across genders. The problematic manifestations of low math self-efficacy identified among females in the local context demonstrated the need to gain further insight into the source of self-efficacy development resulting in these negative self-beliefs. Identifying the source most influential in the construction of negative self-efficacy beliefs through critical inquiry would allow the teacher-researchers and I to take action guided by the female students' perspectives. The research question that guided the study was: *As an administrator-researcher in collaboration with teachers, how can we promote positive self-efficacy beliefs among female students in mixed-gender mathematics classes?* The sub-questions included: *(a) What are the most influential sources of mathematics self-efficacy development among females? (b) How can teachers modify classroom practice to address common gender disparities in mathematical self-efficacy? (c) As an administrator-researcher, what methods are effective in prompting feminist-infused critical inquiry among teachers?*

Maintaining the transparency of the study, this chapter will begin with a detailed description of the context of the research and the purposive sampling methods used to select the participant population. The following section will outline the research design, demonstrating how viewing the problem of practice through a critical feminist lens situated in social constructivism led to the decision to use qualitative methodology within PAR (Lykes & Hershberg, 2012). Further elaborating on the conceptual framework, details will be provided on the development and administration of the questionnaires, focus groups, and interviews used to collect data, as well as the constant comparative approach to data analysis that was applied in alignment with the emancipatory tenets of critical feminist theory (Gannon & Davies, 2012; Hesse-Biber, 2012).

Context and Participants

The K-8 district in focus is set in a suburban town of New Jersey, where the population in 2010 was 90.3% white, 6.5% Asian, 5.4% Hispanic or Latino, 0.8% black or African American, and 1.2% mixed races (US Census, 2010). In 2010, the rate of home ownership was reported at 89.1%, with a median home value of $754,400 (US Census, 2010). In the 2015-2016 school year, only seven of the district's 766 students were eligible for free or reduced lunch (National Center for Education Statistics, 2016). In kindergarten and first grade, our math classes are taught by generalist educators who also teach language arts, science, and social studies, and in second through fourth grade, the generalist educators teach only math and language arts. The fifth through eighth grades are fully departmentalized, with sixth- through eighth-grade math classes also being ability leveled.

As generalizability is not the goal of the action research study, nonprobabilistic sampling measures were employed (Merriam & Tisdell, 2016). The sampling was purposive in order to gather a cadre of teacher-researchers with the necessary background knowledge and interest. Teachers were invited to participate in the study on a volunteer basis, provided that they met the criteria of currently teaching at least one math class and having at least three years of experience involving math instruction with evaluative ratings of effective or highly effective. Such criteria were necessary to strengthen the validity of the insights expressed by teacher-researchers, enable teacher-researchers to draw on prior experience, and ensure that the interventions were being implemented by effective teachers. The target number of teacher-participants was initially three; however, due to collaborative teacher pairs volunteering to participate, I accepted two general education classes and two collaborative classes into the study in order to maintain a balance between the class types and support comparative analyses. Therefore, a total of six teachers participated in the study. One of the selected teachers, Ms. Quade, taught a third-grade general education class, Mr. Erikson taught a fourth-grade general education class, Ms. Nelson and Ms. Holt collaboratively taught a fourth-grade class, and Ms. Davis and Ms. Turner collaboratively taught a fifth-grade class. The female and male students of these classes for whom parental consent was obtained participated in the student questionnaires administered and the applied interventions. While the data analyses and decisions made pertaining to intervention implementation focused on the female experience, males also had equal access to the interventions. These were mixed-gender classrooms, and as an administrator and educator, it would have been unethical to limit male students' access to interventions that they may have found beneficial. Further, certain interventions focused on the development of the mathematical community, which includes the male students in a mixed-gender classroom. The ratios of females to males, according to students' gender identifications on the questionnaires, among the participants enrolled in the classes of Quade, Erikson, Nelson/Holt, and Davis/Turner were 11:8, 7:10, 6:8, and 7:9, respectively. The number of teacher-participants, as well as their corresponding classes, allowed for a variety of perspectives in achieving democratic validity (Herr & Anderson, 2015), while also keeping the sample size small enough to form trusting relationships that prompted honest expression of ideas among participants. The small sample size also increased the ability to provide rich, thick description, allowing for possible transferability that nonprobabilistic sampling does not inherently afford (Merriam & Tisdell, 2016). In reporting the findings from the study, pseudonyms have been used in referencing the teacher-researchers.

As a member of the team of researchers, I will also hold a participant role as an administrator-researcher. Contrary to common classifications of researchers as insiders or outsiders to the study, my insider-outsider status lies on the spectrum between these two identities (Merriam et al., 2001). Grounded in the tenets of critical and feminist research, driving frameworks of the present study, Merriam et al. (2001) view the location of a researcher along the insider-outsider spectrum through the lenses of positionality, power, and representation.

Positionality is impacted by the characteristics we share with a group, such as culture, gender, age, class, race, and religion (Merriam et al., 2001). Gender is a characteristic central to the study. As a female, I was able to better identify with the worldviews of the female students included in the study; however, this connection, including my own gender-related mathematical experiences, also biased my interpretations. Using PAR helped account for these inherent biases by allowing multiple teacher-researchers' worldviews to guide the study as opposed to basing the research solely on my interpretations. Five of the teacher-researchers were female, which granted me further insider positionality in being able to relate to their lived experiences related to gender and math. Since the study also involved future career pursuits, economic status played a role in defining my positionality. Overall, my economic class is lower than that of the students included in the study due to the affluence of the neighborhood, which caused an outsider positionality with regard to interpretations of student responses. As for the teacher-researchers, we hold similar statuses in terms of economic class, strengthening my insider positionality. Another area of positionality that was key to the study, and in which I differ from both the teacher-researchers and students, is that I am an outsider to the classroom community. While I am an insider to the schools, and the students are familiar with me, I am not a daily presence in the classrooms. This outsider positionality further necessitated PAR in order to strengthen the analyses of manifestations of student self-efficacy and the impact of interventions employed. Age is another characteristic in which I differ from the students, which begins to point to another lens of insider-outsider status: power. Due to my age, and being an administrator in the district, this may have caused me to be viewed by students as not only an outsider, but one who has a higher degree of power. These power relations may have also played a role in my collaborations with teacher-researchers, as I formally observe and evaluate the teachers each year. Although I aimed to empower students and teachers by valuing their perspectives throughout the research process, it was essential that I remained cognizant of the power dynamics that could have interfered with obtaining honest input from students and teachers. Having previously taught in the district, I do have strong bonds with the teachers that are atypical of someone in my position. These foundations of our working relationships helped develop a trusting and supportive environment for collaborative work, focus groups, and interviews throughout the study.

The constructivist paradigm holds that multiple truths exist and individuals each develop their own truths through the construction of meaning (Merriam et al., 2001). Therefore, the representation of knowledge conveyed in this study was impacted by my own worldviews, and as such, may differ from the worldviews of the participants, regardless of efforts to keep their voices at the heart of the research. My own experiences as a female child, always comparing my mathematical abilities to my high-achieving brother, impact the way I view the experiences of female students who hold low perceptions of their capabilities in math. The gut-wrenching feelings I have experienced when my own female students have doubted their math abilities also influence the way I view and construct new knowledge. Insider and outsider statuses each have their advantages and disadvantages, from being able to elicit honest responses to viewing details of the setting often overlooked by those who live it. No status is better than the other, but what is essential is constant reflection on one's place in relation to the setting and participants and how this status might impact data collection and analysis (Herr & Anderson, 2015). Feminist theory holds that subjectivity permeates across all facets of the research process, impacting every decision made, and therefore, we must disclose our positionality and the corresponding biases introduced to the study (Hesse-Biber, 2012).

The final participant included in the study was a former interim principal who worked in the district intermittently from 2015 to 2017. Ms. Becker supported the research process by peer-reviewing all dissertation material and plans for the study, and at times, being present during the data collection to evaluate and strengthen the validity of the methodology. Further, Ms. Becker served as my co-rater, engaging in data analysis and offering another perspective on the analyses conducted by the teacher-researchers and me. While Ms. Becker held a degree of insider status due to the relationships formed with staff members during her time in the district, no longer holding a position in the district afforded Ms. Becker an outsider status and worldview that I was unable to embody. In describing teams of insiders and outsiders, Bartunek and Louis (1996) write, “The parties, in a colloquial sense, keep each other honest” (p. 62). Our complementary positionalities strengthened the validity of the study.

Research Design

The current study emerges from the oppressive sociopolitical constructs impacting female math self-efficacy at the macro and micro levels (Hill et al., 2010). Grounded in the ontological framework of social constructivism, that there is no one reality, but rather, multiple realities are constructed through individuals’ interactions with society, and its epistemological tenet that this socially constructed knowledge must be interpreted, the study relied on qualitative methodologies to allow for these individualized interpretations (Merriam & Tisdell, 2016). Also deriving from social constructivist ideology, self-efficacy is a concept that evolves through individuals’ interpretations of interactions with society (Bandura, 1989). Therefore, research on these interpretations must attend to the individual worldviews of the population that is the focus of the study. Relying on quantitative evaluations of these experiences would dismiss the individual truths held by the female students.

Qualitative research can take on a naturalistic or constructionist approach (Silverman, 2013). Given the focus on participants’ perspectives and worldviews, the study aligned with the constructionist model, highlighting the ties to constructivist grounded theory, which derives from social constructionism (Charmaz & Bryant, 2010). Thus, the data collection methodologies of the study were developed with the aim of better understanding how female students' math self-efficacy beliefs were constructed and continue to be constructed in order to disrupt the development of low math self-efficacy beliefs and produce a mode of construction that promotes more positive math self-efficacy among females. Silverman (2013) asserts, "Both inner lives and social worlds are epiphenomenal to the constructive practices of everyday life" (p. 107). Therefore, it was imperative that we investigated the constructive practices relating to math self-efficacy among females in order to affect change upon female students' worldviews with regard to their mathematics potential and the social worlds that derive from and inform these inner beliefs.

Freire (2005), often viewed as the originator of action research, affirmed the importance of critical reflection in education and maintained that schools should serve as platforms for social action (Herr & Anderson, 2015). While Freire did not specifically attend to gender oppression, a common criticism of his work, his critical pedagogy gave voice to feminists who would later take up his call to action (hooks, 1994). In the current study, we heeded this call. In order to pursue our goal of achieving social justice, we needed to critically analyze our current practices and action, or lack thereof, in addressing societal systems of marginalization (Brydon-Miller & Maguire, 2008; Freire, 2005). Negative impacts of low female math self-efficacy demonstrated inequities in educational opportunities in the local context. Although these inequities had previously been overlooked, critical analyses of the practices resulting in decreased math self-efficacy among females, in concert with theoretical grounding and reflection on prior research, had the potential to prompt praxis that could combat these inequities in the local setting, characteristic of action research (Herr & Anderson, 2015). However, as an administrator in the district, I was now more removed from the micro-level setting of the classroom in comparison to my positionality when I was a teacher in the district and first became aware of these gender inequities. Further, emancipatory action taken in the classroom setting would need to be implemented by the teachers of those classes in collaboration with their students. Therefore, the teachers also needed to engage in critical inquiry, and their perspectives as insiders to the classroom settings would be integral to this conscientization (Herr & Anderson, 2015). Thus, participatory action research (PAR) was employed in which the participants took on the roles of researchers (Herr & Anderson, 2015).

As opposed to defining the problem in its entirety *a prioi*, the study needed to launch with an investigation into the problem that would spark critical inquiry among the teacher-researchers and empower them to define the problem, consistent with PAR (Merriam & Tisdell 2016). The problem identification then informed the cyclical PAR to follow. Once the problem was defined, the teacher-researchers worked collaboratively to generate and then implement the action plan. Through critical reflection, the teacher-researchers identified interventions that were successful as well as inequities that remained. These critical analyses led to revisions to the action plan and iterative cycles of implementation, reflection, and revision.

The study was developed as an integration of both investigative and interventional research. Alignment with PAR required that the teacher-researchers and I defined the problem collaboratively, and in order to keep the voices of the marginalized female students at the forefront of the study, this problem identification necessitated investigative research. While the general problem of practice had already been framed based on my classroom observations and discourse with students and colleagues, the specific source of self-efficacy that was leading to inequities in mathematical learning needed to be determined based on interpretations of the worldviews expressed by the female students. Therefore, due to the emergent identification of the problem to be targeted and my commitment to teacher-researcher empowerment, consistent with the values espoused by critical feminist scholars and proponents of PAR (Herr & Anderson, 2015; Merriam & Tisdell 2016), the interventions to be included in the action plan could not be set *a priori*. All interventions leading into the study were hypothetical.

My experiences that prompted the study brought to light the macro-level influences impacting math self-efficacy of female students in the K-8 district in which I, at the time, served as a teacher and currently serve as an administrator. One of these influences was the image of females in relation to mathematics conveyed in television programming and throughout history. While this pointed my attention toward the role of vicarious experiences as a source of math self-efficacy development among females, I was lacking an in-depth understanding of the significance of this source, as well as the impact of the three remaining sources of self-efficacy development: mastery experience, verbal persuasion, and physiological states (Bandura, 1977). Therefore, the study aligned with components of constructivist grounded theory, in that the interventions to be employed were not known at the outset of the study, but rather, emerged from the data collected, ensuring that participants' lived experiences, including input and reflection from teacher-researchers, remained central to the study (Charmaz, 2000). Pre-intervention questionnaires purposefully developed to analyze the sources of self-efficacy at play guided the intervention implementation. Reflecting on the data and prior research, the teacher-researchers and I collaboratively developed a plan of action.

Since I did not know which source of self-efficacy would be targeted at the start of the study, I prepared summaries of interventions based on prior research specific to each source of self-efficacy to support the teacher-researchers in generating the action plan once the target source was identified. These summaries also included possible interventions I had generated throughout the planning process for the study.

The set of possible interventions targeting mastery experience included providing disconfirming experiences for students with low self-efficacy (experiences that would result in success) (Bandura, 1977), such as utilizing scaffolded tasks beginning with low-level entry points that all students could experience success with, or warm-up exercises that prompt success for all learners (Boaler, 2016). Since student perception of success affects self-efficacy, as opposed to actual success, and females tend to self-evaluate themselves lower than males in math, strategies targeting accurate self-evaluation aligned with demonstrated performance were also included as possible interventions (Falco et al., 2010; Gonida & Leondari, 2011). For example, a proposed strategy included providing students with detailed checklists of skills necessary to master a particular concept, which would be used in self-reflecting, rather than simply asking students to generally reflect on their levels of success with the concept in focus.

With regard to vicarious experience, interventions included on the summary list were the use of television clips presenting females who are successful in the math field or having a successful female mathematician engage in mathematical discussion with the students virtually or in-person (Bond, 2016; Harro, 2013). Individualization activities that guide females to view themselves as individuals, rather than strong identification with the socially-constructed gender group they belong to, were also included as potential beneficial techniques in combating any negative vicarious experiences that surfaced (Ambady, Paik, Steele, Owen-Smith, & Mitchell, 2004). Another strategy included pertaining to vicarious experiences was the use of read-alouds depicting female characters who achieve success in mathematics.

The intervention list to be reviewed if our analyses had pointed to the role of verbal persuasion included focusing our efforts on educator and peer praise and encouragement, which have previously been linked to self-efficacy development (Rice et al., 2013). Specifically, these interventions would have focused on the attributions of praise, emphasizing effort over math giftedness, which would also require critical self-analyses of expressions of praise among teachers (Espinoza et al., 2013). Influential verbal persuasion is not only student-specific, but also includes the verbal messages expressed to students in regard to their gender roles and the relation of those roles to mathematics (Steele, 2010). Therefore, an additional potential intervention included was providing verbal persuasion that addresses the biased and inaccurate messages sent to children that females are not typically math people. This form of persuasion would consist of ongoing dialogue and instruction communicating to students that anyone can be successful in math, regardless of their gender.

Finally, the developed list of interventions to support the generation of an action plan focused on physiological states included the desensitization of failure in math, making failure and mistakes a natural part of mathematical work (Boaler, 2016). Strategies for overcoming math anxiety were also included, drawing on the techniques of *Responsive Classroom* in fostering a climate in which students feel supported by peers and therefore more comfortable in taking risks (Griggs et al., 2013). Additional options for interventions targeting physiological states included bibliotherapy, or the use of literature to desensitize math experiences, calming techniques such as focused breathing and positive self-talk, and journaling (Furner & Duffy, 2002; Tobias, 1987). The summary also included analyses of common math practices that elicit stress and anxiety, such as timed assessments (Boaler, 2016). Further, reflection on teacher and parent math anxiety, which has been found to impact student self-perceptions, was also included (Beilock et al., 2009; Schaeffer et al., 2018).

Consistent with the emergent nature of PAR (Merriam & Tisdell, 2016), once the target source of self-efficacy development was identified by the group of teacher-researchers, the list of possible interventions used to generate the action plan was shared with the teachers in a live digital format so that I could revisit literature on this source and further supplement the collection of interventions already proposed. The live nature of this document also enabled the teacher-researchers to add to this list prior to our next focus group in which the action plan was generated.

Throughout the implementation of the selected interventions, data was collected on the targeted construct of the study: levels of math self-efficacy. As interventions were employed, qualitative data was gathered through focus groups and interviews to evaluate changes in self-efficacy, thereby pointing to the level of success of the interventions.

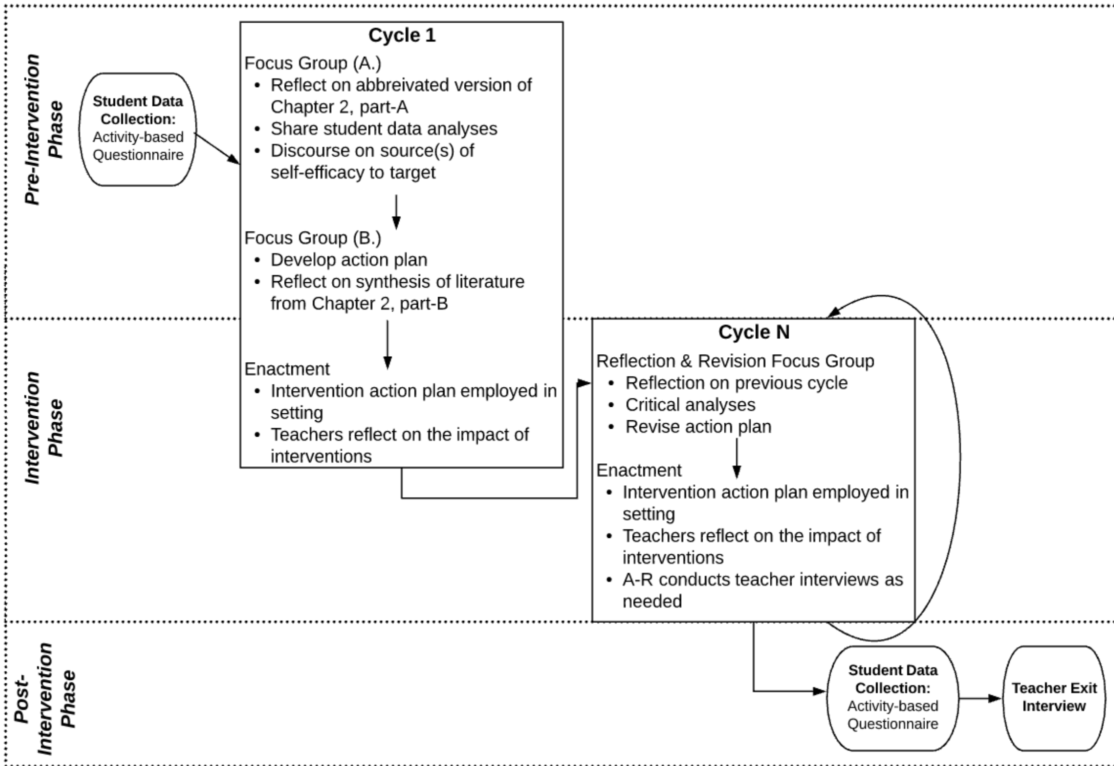

Figure 3.1 The emergent and reflexive design of the study is demonstrated through the cyclical approach to data collection and intervention implementation.

Central to the current study are the action research quality criteria of process validity, dialogic validity, and democratic validity (Herr & Anderson, 2015). Given that the study centered on student perceptions of self, the abstract concept of self-efficacy as it applies to students' individually held perceptions can never be fully known by the researchers, and therefore, a continuously critical stance through process and dialogic validity was essential (Herr & Anderson, 2015). The former incorporates the reflexivity of the study, maintaining that the researchers engage in continuous reexamination through methods such as triangulation, and the latter denotes the critical analysis of the research process in determining the validity of the methodology and results, also referred to as peer review (Herr & Anderson, 2015). Further, in order to overcome the current gender disparities that marginalize females in the field of mathematics, it was essential that the study upheld a commitment to social justice by including multiple perspectives, allowing the voices of educators and students to be heard, consistent with the criteria of democratic validity (Herr & Anderson, 2015).

Process, dialogic, and democratic validity were addressed through the varied methods of data collection, emergent design of data analysis, and inclusion of multiple perspectives. The study was continuously developed and conducted in collaboration with teacher-researchers, as well as a former interim principal who supported the data collection process and served as a co-rater in the analysis of data. Engaging the team of educators in the analysis of data and decisions made regarding further interventions allowed for an ongoing critical examination and reexamination of findings and actions implemented from multiple viewpoints. Further, using multiple means of data collection, including student questionnaires, focus groups, and teacher interviews, in addition to my own log of field notes, strengthened process validity through triangulation (Herr & Anderson, 2015). Aligning with the emergent design of constructivist grounded theory, a driving component of the theoretical framework of the study, the constant comparative method was employed, comparing data collected within and across classes, as well as across collection methodologies (Charmaz, 2000). The means of data collection employed that honored the voices of student- and teacher-participants served to break down barriers of positionality typical of traditional research and increase the democratic validity of the study and commitment to social justice (Herr & Anderson, 2015).

With regard to quality criteria specific to qualitative methodology, the criteria of maintaining a self-critical approach to validity and reliability, making a practical contribution, and ethicality were integral to the study (Silverman, 2013; Tracy, 2010).

The problem of female self-efficacy in math is ongoing, with little improvement in recent years. New understandings are necessary to explain and address this phenomenon and make a relevant contribution to the setting of practice (Silverman, 2013). This end goal can only be accomplished through the use of aligned methodologies that are both valid and reliable (Silverman, 2013). Further, ethics guided every decision made by the research team, especially given that the study involved working directly with children, and therefore, not only was the wellbeing of the children a priority, but also the consent of their parents (Tracy, 2010).

The aforementioned means of triangulation strengthened the self-critical approach to the study. Further, the focus groups I facilitated with teacher-researchers also promoted reflexivity by prompting educators, myself included, to reflect on the data collected as well as our own experiences to uncover our perceptions and biases and allow our worldviews to be changed through an analysis of others' perspectives. This critical analysis led to the identification of influences on students' math self-efficacy and interventions that proved to be successful in improving female self-efficacy in math, thereby making a profound impact on the setting (Herr & Anderson, 2015; Silverman, 2013). The ethicality of the study was upheld through the voluntary nature of participation by students and teachers, including the obtainment of parent consent for all student participants, the ability for participants to withdraw from the study at any point, and post-study interventions necessary to further address misconceptions and biases identified during the course of the study (Tracy, 2010).

Data Collection Instruments

As the goals of the study center on the mathematical experiences of female students, the constructive practices that create these students' inner lives and social worlds needed to be examined, making student questionnaires an appropriate fit for the study (Adams & Cox, 2008; Silverman, 2013). Empowering teacher-researchers through PAR, focus groups were necessary to support the educators in collaboratively analyzing the questionnaire data, generating action plans in addressing the problem, and reflecting on the impacts of modifications to classroom practice (Marshall & Rossman, 2016). In order to attend to individual perspectives among the teacher-researchers and ensure that they were supported in engaging in praxis toward social justice, as well as reflect on the success of the study in prompting critical inquiry among teachers, one-on-one, or two-on-one in the case of collaborative pairs, interviews were necessary (Marshall & Rossman, 2016).

Questionnaires

A form of researcher-generated documents, questionnaires allow the researcher to investigate a problem of practice by obtaining data central to the phenomenon being studied (Merriam & Tisdell, 2016). Similar to a structured interview in that the questions are pre-set, questionnaires ask participants identical or similar questions (Fortune, Reid, & Miller, 2013). Often used in place of interviews when there is a large number of participants from which information is sought, questionnaires can be beneficial in guiding additional data collection measures by pinpointing a problem or area of focus for further investigation (Adams & Cox, 2008). Drawing on these advantages, a pre-intervention questionnaire was used in the present study to identify the specific source of self-efficacy development to be the focus of the action plan and further analyses of self-efficacy development. The questionnaire allowed for a practical means of collecting data on students' beliefs, attitudes, behaviors, and interpretations of experiences (Rowley, 2014), given that there were 66 student participants in the study and conducting interviews with each student would not have been feasible due to the time constraints of the research study and my desire to limit interference with instructional time. At the conclusion of the study, a post-intervention questionnaire was also used in order to gather data on changes in students' perceptions relevant to math and self-efficacy as well as their reflective feedback on the employed interventions.

The pre- and post-intervention questionnaires were strategically developed to be activity-based, prompting experiences that students were asked to reflect on. Questionnaires may be closed-ended, typically used to gather numerical data, or open-ended, offering qualitative data (Zohrabi, 2013). In the current study, the developed pre- and post-intervention questionnaires relied heavily on open-ended questions in order to bring student voices to the forefront. Three closed-ended activity questions were also used on each questionnaire, but they were used in conjunction with open-ended follow-up questions. One of these questions was a math problem intended to mimic a typical math experience in the classroom. The problem was complex enough to challenge the students across grade levels but only required prior knowledge of basic addition and multiplication, concepts covered at the start of third grade. The students were then asked to reflect on the physiological states experienced during this task. The second closed-ended question asked students to sort individuals according to the professions the students believed the individuals held, which was followed up with an open-ended question that asked students to reflect on why they sorted the individuals and professions in the way they did. The third closed-ended question asked students to identify math role models that they would then reflect on. Because the central goal of the pre-intervention questionnaire was to gain insights on female students' math self-efficacy levels and development, the questions were formulated using the components of self-efficacy explicated by Bandura (1993), leading to the examination of how students "feel, think, motivate themselves, and behave," also referred to as their affective, cognitive, motivational, and selection processes (p. 118). The activity-based questions were derived from the sources of self-efficacy development identified by Bandura (1977): mastery experience, vicarious experience, verbal persuasion, and physiological states. Two open-ended questions, at times paired with closed-ended questions as described above, were developed per source to evaluate the significance of mastery experience, vicarious experience, verbal persuasion, and physiological states in developing math self-efficacy beliefs. With regard to vicarious experience, a third activity was included, adapted from the work of Ambady et al. (2001), in which students were asked to listen to a short story of a successful math student and retell the story as my co-rater and I attended to the gender pronouns used. The purpose of this additional activity was to ensure that we examined not only explicit bias pertaining to gender and math but also implicit biases which may impact vicarious experiences. Finally, two open-ended questions not tied to specific sources of self-efficacy development were included with the intent of gauging general self-efficacy beliefs in math. The students at the same grade level received identical questionnaires, and while the topics of the questionnaires remained the same across varying grade levels, minor adjustments were made to questions that asked students to reflect on prior and future experiences, such as changing “middle school” to “high school.” The pre-intervention questionnaire is included in Appendix A.

In developing questionnaires, it is important to be cognizant of the vocabulary used, the length and clarity of the questions, and any unintentional leading embedded in the questions (Adams & Cox, 2008). Piloting the questionnaires can help point out possible flaws. Prior to utilizing the pre-intervention questionnaire in the study, my co-rater and I each administered the questionnaire to a student outside of the study and observed as the students completed the questionnaire, taking notes for later comparison. After meeting with my co-rater and reviewing the notes we had each made as we observed our pilot students complete the questionnaire, we made adjustments to the terminology used, provided definitions where necessary, such as in describing the STEM and non-STEM professions used in one of the questions, revised the wording of the questions to add clarity, and reformatted the layout of the questionnaire.

While the study was ongoing, after we had identified the source of self-efficacy development to be targeted, I began to compile the post-intervention questionnaire. This questionnaire mirrored the questions from the pre-intervention questionnaire, but only included those relevant to the source of self-efficacy that was the focus of the action plan, as well as a secondary source that the teachers at times attended to due to its impact displayed in the pre-intervention questionnaire data. The post-intervention questionnaire also included reflective questions that asked students to provide feedback on which, if any, interventions they found to be most beneficial and why these interventions were or were not beneficial (see Appendix X for the post-intervention questionnaire).

Focus Groups

Central to critical feminist theory is the cultivation of emancipatory discourse around injustice and inequity (Gannon & Davies, 2012). A form of interviewing that occurs in which the facilitator asks questions of a group instead of an individual, focus groups promote discourse around targeted topics (Marshall & Rossman, 2016). Aligning with the social constructivist paradigm, focus groups acknowledge the social component of knowledge construction, enabling participants to develop and share understandings emerging from the group discourse and expressed ideas of others (Marshall & Rossman, 2016; Morgan, 2010). Focus groups provide a forum for critical reflection that points to the power of collaboration in bringing about social justice (Willis, 2008). Using focus groups with the teacher-researchers provided a space for this emancipatory discourse. Proponents of critical theory and feminist theory alike promote the inclusion of those with power in such discourse to help bring about social change (Gannon & Davies, 2012). While we have experienced the oppressive structures of society in relation to gender and math, either through our own first-hand experiences or in struggling alongside our students, we also have the power to modify our educational practices to combat the injustices imposed by society. This starts with using our voices. Focus groups are a beneficial tool for qualitative research when the goal is to define a problem, reflect on the success of interventions or practices, and develop new ways of addressing a problem (Mahoney, 1997). The aims of the longitudinal focus groups used in the study were to gain insight into problematic gender disparities in levels of math self-efficacy and the impact of sources of self-efficacy development (Bandura, 1977), generate an action plan to address these identified areas of need, and evaluate the effectiveness of employed interventions. Additionally, the focus groups were intended to strengthen the teacher-researchers' critical awareness of the inequities in their classrooms. These focus groups were semi-structured, with questioning used to examine specific topics but also allowing for open-ended discourse that empowered the teacher-researchers to engage in their own self-directed critical analysis (Morgan, 2010).

In conjunction with topic-specific questioning, stimulus materials were also included in each focus group to prompt critical reflection and emancipatory discourse (Silverman, 2013). At the outset of the study, these stimulus materials were developed with the intent of initiating critical analyses among the teacher-researchers and sparking their awareness of the problem of practice. As the study progressed, stimulus materials served the purpose of supporting the development and revision of action plan interventions, and prompting reflections on manifestations of female math self-efficacy in the classroom and any shifts observed. The discourse that emerged as a result of these stimulus materials, as well as targeted questioning, fostered critical inquiry among the teachers as they pointed to systemic influences impacting female self-efficacy in math. This collaborative discussion also initiated a support system among the teachers in which they offered strategies and used questioning to address areas of concern relating to female math self-efficacy (see Appendix E for focus group protocols and prompts).

Interviews

Interviewing is a means of data collection that can fit a variety of intentions. Interviews might be used to inquire about deeper worldviews and understandings held by the interviewee, or they might be used to engage in collaborative construction of knowledge (Marshall & Rossman, 2016). Such interviews can range from being unstructured to structured, taking place as an informal conversation or being guided by scripted questions (Marshall & Rossman, 2016). Regardless of the format, respectful and trusting relationships are necessary in order to gather meaningful data (Marshall & Rossman, 2016). During the second cycle of the study and at the conclusion of the study, semi-structured interviews were used with each teacher-researcher or collaborative pair of teacher-researchers. In order to maintain a comfortable environment without the feelings of tension often prompted by formal interviews, these interviews were conducted as lunch meetings whenever possible, as well as collaborative discussions during the teachers' prep periods (Marshall & Rossman, 2016). I used a form of dialogic interviews, as described by Marshall and Rossman (2016), which included pre-planned questions that maintained a focus on topics related to female math self-efficacy development and the enacted interventions, as well as the co-construction of knowledge in reflecting on the efficacy of interventions and generating methods of improving these interventions. I typed all responses to the pre-planned questions verbatim. After engaging in conversations that prompted the co-construction of knowledge, I recorded notes on these discourses as well. In the final round of interviews, the pre-planned questions were also used to gather data on the success of the study in prompting critical reflection and awareness among the teacher-researchers (see Appendices L and N for semi-structured interview prompts).

The emergent nature of critical feminist theory and qualitative PAR both enabled and relied upon interconnections between the above data collection instruments (Clarke, 2012; Herr & Anderson, 2015). The student pre-intervention questionnaires directly influenced all future focus groups and interviews, and the insights and problems identified in focus groups led to the construction of interview questions and dialogic topics that emerged during interviews. Ongoing data analyses conducted throughout the study supported these connections (Charmaz, 2000).

Research Procedure

PAR embodies a cyclical and emergent design, requiring that the researcher is comfortable with a degree of messiness to the study (Herr & Anderson, 2015). The current study epitomizes these characteristics of PAR, as not only themes and patterns for analysis, but the interventions themselves emerged from data collected within the study. Prior to the launch of the study, all teacher-researchers received resources outlining the key notions of self-efficacy, including the sources of self-efficacy development identified by Bandura (1977). This enabled the teacher-researchers to play key roles in the data collection and analysis processes, as well as the ongoing design of the study.

In the first week of the study, all students enrolled in the math classes of the teacher-researchers completed the aforementioned pre-intervention questionnaire. I visited each class to administer the pre-intervention questionnaires while the teacher-researchers were in planned professional development sessions, minimizing any negative impacts on classroom instruction. All student participants were provided with numbers to record on their questionnaires in place of their names in order to maintain the confidentiality of their responses. Also in the first week of the study, my co-rater and I visited each class to pull students one-on-one for the administration of the retell activity described above. This activity took approximately one to two minutes per child. Again, numbers were recorded in place of names.

As affirmed by Herr and Anderson (2015), in PAR, data analysis does not begin at the conclusion of the data collection process, but rather, is initiated at the outset of the study and is ongoing throughout. Thus, my co-rater and I began to analyze the questionnaire data the same day that it was collected. Due to time constraints, we pre-coded and categorized the data as described below in order to allow the teacher-researchers to efficiently use the two hours allotted for the initial focus group. Charts of these analyses, which consisted of frequency counts conveying how often student responses aligned with certain categories as well as In Vivo quotes were placed into binders for each teacher-researcher to review at the first focus group.

The following week, the teacher-researchers and I joined together in the first focus group, termed Focus Group 1A (see Appendix E for focus group protocols). We began the focus group by reviewing an assignment that had been provided with the brief reading materials on the concept of self-efficacy, in which the teacher-researchers were asked to create examples to demonstrate each source of self-efficacy. The teacher-researchers were asked to share out their examples as their colleagues identified the source of self-efficacy development being conveyed. As the teacher-researchers engaged in these activities, I recorded notes on a monitoring chart to track their accuracy in identifying sources of self-efficacy. This allowed me to determine whether or not additional instruction on self-efficacy development was necessary prior to reviewing the student data. The teachers-researchers were also asked to complete an activity in which they had to sort fictional and actual student quotes based on the source of self-efficacy demonstrated. This activity was completed in groups of three, and the solutions were then shared out across groups, supporting the development of collaborative relationships.

Again, I recorded notes on the monitoring chart to evaluate the teacher-researchers' accuracy. Following the activities used to review the concept of self-efficacy and its sources of development, I provided the teacher-researchers with a mini-questionnaire that mirrored the types of activities the students had completed. The teacher-researchers were then asked to share out their responses, which were recorded on chart paper. I asked the teacher-researchers to predict how their responses would relate to or differ from the student responses. Next, I provided teachers with quantitative highlights from the student data to begin to spark their critical inquiry and ease them into the data.

At this point in the focus group, I provided each teacher-researcher with a binder of student data from the questionnaires, organized by class and separated by question set according to the source of self-efficacy targeted. The teachers were provided with approximately seven minutes to review the data from the first set of questions. After independently reviewing the data, the teachers were asked to share out about what stood out to them, what patterns they noticed, what they were wondering, and what source of self-efficacy appeared to be surfacing. These conversations were audio-recorded. This cycle continued as each set of data was reviewed and collaboratively analyzed. At the end of the focus group, the teacher-researchers were asked to identify the source(s) of self-efficacy they believed to be most influential among their female students. Based on their findings which will be presented in the next chapter, the team of teacher-researchers decided to develop an action plan centered on the source of physiological states.

With the target source identified, I provided the teacher-researchers with a digital version of the summary sheet of possible interventions focused on physiological states in math to support their generation of the action plan. The teacher-researchers were invited to add to this summary sheet prior to the second stage of this focus group which would take place when we returned from the weekend.

The second stage of this pre-intervention collaborative work, termed Focus Group 1B, was aimed at generating the action plan. We began this focus group by developing a list of sub-goals that we hoped to achieve as we worked to improve female self-efficacy in math by decreasing the influence of negative physiological states that had previously oppressed these students. Targeting these sub-goals, the teacher-researchers engaged in dialogue about the interventions they believed would be most beneficial to their students based on the findings from the student questionnaires. They then outlined the action plan to be implemented.

The teacher-researchers decided to develop an action plan that all grade levels would follow. While the rational for the interventions will be outlined in more detail in the following chapter due to the inextricable ties to the emergent findings, an overview of the intervention sequence is provided here. The team agreed that they first needed to establish the classroom setting as a safe place in which female students could self-reflect on and express their thoughts and feelings in relation to mathematics, combatting the male-dominant structures that privilege male voice and masculinity in math (Hesse-Biber, 2012; Frankenstein, 1992). Aligning with this aim, the teacher-researchers also saw the importance of proactively desensitizing mathematical experiences by addressing exaggerated perceptions of threat and normalizing struggle through self-reflective processes, beginning to target the anxiety-producing conditions of the classroom. Therefore, the teachers decided to focus on the interventions of math-focused morning meetings and journaling in the first cycle of the action plan. In the following cycle(s), they would begin to focus on coping mechanisms that students could employ when they encountered the negative physiological states the teacher-researchers identified in the pre-intervention questionnaires. Since they intended to use the 'Bedtime Math' app as a home connection, the teacher-researchers also decided to share this resource with their students as a supplemental intervention beginning in the first cycle.

After six days of intervention implementation in the first cycle, all teacher-researchers gathered together for Focus Group 2. In a semi-structured format, the teacher-researchers responded to a series of questions including those specific to the employed interventions and the success or inadequacies identified thus far, as well as suggestions for the direction of the study. Through social interaction, the teacher-researchers discussed the strengths and weaknesses of the employed interventions and discussed possible methods of modifying the action plan, upholding the reflexive nature of action research (Herr & Anderson, 2015). Since we had reached the end of our allotted time for the Focus Group 2 as we were mid-discussion on the weakness of the interventions, we decided to continue the focus group the following day. This provided me with the opportunity to collaborate with my co-rater, who had been present during the focus group, and reflect on the strengths and weakness of the interventions that had been shared out by the teacher-researchers, as well as the proposed interventions the teacher-researchers discussed in the previous focus group, in order to integrate these ideas together. Based on the findings from Cycle 1, this discussion focused on the need to bridge the gap between being able to identify coping mechanisms in isolation when the female students are in calm states and actually applying these mechanisms in the moment when emotional states are aroused. Before the continuation of the focus group the following day, I developed a “toolkit” to serve as this bridge. After group deliberation, the teacher-researchers made the decision to integrate this toolkit into their revised action plan, which was implemented in Cycle 2.

In Cycle 2, the teacher-researchers continued to implement math-focused morning meetings and journaling, and they began to roll out the toolkit described above. In the third-grade and general education fourth-grade classes, the toolit was rolled out in a series of whole-group morning meetings. In the fourth-grade collaborative and fifth-grade collaborative classes, the students were asked to reflect in their journals about whether or not they experience feelings of frustration, anxiety, or stress in math class and would be interested in learning strategies for overcoming these negative thoughts and feelings. The toolkit was then rolled out in a small-group format to students who expressed interest in learning these strategies. Due to the high quantity of students who expressed interest, two small group rollouts were conducted in each class. Since the fifth-grade classes are departmentalized, and the teachers only see these students for homeroom and the math block, I facilitated the toolkit rollout in small groups with the fifth-grade students.

In addition to the core interventions of the math-focused morning meetings, journaling, and toolkit, the teacher-researchers also decided to supplement these interventions by bringing in a female mathematician to share her struggles with the class and how she overcame negative physiological states in math, as well as continuing to support the home connections. We organized for a retired female Wall Street banker to meet with the students in each grade level, describing her pathway to a career in mathematics, how she coped with challenges in a male-dominated field, and the differences between her positive self-beliefs with regard to her math capabilities and the impact it had on her as a mathematician in comparison to the negative self-beliefs her sister held in relation to her math capabilities and the impact it had on her sister's math experiences. Connecting the work being completed in the classroom to the students' home environment, the teacher-researchers also provided a handout to parents that offered 'strategies and tips' to promote perseverance through coping mechanisms as well as positive mathematical self-beliefs that confront gender stereotypes.

During this second cycle, I met with each teacher, or pair of teachers in the case of the collaborative classes, to reflect on the success of the interventions mid-cycle and offer support or any necessary guidance. In these meetings, I also introduced a "Look-fors Checklist" in order to support teachers in identifying whether or not changes were occurring in the manifestations of math self-efficacy among their female students (see Appendix K). In this second cycle, the teacher-researchers also decided to begin collecting input from students through informal one-on-one discussions in the classroom setting to better gauge the effectiveness of the interventions for each of the female students. The teacher-researchers shared this feedback gained through informal conversations during the collaborative focus groups to support reflections on the interventions employed and determine necessary revisions.

Ten school-days after our second focus group, the teacher-researchers met together again for the third and final focus group. I asked the teacher-researchers to bring with them the posters that each class developed during the rollout of the toolkits. We hung these posters up around the room, and the teacher-researchers participated in a gallery walk. After this stimulus activity, the teacher-researchers were invited to ask questions about the toolkits they viewed or provide any reflections they had. In order to help the teacher-researchers reflect on the manifestations of self-efficacy they had observed among their female students at the start of the study, I began this focus group by having the teacher-researchers use words and/or drawings to fill in an outline of a person in way that captured the manifestations displayed by their female students prior to beginning interventions. The teacher-researchers shared these with the group. As we moved into semi-structured questioning, I encouraged the teacher-researchers to continue to reflect back on these diagrams as they analyzed shifts in self-efficacy development among their female students (see Appendix E for the focus group protocol).

Because the teacher-researchers felt that they needed more time to continue implementing the interventions with their students and gather data on the benefits or shortcomings of the interventions, we decided to continue the action plan implementation for six more school-days before I began to conduct final interviews with the teacher-researchers. In these semi-structured interviews, I asked the teacher-researchers questions specific to the interventions and manifestations of female math self-efficacy as well as questions about the design of the study. The teachers were also provided with the opportunity to offer any additional insights at the end of the interviews. After conducting the teacher interviews, I visited each class again to administer the post-intervention questionnaires, using the same protocol as the administration of the pre-intervention questionnaires.

As noted above, process, dialogic, and democratic validity are action research quality criteria of primary importance in the study (Herr & Anderson, 2015). Throughout all stages of the data collection and analysis, I collaborated with my co-rater. The protocol for each focus group and interview was shared with my co-rater, and she attended the second focus group, critically analyzing and providing feedback on the methods employed. As described below, the questionnaires were reviewed, coded, and analyzed by my co-rater, and we compared our analyses prior to sharing them with the teachers. In addition to the support of my co-rater, process, dialogic, and democratic validity are addressed through the collaboration with teacher-researchers in collecting and analyzing data and collectively making decisions regarding the progression of the study based on emerging findings.

From a self-critical standpoint in regard to methodology, my positionality must be taken into consideration. My experiences in mathematics as a female and in working with female students possessing low math self-efficacy inevitably impacted the ways in which I interpreted the data. Feminist theory holds that all research is inherently subjective, and therefore, it is essential that I disclose these biases that may impact my analyses, as well as decisions made in conducting the study (Gannon & Davies, 2012). Utilizing PAR helps to combat these biases, as the data is viewed from multiple perspectives, but we all interpret the data from our own worldviews, and therefore, our interpretations are subjective based on that ways in which we construct meaning (Merriam & Tisdell, 2016).

The quality criteria of ethics are also central to the study, especially given my primary role as an administrator with a commitment to student and teacher wellbeing. In addition to engaging teachers in the study on a volunteer basis and obtaining parental and pupil consent for all student participants, careful measures were taken to protect the privacy of data collected throughout the study. In place of recording student names on the pre- and post- intervention questionnaires, a numbering system was used to strengthen the anonymity of the data. As for the teacher-researchers, pseudonyms have been used in reporting any data from the study.

Methods of Data Analysis

Drawing on the notions of grounded theory, the analysis of data took on an emergent design with data being analyzed throughout the study, also a quality of PAR, in order to develop ideas about the phenomenon and guide the study (Charmaz & Bryant, 2010). Although the constant comparative method was originally developed by Glaser and Strauss (2017) for the purposes of grounded theory, this method of analysis is often applied to other forms of qualitative research (Onwuegbuzie, Dickinson, Leech, & Zoran, 2009). This inductive method of analysis involves coding the collected data and organizing the coded data into emergent categories or themes (Hewitt-Taylor, 2001).

Across all sub-questions, a cyclical process of constant comparative analysis was applied to the data collected. The first set of data analyzed was that which was collected through the student questionnaires, intended to address the first sub-question: What are the most influential sources of mathematics self-efficacy development among females? The analyses from this sub-question guided all future actions in the study. Beginning with the initial stage of constant comparative methodology in analyzing the student questionnaires, open coding, and when possible, In Vivo coding, was used for emergent data analysis, ensuring that the students' voices guided the study (Guest, 2012; Saldaña, 2009). In Vivo coding allows for critical inquiry that moves away from assumptions developed through biased societal influence, ensuring that student voices are heard as their words and phrases directly emerge as the codes (Saldaña, 2009). The applied coding empowered marginalized female students and enabled the expression of their worldviews to bring about social change (Lastikka & Kangas, 2017). In deriving the codes, my co-rater and I first completed cold reads of the student questionnaires through the lens of the sub-question in focus. We then completed a second read, highlighting units of meaning that were relevant to the sub-question (Guest, MacQueen, & Namey, 2012). Across the study, a unit of meaning was identified as a string of words or phrase that expressed a complete idea; if two different ideas were expressed in one sentence, these were coded as two separate units of meaning (De Wever, Schellens, Valcke, & Van Keer, 2006). As we completed this highlighting process, we remained attentive to the text that contained "impacting nouns, action-oriented verbs, evocative word choices, clever or ironic phrases, similes and metaphors," or repetition within and across participant responses (Saldaña, 2009, p. 75). Focusing on the highlighted data, codes were derived directly from the student responses by comparing data collected across students and classes, looking for commonalities as well as relevant units of meaning that stood alone (Strauss & Corbin, 1998). We met together to compare and align our derived codes. These codes were applied to individual units of meaning, which were categorized according to themes that emerged from the identified codes. For questionnaire activities that produced closed-ended responses followed up with open-ended reflection, we noted the frequencies of the various closed responses provided and followed the above methods of analysis for the open-ended portions of the questions. The open and In Vivo codes were then themed. Student data were grouped into categories, looking for patterns across the codes. For example, the codes, "stupid," and "failure," might have been grouped under the category of 'negative views of self.' In some cases, this category became the overarching theme, and in other instances, the overarching themes encompassed multiple categories. These analyses were organized in charts that included example In Vivo quotes from students representing particular categories and themes, as well as frequency counts displaying how often certain codes appeared across the student responses. Although numerical representations of data are often associated with quantitative analyses, providing counts to capture how often a code or theme appears in qualitative data allows researchers to better identify patterns in the data and maintains a degree of precision that is lost in using terms such as “most” or “many” to describe findings in qualitative data (Maxwell, 2010). The analyses from the student questionnaires were used by the research team to better understand students’ levels of self-efficacy in math and identify the source of self-efficacy development surfacing as being most influential among female math students.

The second sub-question, focusing on how teachers can modify classroom practice to address common gender disparities in mathematical self-efficacy, was addressed through data collected in teacher-researcher focus groups and interviews, during which the educators reflected on their classroom observations and interactions with students. Focus group dialogue was audio-recorded and transcribed throughout the study. In transcribing these focus groups, I used the speech-to-text tool of Google voice typing, repeating the discourse aloud as the tool transferred these verbalizations into written text. Edits reflecting the exact dialogue of the teacher-researchers were made throughout this process. As described above, interview data were collected through both verbatim scribing and notes made following dialogue in which the teacher-researchers and I engaged in the co-construction of knowledge. Analyses of the focus group and interview data followed a cyclical constant comparison approach similar to the methods applied in analyzing the student questionnaires. My co-rater and I independently completed cold reads of the transcriptions and interview data from within a single cycle, followed by a second read in which we again attended to “impacting nouns, action-oriented verbs, evocative word choices, clever or ironic phrases, similes and metaphors,” or repetition of ideas relevant to the sub-question in focus (Saldaña, 2009, p. 75). Comparing dialogue expressed across teacher-researchers and dialogue expressed across focus groups and interviews within a single cycle, we developed codes based on the data using open coding and In Vivo coding. These codes were compiled into a codebook with descriptions of their meanings. The codes were applied to the units of meaning identified in the transcriptions, and in applicable cycles, interview data. Next, the coded data was grouped into categories and themed. As we moved on to each subsequent cycle of the study in analyzing the collected data, we added to the codebook as new codes emerged. The coded data was again categorized and themed.

Also informing the second sub-question was the post-intervention questionnaire. The data from this questionnaire was analyzed using the same cyclical process of constant comparative analysis applied to the pre-intervention questionnaire. Comparisons were made between the two sets of coded and themed data.

Data collected from focus groups and interviews were also used to address the third sub-question: As an administrator-researcher, what methods are effective in prompting feminist-infused critical inquiry among teachers? The process of coding and theming the data was the same process applied during analyses for the second sub-question; however, the codes and themes differed as the data were viewed through a different lens. These codes were compiled into a separate codebook designated for the third sub-question. Due to constraints of practicality and time, I coded and themed this data independently and shared the analyses with my co-rater for peer review.

Each stage of coding upheld the quality criteria of process, democratic, and dialogic validity through the collaborative nature of the analysis phase and the perspectives included (Herr & Anderson, 2015). Analyses of student data collected through the pre-intervention questionnaires were critically examined by teacher-researchers, adding their voices to the conclusions drawn. Additionally, my co-rater engaged in peer review of all analyses made, strengthening the dialogic validity (Herr & Anderson, 2015). Democratic validity was further supported through the use of open and In Vivo coding, which brought the perspectives of female students to the forefront and gave them a voice in the pursuit of social justice in the face of societal gender bias (Herr & Anderson, 2015).

Summary

Described above, the present study was situated in a social constructivist framework, viewing the problem of practice through the lens of critical feminist theory. Critical inquiry was carried out through PAR using qualitative methodologies in order to attend to and interpret individual worldviews. The participant group was selected using purposive sampling methods, which set criteria for participation based on teacher performance and experience. Through an emergent and reflexive approach, student questionnaires were used to examine student worldviews, specifically, the sources of self-efficacy surfacing as being most influential in female math self-efficacy development, which then informed the cyclical action plan. Through teacher-researcher focus groups and interviews, the classroom educators critically reflected on the impacts of the interventions included in the action plan and made necessary revisions for future implementation. Across this cyclical process, data from focus group transcriptions and interview notes were analyzed through constant comparative methodology in order to examine the efficacy of revisions to classroom practice and the teacher-researchers' engagement in critical inquiry and reflection. The qualitative data collected across the pre-intervention, intervention, and post-intervention phases of the study enabled the findings and analyses included in Chapter Four to be presented in large part from the perspectives and words of the teacher-researchers and students.

Chapter 4

Findings

The present study was conceptualized in response to the problematic gender disparities identified with regard to mathematical self-efficacy in the local context. Task avoidance, low perseverance, passive behaviors, negative affective responses, and negative self-beliefs in math among female students, as well as a deficit view of their gender in relation to math, demonstrated the current inequities in mathematical experiences across genders as well as implications for future math participation. The purpose of this study was to critically examine female mathematical self-efficacy and the sources that are most influential in the development of math self-efficacy beliefs among females in order to engage in praxis, identifying and employing modifications to classroom practice that strengthen female self-efficacy in math. The following research question was investigated in response to this problem of practice: *As an administrator-researcher in collaboration with teachers, how can we promote positive self-efficacy beliefs among female students in mixed-gender mathematics classes?* The sub-questions were: *(a) What are the most influential sources of mathematics self-efficacy development among females? (b) How can teachers modify classroom practice to address common gender disparities in mathematical self-efficacy? (c) As an administrator-researcher, what methods are effective in prompting feminist-infused critical inquiry among teachers?*

The pursuit of social justice requires that researchers and activists move beyond commonly held and biased assumptions by ensuring that the voices of the marginalized population drive their efforts. Qualitative methodologies applied through feminist-infused critical inquiry brought the multiple truths of the participants in the present study to the forefront. The study was launched through the use of student questionnaires that directly guided the actions taken by the research team. Maintaining an emergent and reflexive approach, reflective focus groups and interviews prompted self-critical analyses and ongoing adjustments to the action plan in pursuit of equitable learning opportunities for female math students driven by their worldviews.

This chapter will begin with an overview of the findings pertaining to female students' self-efficacy development in math, which determined the source of self-efficacy that would be targeted throughout the study. The subsequent section will move through a sequential overview of the developed action plan aimed at strengthening female math self-efficacy through the identified source, and the revisions made to the action plan over a series of three cycles. The final section will provide a behind-the-scenes perspective of the effectiveness of strategic actions taken to engage teacher-researchers in feminist-infused critical inquiry, as well as necessary unplanned actions due to the emergent nature of the study. Throughout the chapter, the four classes included in the study will be labeled with the name of the teacher or teacher pair, followed by the number representing the grade level of the class, and finally, the letter "C" or "G" designating collaborative or general education classes, respectively.

Sources of Self-Efficacy

Critical feminist research stipulates that the findings must be derived from the lived experiences of the oppressed population (Hesse-Biber, 2012), or in this case, the female mathematics students who participated in this study. In order to gather data about the lived experiences of these participants, students in third through fifth grade who were enrolled in the classes taught by the teacher-researchers were provided with questionnaires, which incorporated activity-based questions prompting self-reflection (see Appendix A). These questions were intended to investigate the four sources of self-efficacy development identified by Bandura (1977) and their influences on female students' mathematical experiences. Further bridging the disconnect between the researcher and the researched, the teachers who would be directly carrying out the interventions with their students engaged in PAR. They critically analyzed the student data gathered from the questionnaires to determine which source of self-efficacy was surfacing as being most influential among their female students (Herr & Anderson, 2015). The raw data generated through the questionnaires were organized into data sets aligned with the four sources of self-efficacy (Bandura, 1977) prior to being reviewed by the teacher-researchers. While all four source-aligned data sets were analyzed during the focus groups, the data and analyses presented here will focus on two of the four sources identified by the teacher-researchers as having the most prominent impact on female math self-efficacy in this context. Although verbal persuasion and mastery experience were noted as important, the teacher-researchers did not find these to be as meaningful. Reasons included the growth-based nature of the female student responses in reflecting on teacher feedback and prior experiences, as well as the lack of gender differences when compared to the disparities surfacing in questions targeting physiological states and vicarious experience. Physiological states prompted the strongest concern among teacher-researchers and was selected as the source to target through action plan interventions. Though it was not the primary focus of the action plan, data gathered on the source of vicarious experience still prompted new critical awareness among the teacher-researchers and influenced decisions made in planning and implementing interventions.

Vicarious Experience

Bandura (1977) identifies vicarious experience as a source of self-efficacy development in which one evaluates her own abilities based on perceptions of others' successes and perceived similarities to those models. On the pre-intervention questionnaire, all students responded to five questions that evaluated the impact of vicarious experience in relation to female math self-efficacy development (see Appendix A). Table 4.1 displays the student responses to questions five and six, which required students to read the descriptions of eight professions, four STEM-based and four humanities-based professions, and match photos of four male and four female adults to the professions the students thought they held.

In Quade-3G, 33% of the individuals placed into STEM fields were female. In the Erikson-4G, 22% of the individuals placed into STEM fields were female. In Nelson/Holt-4C, 36% of the individuals placed into STEM fields were female. Finally, in Davis/Turner-5C, 20% of the individuals placed into STEM fields were female. Across all grade levels, 28% of the individuals placed into STEM fields were female. After matching the images with professions, students were asked to discuss why they placed the individuals in the way that they did. Only five students, all of whom were female, referenced gender in response to this question. One student said, “F looks like an engineer because most engineers are boys.” Another student commented, “I matched the way I did because I looked at their gender. I know that most of the time males are engineers and librarians are usually females." Although gender was only referenced in five responses, the low number of females placed in STEM fields suggest that in addition to the explicit gender references made, implicit biases regarding gender are present among this group of students. The societal privileges afforded to males, including the false narratives of males’ biological math superiority and a history of female oppression in which STEM educational pathways were reserved for males, have led to the current underrepresentation of females in STEM and the ongoing acceptance by both genders that females are mathematically inferior (Good et al., 2012; Hill et al., 2010; Zittleman, 2007). This oppressive imbalance and male-dominant propaganda perpetuate such educational and professional disparities as these societal messages are passed on to our female youth.

Questions seven and eight asked students to identify people they viewed as being successful in math and reflect on whether these were innate talents or developed through effort. When describing individuals who the students believed to be successful at math, the girls in Quade-3G selected eight males and seventeen females, the girls in Erikson-4G identified seven males and seven females, the girls in Nelson/Holt-4C identified five males and seven females, and girls in Davis/Turner-5C described eleven males and six females as being successful at math. The boys in Quade-3G selected eighteen males and two females, the boys in Erikson-4G selected seventeen males and seven females, the boys in Nelson/Holt-4C selected eight males and three females, and the boys in

Davis/Turner-5C selected sixteen males and eight females as being successful in math. Across the third- and fourth-grade classes, both girls and boys more often described these talents as being developed through effort as opposed to describing these talents as innate abilities. In the fifth-grade class, one female student attributed these talents to innate abilities, three females attributed these talents to effort, and three females conveyed mixed responses, such as:

> I think my brother became good at math by practicing. I practice every day with math but I still don't get good grades. I always thought my brother was born this way because he never EVER needed help with anything. I always needed help.

As for the boys in this class, the majority referenced effort and growth as opposed to innate ability.

Table 4.1
Student Questionnaire Responses: Questions 5–6

Class: Student count	Student Responses: Girls		Student Responses: Boys		Total Student Responses	
	Number of females placed in STEM	Number of males placed in STEM	Number of females placed in STEM	Number of males placed in STEM	Number of females placed in STEM	Number of males placed in STEM
Quade-3G 11 girls; 8 boys	16	28	9	23	25	51
Erikson-4G 7 girls; 10 boys	4	24	11	29	15	53
Nelson/Holt-4C 6 girls; 8 boys	7	17	13	19	20	36
Davis/Turner-5C 7 girls; 9 boys	4	24	9	27	13	51
Totals:	31	93	42	98	73	191

Table 4.2 presents the results from the questionnaire activity in which students were asked to retell a story about a successful math student. Of the 64 students who completed the activity from across all grade levels, (30 females and 34 males), 38 students used male pronouns, six used female pronouns, nine did not use gender-specific pronouns, six equally mixed gender-specific pronouns, and five mixed gender-specific pronouns with a primary reliance on male pronouns.

In the responses to both the profession-matching activity and the selections of individuals who are successful in math, there is a pattern in which girls are less likely to place females into STEM fields or select female math models as they increase in grade levels. In third grade, 36% of the individuals that girls placed into STEM were female, 21% were female in fourth grade, and 14% were female in fifth grade. In selecting female math role models, 68% of those selected by third-grade girls were female, 54% of those selected by fourth-grade girls were female, and 35% of those selected by fifth-grade girls were female. When you separate the two fourth-grade classes, Nelson/Holt-4C stands out as having selected more females as STEM professionals in comparison to Erikson-4G (29% to 14%) and having selected a higher percentage of female math role models (58% to 50%). In the retell activity, there was also a trend in which girls were more likely to use solely male pronouns as the grade level increased, with the exception of this collaborative fourth-grade class. In Quade-3G, 50% of the girls used male pronouns, in Erikson-4G, 57% of the girls used male pronouns, and in Davis/Turner-5C, 86% of the girls used male pronouns. In Nelson/Holt-4C, 17% of the girls used only male pronouns. This was also the only class in which male students used female-only pronouns (38% of the boys in this class). As Maxwell (2010) affirms, applying these numerical descriptions to each individual class as opposed to the total population allows us to maintain the diversity of the group, which is crucial to critical qualitative research (Charmaz, 2017). Although there is an overall trend in which girls are less likely to view females as successful in STEM and math as grade levels increase, this is not always the case in Nelson/Holt-4C.

Table 4.2
Student Questionnaire Responses: Question 17

Female Student Respondents						
Class	**Only male pronouns**	**Only female pronouns**	**No gender-specific pronouns**	**Equally mixed gender pronouns**	**Mixed gender pronouns with primary reliance on male pronouns**	**Mixed gender pronouns with primary reliance on male pronouns**
Quade-3G	5	1	2	0	2	0
Erikson-4G	4	1	1	0	1	0
Nelson/Holt-4C	1	1	2	2	0	0
Davis/Turner-5C	6	0	0	0	1	0
Total:	16	3	5	2	4	0

Male Student Respondents						
Class	**Only male pronouns**	**Only female pronouns**	**No gender-specific pronouns**	**Equally mixed gender pronouns**	**Mixed gender pronouns with primary reliance on male pronouns**	**Mixed gender pronouns with primary reliance on male pronouns**
Quade-3G	6	0	0	2	0	0
Erikson-4G	8	0	1	1	0	0
Nelson/Holt-4C	3	3	1	1	0	0
Davis/Turner-5C	5	0	2	0	1	0
Total:	22	3	4	4	1	0

In reviewing these data with the teacher-researchers, a finding that stood out to the group was that across the fourth- and fifth-grade classes, the “boys put more females into STEM than the girls did," as described by Mr. Erikson. Ms. Davis continued on to discuss how this seemed to show "self-deprecating responses… it feels like on the girls' end, not on the boys' end." Additionally, in analyzing the trend that third-graders were more likely to select same-gender mathematical role models, while in the general education fourth-grade class, girls selected males and females at an equal rate, and then by fifth-grade, girls were selecting more male role models, Ms. Davis pondered:

> Do you think that's because moms, and I hear this a lot at conferences, when they start to get to higher level math, they're like 'I can't do this anymore, I don't know how to help them'… so it starts to get beyond the stuff everyone seems to have a better understanding of?

Fellow teacher-researchers responded that they had similar experiences with female parents. The oppressive beliefs internalized by the adult generation are passed down to their daughters through these disempowering self-notions. In reflecting on the entire question set, Ms. Turner responded:

> Well, because there is education right now, and obviously the males are hearing it and it's not applying to them, so they're hearing it and internalizing it, but maybe the females, I would imagine they're hearing the same thing, I mean we're all trying to say that, you know, females can be in all these roles, and their parents are in these roles, lots of moms are lawyers and doctors and have very professional jobs, so it seems like the boys are getting that and seeing that, but for some reason the girls are not, and so there's something else that's making that happen.

The Band-Aid that is the recent trend in media and pop culture to promote females in STEM, while a positive message, fails to address the underlying systemic inequities established in an educational system developed by the dominant male population that leads to female underrepresentation in STEM (Schiro, 2013). Thus, publicizing these messages without engaging in praxis to break down the barriers that serve to prevent females from entering the math and science fields is fruitless.

The teacher-researchers were also surprised about "how much the word 'college' came up" in the students' descriptions of their mathematical role models. The emerging conversation went on to discuss the role that the high socioeconomic status of the district plays in students' analyses of what it means to be successful in math, as well as the competitive nature of the community, describing the messages the students receive as "you can't fail, you have to be up there." This ideology aligns with the social efficiency model of education that reproduces current societal and capitalist structures, structures that place males at the top (Schiro, 2013). Stemming from a masculine view of education and grounded in behaviorism, this performance-based perception of education fails to recognize the importance of developing compassionate humans and disrupting marginalizing societal structures (Gonick, 2007; Schiro, 2013).

In reviewing the pronoun use across the student retells, all of the teacher-researchers were surprised at how many females used male pronouns. Ms. Turner stated, "I almost thought it would've been more like the girls would have thought it was a girl more and the boys would have thought it was a boy more just because of the gender you are." The limited use of female pronouns in the retell activity led to Ms. Holt questioning, "I just think like why? Why is it male dominant? It just makes me think why? Is it predisposed?" to which Ms. Nelson responded, "Society."

Physiological States

Bandura (1977) identifies physiological states as one of four sources of self-efficacy development. Negative physiological states, including stress, anxiety, self-doubt, visualizations of failure, and perceived inability to cope, lead to the development of negative self-efficacy beliefs (Bandura, 1977; 1989). These damaging mindsets that are more prevalent among marginalized groups typically result in avoidance behavior or early withdrawal from certain tasks or environments (Bandura, 1989; Frankenstein, 1992).

Questions two through four from the questionnaire generated verbal and pictorial data that captured the feelings students associate with challenging mathematical experiences in order to identify the impact of physiological states in math (see Appendix A). My co-rater and I pre-coded this data prior to presenting it to the team of teacher-researchers during the first focus group. These codes are listed in Table 4.3. Our inter-rater reliability was established at 93% agreement (De Wever et al., 2006), thus assuring the trustworthiness of the coding before sharing the coded data with the teacher-researchers.

After the codes were derived from the student data and applied to the identified units of meaning (Wever et al., 2006), these pieces of data were grouped under "problematic" or "non-problematic" responses. Units of meaning grouped under "problematic" included those that expressed negative views of self, frustration, anxiety, states of confusion, or a focus on the challenge of the problem. The latter two draw our attention to thoughts and feelings that can be a natural part of productive mathematical experiences, but only if they are accompanied by positive perceptions of coping abilities and effective coping mechanisms, which would be represented under “non-problematic” units of meaning (Bandura, 1977/1989). Therefore, in unpacking the data, we will look at the interaction between the two. Units of meaning categorized as “non-problematic” included thoughts and feelings that expressed perseverance or coping behavior, communicated “confidence” in or positive views of the student’s own math capabilities, focused on how “easy” the problem was, or centered on processes used in solving the problem.

Table 4.3
Codes for Student Questionnaire: Questions 2–4

Code	Description
Negative self	Thoughts and feelings communicated negative views of self in relation to math
“Frustration”	Expressed feelings of "frustration"
Anxiety	Expressed feelings of anxiety
“Confusion”	Described a state of "confusion"
“Challenging”	Thoughts and feelings focused on the student's perception of how “challenging” the problem was
Growth/Coping	Described how he/she moved from a negative state to a positive state
“Confidence”/ Positive view	Thoughts and feelings communicated “confidence” in or positive views of his/her math abilities
“Easy”	Thoughts and feelings focused on the student's perception of how “easy” the problem was
Processes	Thoughts were focused on processes used in solving the problem

Note. Codes enclosed in quotation marks signify In Vivo codes

Problematic responses. As displayed in Table 4.4, across all four classes included in the study, the female students expressed negative physiological states more often than the males. Across 29 of the 31 female students, 83 individual units of meaning were labeled with problematic codes. Across the 17 male students (out of a total of 35 males) who expressed problematic thoughts or feelings, 35 units of meaning were labeled with problematic codes. Among the problematic responses, negative views of self were communicated by female students through a total of 15 units of meaning, across seven students; five of these females were in fifth-grade. Negative views of self were expressed by females through comments such as, "Math is hard and I don't understand," "I'm so bad at this," "You're horrible," "You're bad at math," "You'll never get it right," "I stink at math," "If I can't do math, my life is hopeless," "I feel sorry for all the teachers who spend extra time helping me," and "Maybe I'm not smart enough." Across all three grade levels, there were no males who expressed negative views of self in relation to math. Feelings of frustration surfaced in 12 units of meaning, as defined in Chapter 3, across the responses from ten females, while among the male population, descriptions of frustration were only found in four units of meaning across the responses from three males. Female students communicated feelings of frustration through responses that included, "I was feeling very frustrated," and drawing a figure with clenched teeth yelling, "What!" Males conveyed feelings of frustration through comments such as, "I was frustrated," and "I felt like I needed to flip a table." Six units of meaning in the female responses communicated feelings of anxiety, which surfaced among five female students. Three units of meaning conveyed anxious feelings among the male population. These three responses were spread across three male students. Feelings of anxiety were expressed by females through statements such as, “I felt stressed,” and “Rush of worry,” as well as a student who described the picture she drew by explaining, “This is me locked in a pitch black room with the paper… I am yelling for help… I’m locked in a pitch black room for the rest of my life.” Two of the males who expressed feelings of anxiety focused on the element of time, writing, “I was a little scared because I might run out of time on this,” and “I was nervous that I wouldn’t get it done in time,” as well as a third student who wrote, “I was stressed out." Although the statement did not fit any of the codes that emerged, it is important to also note the problematic response of one female who wrote, “MATH = Mental Abuse to Humans.”

Table 4.4
Student Questionnaire Responses: Questions 2–3

Class; *Student Count*	**Problematic**	**Non-problematic**
Female Students		
Quade-3G; *Student Count: 11*	10 (91%)	4 (36%)
Erikson-4G; *Student Count:7*	6 (86%)	3 (43%)
Nelson/Holt-4C; *Student Count:: 6*	6 (100%)	5 (83%)
Davis/Turner-5C; *Student Count:7*	7 (100%)	4 (57%)
Total Female Responses:	29 (94%)	16 (52%)
Male Students		
Quade-3G; *Student Count:8*	5 (63%)	7 (88%)
Erikson-4G; *Student Count:10*	4 (40%)	9 (90%)
Nelson/Holt-4C; *Student Count:8*	5 (63%)	4 (50%)
Davis/Turner-5C; *Student Count:9*	3 (33%)	7 (78%)
Total Male Responses:	17 (49%)	27 (77%)

Note. Students may be represented in both the ‘Problematic’ and ‘Non-problematic’ columns, dependent on the units of meaning communicated in student responses

As mentioned above, states of confusion and a focus on the challenge of the problem were categorized as problematic, but will be analyzed in relation to the presence of non-problematic responses, as these thoughts only remain problematic if the student does not also express positive perceptions of her coping abilities and apply effective coping mechanisms (Bandura, 1977/1989). Among the female questionnaires, states of confusion were communicated in 39 units of meaning, which were expressed across 20 females through statements such as, “I’m SUPER confused,” “My mind felt blank,” and “This is me as soon as I see the problem because I have no clue what to do (reference to a drawing of a sad face).” Across nine males, 18 units of meaning conveyed states of confusion, with comments such as, “My mind is fogged with thoughts... I don't even know where to start" and “I was confused.” Interestingly, while seven of the 31 females focused on the level of challenge of the problem, communicated through ten units of meaning, eight of the 35 males also focused on the level of challenge of the problem through ten units of meaning. Even though 65% of females expressed states of confusion and only 26% of males expressed states of confusion, the percentages of males and females who focused on the level of challenge were equivalent (when rounded to the nearest whole percent). Viewing these responses in relation to whether or not the students also expressed non-problematic responses, which may point to their ability to overcome the states of confusion and challenge that were encountered, of the 24 females who expressed thoughts or emotions categorized under either “states of confusion” or a “focus on the challenge of the problem,” 13 did not express any non-problematic thoughts or feelings. Of the 15 males who expressed thoughts or emotions categorized under either “states of confusion” or a “focus on the challenge of the problem,” eight did not expressed any non-problematic thoughts or feelings.

Non-problematic responses. Non-problematic comments were expressed by males with greater frequency than females across three of the four classes included in the study, with the exception being Nelson/Holt-4C, which is also the class that did not fit the trends that surfaced under the source of vicarious experience and will be further discussed below. Among the 16 (out of 31 total) females who communicated non-problematic responses, 12 expressed perseverance or coping behavior through 19 units of meaning. Of the 27 (out of 35 total) males who communicated non-problematic responses, nine expressed perseverance or coping behavior through 12 units of meaning. This was the only non-problematic category in which there were more female respondents than male respondents. However, this finding is not surprising given that females also expressed negative physiological states or states of confusion and perceived challenge with greater frequency, which would necessitate perseverance or coping behaviors, in comparison to males who less frequently expressed these states. Across the study, 29 out of 31 female students (93.5%) expressed negative physiological states. Out of these 29 females, 12 (40%) expressed perseverance or coping mechanisms. Perseverance or the use of coping mechanisms was communicated by females through responses such as, “After I completed it, I calmed down,” “Then I figured it out and I was proud of myself,” and “I always remember what my mom told me, ‘Think positive and positive things will come back.’” Males communicated perseverance or coping behaviors with responses that included, “The picture is of me getting stuck and persevering through problems,” “Come on, you can do this,” and “I realized it wasn’t really hard at all.” Two females communicated confidence or positive views of self through three units of meaning, which included, “I was smart,” and “I felt confident.” Three males also communicated these thoughts through three units of meaning which included, “Feeling confident about how I can answer this,” as well as a male who described the picture he drew, writing, “The blobs with swords are brain warriors defeating the question. The question is going to get annihilated when I get the answer.” While no females expressed that they viewed the problem as easy, six males expressed this reaction through ten units of meaning. Such units of meaning included, “It was easy… All I had to do was calculate,” “I felt good and less challenged, I thought it was easy,” “Math is easy,” and “I don’t have to think about it much.” Four females demonstrated a focus on the processes used to solve the problem through 11 units of meaning, while 13 males communicated this thinking through 30 units of meaning. Responses categorized under this code included, “I thought it was 8 because there were 8 triangles around it,” and “Moon is two, so moon + moon + moon + moon = sun.”

Trends and findings. When the teacher-researchers were provided with the data across grade levels, the thoughts and feeling expressed by the students as they completed the math task aroused a state of shock and devastation among the educators. This spark of transformation among the teachers will be further elaborated upon below, but for the purposes of the focus on sources of self-efficacy, I will focus on the students. Two major problems emerged from the data: (a) There was a greater population of female students who were experiencing negative physiological states without expressing the application of coping mechanisms to overcome these states and enter into positive states, and (b) even when female students conveyed an ability to cope with the expressed negative physiological states, their comments conveyed a drastically different mathematical experience from the male students.

A finding that prompted immediate concern among the teacher-researchers and me was that none of the 35 male students demonstrated negative views of themselves or their capabilities in regard to math while seven female students (22%) expressed these negative beliefs. The thoughts and feelings expressed by the girls correspond with the physiological states of self-doubt and visualizations of failure identified by Bandura (1977/1989) as impacting one's self-efficacy development in a given area. The females not only doubted their ability to solve the current problem, "Ugh, I probably got this wrong", but they also engaged in negative self-talk, "You're horrible," "You'll never get it right," and reflected on their perceptions of ineptitude in math in general, "I stink at math," as well as extended these thoughts to a general lack of intelligence, "Maybe I'm not smart of enough." These negative self-views were more prevalent among the fifth-grade students, with only two fourth-graders and no third-graders expressing negative self-beliefs. Similar to the finding of Banjong (2014) that elementary female students felt more successful in math than middle school female students, the increase in negative self-views in the present context conveys that students are beginning to develop internalized negative self-perceptions in relation to math as they increase in age, rather than attributing their struggles to a specific problem or viewing their capabilities as being malleable. These negative self-associations with math among females are perpetuated by societal gender roles that are not being disrupted by our classroom practices, as well as continued anxiety-ridden views of mathematics (Boaler, 2016; Harro, 2013; Frankenstein, 1992). The high anxiety levels that often arise in math serve as a barrier that preserves hegemonic systems in which the field of math is reserved for those who are fortunate enough to be born with a societally-fabricated 'math-gene,' a characteristic typically assigned to white males (Boaler, 2016; Harro, 2013; Steele, 2010; Frankenstein, 1992).

In addition to the disparities in the frequencies of problematic thoughts and feelings versus non-problematic thoughts and feelings expressed across the males and females, the teacher-researchers and I were also "shocked at the severity" of the female responses, a conversation sparked by the fourth-grade student who drew a picture that she described as "me locked in a pitch black room with the paper... I am yelling for help... I'm locked in a pitch black room for the rest of my life." Mr. Erikson reacted to his student's comment, "I can't believe that you would go into that much detail about… it's that stressful and painful to you." The ensuing conversation continued on to analyze the lack of severity in and comical nature of the male responses in comparison to the female responses. While the female responses conveyed feelings that their lives would be "hopeless" if they could not overcome their perceived mathematical deficiencies or that they "can't do" or "understand" math, the males overwhelmingly reflected on the ease of the problem and even described "blobs with swords" as "brain warriors defeating the question" that would soon be "annihilated." The latter expressions are supported by androcentric views of mathematics, whereas the emotions conveyed by the girls represent a femininity that society has ostracized from the field (Hesse-Biber, 2012; Frankenstein, 1992).

Looking across the grade levels, patterns emerge that demonstrate divergent trends among the females and males. While the frequency of problematic thoughts and feelings communicated by females remains relatively stable across the three grade levels at 91%, 92%, and 100%, the negative thoughts and feelings expressed by the male population decreases by 30% from third to fifth grade, with these negative states expressed by 63% of third-grade males, 50% of fourth-grade males, and 33% of fifth-grade males. It is important to note that when you separate the two fourth-grade classes, the group of males in Nelson/Holt-4C again stands out, as they expressed the same level of negative states as the third-grade males. The trend of decreasing negative states among males as grades increase is complemented by the increase in expressions of confidence and how "easy" they viewed the problem to be. These upper-grade males described thoughts and emotions such as, "I feel strong and confident," "It was easy… All I had to do was calculate," and "I don't have to think about it much," exuding a level of confidence that is growing among the males as their negative states decrease; whereas the female population continues to exhibit high frequencies of negative physiological states. Our classroom practices have been supporting the growth of mathematical self-efficacy among males while maintaining the oppression of females as their negative self-beliefs in math remain unchanged.

Continuing to analyze the disparities between the male and female responses as well as patterns across grade levels, the teacher-researchers also identified that:

> …the female responses talk about how other people perceive them more than the male responses, like for example, 'I see everyone zipping through problems,' 'I don't want to ask my question because I think it is stupid,' 'You see finishing when you're still on question one. It gets me really stressed and then I start making silly mistakes,' like things that other people would perceive about them.

All of these responses, which were reflections on whether or not the students experienced the thoughts and feelings prompted by the questionnaire in their typical math classes came from female students in Davis/Turner-5C (see Table 4.5). Additional responses to this question from the female fifth-graders in which they alluded to others' perceptions or compared themselves to others included, "If I don't get something I will think I'm not smart and everyone is smarter than me," and "I try to be confident but then I just feel like I have to be perfect." One of these students also commented in the second question, "I feel sorry for all the teachers who spend extra time helping me." No students in third or fourth grade reflected on perceptions of others or comparisons to others, and across all three grade levels, no males made these references. Bandura (1993) asserts that social comparison is a common method of self-evaluation, and negative evaluations of one's performance in comparison to peers can inhibit performance. Further, persevering through a task when there are social consequences requires strong positive self-efficacy (Bandura, 1993).

Self-efficacy and mathematical accuracy. Following analyses of the responses for questions two through four, the teacher-researchers were asked to make predictions about the levels of accuracy with which the female and male populations in each class answered the math problem. The predictions and actual accuracy are displayed in Table 4.6. These results led the teacher-researchers to the question of why the females were "so negative" in their reflections even though they had accuracy rates comparable to the males.

Table 4.5

Question 4 Responses from Females Who Expressed that They Experience the Thoughts and Feelings Prompted by the Questionnaire in Their Typical Math Classes

<table>
<tr><th>Class</th><th>Expressed “Problematic” views</th><th>Expressed “Non-problematic” views</th></tr>
<tr><td>Quade-3G</td><td>"Yes because sometimes I felt stressed and then I get confused and when I am confused I feel stressed."
"I am sometimes because some tasks are hard for me but most of the time I am not that confused."
"Sometimes because sometimes my work is really easy and sometimes it is hard."
"Yes when I get stuck on a problem I get frustrated."
"Sometimes I get confused and frustrated in math class but most of the time I don't."</td><td></td></tr>
<tr><td>Erikson-4G</td><td>"Yes, I sometimes do when Mr. Erikson first introduces something new to us in math. I say, 'What? I don't get it!"
"Yes, I do experience these thoughts and feelings, especially when we start a really hard unit and I don't get one thing. I experience these thoughts and feelings because I am known to get stressed out to myself."
"I sometimes do because sometimes I get an answer and it's wrong so it makes me confused."</td><td></td></tr>
<tr><td rowspan="2">Nelson/ Holt-4C</td><td colspan="2">"It depends on the math problem I am doing."
"I do experience these feelings sometimes."
"Yes I do sometimes I know stuff really fast but sometimes I have no idea what I am doing."
"It depends on the problem.”</td></tr>
<tr><td></td><td>"It depends on the problem if it's an easy problem I will feel like why are we doing this - If it's a hard problem everybody likes a challenge, so I will persevere and work through the challenge"</td></tr>
<tr><td>Davis/ Turner-5C</td><td>"I think like this all the time. I try to be confident but then I just feel like I have to be perfect. I usually feel this way in tests because nobody is there to help you. You see kids finishing when you're still on question 1. It gets me really stressed and then I start making silly mistakes."
"I experience some of these in my math class and I feel blank and confused."
"I sometimes do feel pressured because sometimes when I don't get something right I think I'll never get it right"
"Yes because in my head, math is stressful, and I feel this because I see everyone zipping through problems."
"Sometimes because if I don't get something I will think I'm not smart and everyone is smarter than me."</td><td></td></tr>
</table>

Note. Centered responses spanning across both columns illustrate that these students expressed views categorized as “Problematic” and “Non-problematic”

Table 4.6
Teacher Predictions of Accuracy for Question One Versus Actual Accuracy

Class	Predictions of correct answers from females	Predictions of correct answers from males	Actual correct answers from females	Actual correct answers from males
Quade-3G	6 or 7	3	6 (out of 11 total respondents)	5 (out of 8 total respondents)
Erikson-4G	4 or 5	7 or 8	7 (out of 7 total respondents)	8 (out of 10 total respondents)
Nelson/ Holt-4C	3 or 4	2	5 (out of 6 total respondents)	7 (out of 8 total respondents)
Davis/ Turner-5C	4	4	6 (out of 7 total respondents)	8 (out of 9 total respondents)

Final Thoughts and Selecting a Source

In addition to reviewing the four sets of questions targeting each source of self-efficacy development, the teacher-researchers were also provided with student responses to an open-ended question that allowed the students to share any additional thoughts they wished to express with regard to math. These results are displayed in Table 4.7. During the focus group, the teacher-researchers expressed how it would also be beneficial to review responses across question sets for individual students in order to analyze the similarities and differences across one student's responses. In anticipation of this, I had reviewed the student questionnaires across grade levels, paying attention to students who used extreme language in expressing either low self-efficacy or high self-efficacy. Ensuring that I had at least one student from each grade level, I extracted all of the response data from each student and placed these data into student-specific charts, allowing the teacher-researchers to see snapshots of eight different students (see Appendices C and D).

Table 4.7
Student Questionnaire Responses: Question 16

	Female	Male
Quade-3G	"I don't like math." "I do not like math." "I really like math and it is one of my top three subjects. One of the things I like in math is tasks and working with partners."	
Erikson-4G		"I'm not confident enough about math because I get 3/4 of my math wrong." "Math is very easy for me. It's relaxing."
Davis/ Turner-5C	"I think math is really fun but really struggling. I want it to be my thing cause ELA is definitely not my thing. And I want my parents to be proud of me, cause I feel stupid because I'm in collaborative ELA." "I feel like in math to really understand it you need the right teacher. I think that because if you have a grumpy teacher you'll be discouraged but if you have a understanding teacher you'll feel inspired." "MATH = Mental Abuse To Humankind" "When Ms. Davis hands out a sheet and in like a minute someone screams I am done that makes me feel bad because I am not done yet."	"I like math." "Why am I good at math but bad at reading?"

Viewing the student snapshots side by side allowed the teacher-researchers to see a more complete picture of each individual student included in the data set and grasp the disparities in self-efficacy between students. While I had attempted to include both female and male students in the four snapshots of students with low math self-efficacy and the four students with high math self-efficacy, there were no male students included in the study who used extreme language to express low self-efficacy and maintained this negative self-efficacy across the questionnaire. Therefore, the teacher-researchers viewed snapshots of four females with low math self-efficacy, and three males and one female with high math self-efficacy. The latter female was the only female in the study to consistently express high math self-efficacy throughout the questionnaire, and she only used extreme language in two questions. The teacher-researchers immediately noticed gaps between students with low math self-efficacy and those with high self-efficacy:

> Ms. Holt: I'm just looking at one of the males, like how confident: "Math is really easy for me, it's relaxing."
>
> Mr. Erikson: And these are both in my class, so there's the huge discrepancy I have.
>
> Ms. Holt: Like to see how calming of an experience math can be to them and then to look at the other students.
>
> Ms. Quade: One of my males wrote, "Yes because like I said a lot, I am really good at math, not trying to brag," whereas the female continuously said in her response, "I get confused," "Stressed," "I get confused when I am stressed," "I am not confident," so just seeing that difference.

The teacher-researchers also connected the student responses to the sources of self-efficacy that were emerging:

> Mr. Erikson: In this one, question 14, she's saying like, "I let myself down and say I can't do it a lot."
>
> Ms. Holt: She has like this negative self-talk that is consistently, like a record playing over and over.
>
> Ms. Holt: Yeah, like that's huge right there, "I think this because I let myself down and say I can't do it a lot." It's exactly what we were talking about earlier, that physiological.

In this dialogue, the teacher-researchers were noticing the thoughts of self-doubt experienced by the student during mathematical situations, which Bandura (1989) characterizes as a negative physiological state that is a source of low self-efficacy. Reflecting on these physiological states expressed by the female students, Mr. Erikson posed the question:

> And the whole point of why we're here, like how do you help them? She understands that this is how she feels and what's affecting her, that almost sounds like it's a cry for help there, like - *I don't know what to do past that, I know it's a problem. I know it's affecting me.* And then we need that next step of okay how do we now recognize the problem and how do we help change it?

The teacher-researchers were then asked to identify which source seemed to be having the greatest impact on self-efficacy development among the female snapshots. The teacher-researchers collectively responded that the source of physiological states was standing out the most, drawing on quotes from students, "Like look at question four, 'Stressed,' '…frustrated,' '…these thoughts,' '…that's stressful.'"

At this point in the focus group, the teacher-researchers were asked to select the source(s) of mathematical self-efficacy development that they found to be most influential for the female students based on the data from the questionnaires and drawing on their prior experiences, which would be the source(s) targeted through the intervention cycles. The teacher-researchers immediately responded that they would target the source of physiological states. The teacher-researchers elaborated:

Ms. Quade: It makes me so upset that they're at the age, some of my students are eight not even nine years old, and they're feeling this much stress or anxiety about something it's just…

Ms. Holt: Heartbreaking.

Ms. Quade: It's heartbreaking that they're experiencing that at a young age, and anyway to have them feel comfortable in themselves and school and their experiences is so important.

With our new critical awareness of the oppressive realities of female students' mathematical experiences and our classroom practices that perpetuate this marginalization, we collectively agreed to target the source of physiological states through emancipatory praxis. Although we did not specifically focus in on the source of vicarious states, awareness of students' gender-biased views of mathematics helped us to see the interconnections between the vicarious experience and physiological states, which we drew on in developing the action plan.

Disparities in Data from the Collaborative Fourth-Grade Class

As described above, Nelson/Holt-4C was viewed as an outlier in relation to multiple trends identified across the student questionnaire data, such as the decrease in females placed into STEM fields as grade levels increased and a greater frequency of non-problematic responses to the first question set among males in comparison to females. Additionally, Nelson/Holt-4C was the only class in which boys (38%) used solely female pronouns in the retell activity. Of the females in this class, 83% expressed non-problematic responses to the math task activity, whereas in the other three classes, non-problematic responses were expressed by only 36%, 43%, and 57% of females in these classes. On the other hand, this class had the lowest percentage of boys expressing non-problematic responses, 50% in comparison to 88%, 90%, and 78% in the other three classes. These findings prompted further investigation into the characteristics of the students in this class to identify possible rationale for these divergences. Ms. Nelson and Ms. Holt described that the class was comprised of a male population who struggles in math academically, with four males who completed the student questionnaires having individualized education plans (IEP) as well as two males who chose not to complete the questionnaires, in comparison to two females with IEPs, both of whom completed the questionnaires. In analyzing the average scores earned by students on eight math performance assessments administered throughout the year, the population of students performing above the median average score consisted of six females and two males. Given the high population of struggling male students in the class, this finding is not surprising, as students are strategically placed during the scheduling process to develop classes that are heterogeneously mixed in terms of ability levels, and thus, a greater number of higher-performing females were placed into this class. Therefore, it is likely that the outlier status of Nelson/Holt-4C was due to the class' large population of females who are successful in math in comparison to the struggling male population.

Call to Action

Applying critical feminist theory to the classroom setting, we are called to act "with and on behalf of young people in education" by allowing the perspectives of our students to guide emancipatory research and praxis toward equitable learning (Hesse-Biber, 2012, p. 337). The data gathered from the student questionnaires allowed us to hear the worldviews of our female students and become conscious of the structures that oppress their mathematical growth. The androcentric view of mathematics, focused on performance, promoting the notion of math as an innate ability, and replete with anxiety, serves to reproduce the current societal structures in which females continue to be underrepresented in mathematics (Hill et al., 2010; Frankenstein, 1992). This culture of mathematics not only produces negative physiological states among female students, but marginalizes the femininity associated with expressing such emotions. The work of this study sought to disrupt this cycle.

Promoting Self-Efficacy: Taking Action is a "Necessity"

With our deep dive into the thoughts and feelings of the oppressed female students complete and the resulting decision to focus on physiological states as a source of self-efficacy, it was time for the teacher-researchers and I to start developing our intervention plan. PAR grounded in critical feminist theory engages researchers in a collaborative, cyclical process of investigation leading to critical awareness and taking action guided by this new consciousness to effect change in the daily lives of the oppressed (Hesse-Biber, 2012). Ms. Turner captured this commitment to emancipatory research in the first focus group when she asserted that taking action was "a necessity."

Throughout the three intervention cycles, transcripts of the conversations from teacher focus groups were generated from audio recordings, and data from teacher interviews were gathered through verbatim scribing and note-taking. For the first cycle of data analysis that began with the first teacher-researcher focus group, my co-rater and I achieved an inter-rater reliability of 85% (De Wever et al., 2006). After coding the transcriptions, relevant data were placed into tables, grouped by the emergent themes that they supported, and frequency counts describing how often these themes surfaced across the data were added to each table.

Generating the Action Plan

As a follow-up to our first focus group meeting in which we unpacked the data generated from the student questionnaires, the team met together to continue the planning stage of PAR with the aim of generating the action plan of interventions to employ in the classrooms. Based on the problematic views females expressed on the student questionnaires, we set the sub-goals of the intervention plan as the desensitization of negative mathematical experiences by addressing exaggerated perceptions of threat and normalizing struggle, strengthening female students' abilities to identify and self-monitor physiological states, and guiding students to apply and internalize coping mechanisms to overcome negative physiological states.

As the teacher-researchers generated the action plan through collaborative discourse, themes that emerged could be broken down into two categories: (a) the impacts on the female students' mathematical experiences that teachers had hoped to see in their classrooms, and (b) means of effective and efficient implementation in the context of the elementary classroom. The codes that corresponded with the former category included "Student Self-reflection," "Safe Place," "Peer Support," "Coping Strategies," "Desensitization," "Perseverance," and "Role Model Disclosure." Codes corresponding with the latter included "Practicality," "Grade Specific," "Scaffolding," "Integration," and "Home Connection" (See Appendix H for the codebook with descriptions). The data from which these codes and emergent themes were derived are presented in Appendix F.

As the teacher-researchers proposed interventions based on the findings from the student questionnaires, themes emerged relating to the shifts they hoped to see in the climate of their math classes and the female math behaviors. One of the themes that emerged was the need to establish the classroom as a safe place in which students feel "comfortable sharing their honest feelings." Data from the questionnaires had revealed that up until this point, female worldviews in the math classroom had been silenced. Giving female students a voice in the classroom required establishing a space in which their ideas would be valued and respected. The interventions described as targeting this development included journaling and math-focused morning meetings. While journaling would allow for a "private" outlet for reflection and expression of thoughts, morning meetings, if executed effectively, would provide a communal space in which students could share their experiences with peers and work through struggles together (Griggs et al., 2013).

Female responses on the student questionnaires showed increased levels of angst in math. These negative emotions associated with math are fueled by societal views promoting the existence of 'math people' and 'non-math people' (Boaler, 2016; Frankenstein, 1992). In order to disrupt these hierarchical barriers, teachers need to engage in emancipatory discourse with students to address these societally-imposed false ideologies. The teacher-researchers pointed to the establishment of the safe spaces described above as venues for the desensitization of math experiences. Students as well as teachers could engage in conversations, or written reflections, about their struggles in math in order to normalize this struggle. Desensitization would also be prompted through conversations about exaggerated perceptions of threat.

Continuing to target this aim of desensitization, the teacher-researchers considered the work of Schaeffer et al. (2018), who found that when parents engaged in mathematical activity with their first-grade children through a 'Bedtime Math' app, the negative impact of the parents' math anxiety on their children's achievement decreased. Therefore, the teacher-researchers thought that setting up this home connection through the 'Bedtime Math' app could help strengthen the desensitization of math experiences that they would be working on in the classroom by engaging in desensitization activities at home. Further, this intervention could simultaneously address the problematic findings relating to vicarious experience that demonstrated a decrease in female selections of their mothers as math role models as they increased in age. Another intervention posed as not only targeting physiological states but also having the potential to impact the source of vicarious experience was to organize a Skype or visit with a female mathematician about the challenges she had encountered in her math experiences.

The final theme discussed pertaining to the classroom climate was the need to create structures that prompted students to serve as supports for each other, given that they "work in a lot of pairs or small groups." The teacher-researchers pointed to the morning meetings in prompting this sense of community and the need to tie interventions into collaborative work.

In the student questionnaires, negative physiological states were demonstrated as students engaged in negative self-talk and detailed feelings of anxiety, frustration, and self-doubt overpowering them. Succumbing to these negative states leads to self-disempowerment (Freire, 1968). To counter this, we needed to empower female students with the tools to emancipate themselves from these debilitating thoughts and feelings.

Therefore, the teacher-researchers identified the need to equip students with strategies for self-monitoring and recognizing negative physiological states, as well as coping mechanisms that could be applied in situations in which they do enter into negative physiological states. Journaling and math meetings were identified as means of supporting the recognition and self-monitoring of negative physiological states, as journaling would prompt students to become "more in tune" with the thoughts and emotions they experience in math, and morning meetings would allow for discussions of what these states look and feel like. In terms of coping mechanisms, the teacher-researchers shared intentions to teach the students calming techniques and problem-focused coping mechanisms (i.e., strategies used to help students begin to work with the math problems). With regard to techniques to cope with their emotional states, teacher-researchers considered movement and breathing strategies, such as building on the those taught through the social-emotional programs the district implements, *Jesse Lewis Choose Love Movement* and *Zensational Kids,* and connecting them directly to mathematics. Teacher-researchers also described how they wanted students to be able to "break apart a problem when they first get it" and learn "problem-solving strategies that they have in their back pockets for when they struggle."

In addition to the predicted impacts on female self-efficacy, rationale for the selected interventions also connected to efficiency and effectiveness. Teacher-researchers continually reflected on the practicality of each intervention to ensure that it would be manageable and thus allow for success, such as the seamlessness of the implementation of the math-focused morning meetings since there was already a time designated in each grade level's schedule for morning meetings. These discussions also centered on the integration, and sometimes interdependence, of multiple interventions. The teacher-researchers noted how particular prompts could be used in both morning meetings and journaling and certain interventions would rely on the success of others, such as self-monitoring strategies and coping mechanisms, with the former prompting the application of the latter. Finally, the team anticipated the need for scaffolding and grade-specific modifications in order to increase the effectiveness of the interventions. Ms. Quade was concerned about her students' abilities to articulate their thoughts and feelings in written form, and her colleagues in the group shared out strategies that could be used for younger students, such as including emojis that students could select to convey their emotions. The teacher-researchers organized their analyses and intended interventions into the sequenced plan outlined in the previous chapter.

Reflections on Cycle 1

Throughout the next six days, the teacher-researchers began to implement math-focused morning meetings with their students and introduced math journals. The teacher-researchers could utilize the prompts that I had provided them for the morning meetings and journals, or they could create their own. The prompts the teacher-researchers used throughout the cycle are displayed in Appendix G.

In analyzing the data from the second focus group, in which the teacher-researchers reflected on the implementation and levels of success of the interventions in Cycle 1, my co-rater and I developed new codes as they emerged from the data, in addition to utilizing the codes developed as a result of the first focus group. These new codes, which can be found in the codebook (see Appendix H), are "Effective Student Self-reflection," "Ineffective Student Self-reflection," "Effective Coping," "Ineffective

Coping," "Teacher Awareness," "Power Dynamic," "Individuality / Diversity," "Emergent," "Relatability," "Peer Comparison," "Speed," "Ongoing," "Journaling Limited," "Morning/Math Meeting - Peer Driven," "Morning/Math Meeting – Public," "Risk of Lowered Expectations," "One-to-one Coaching," "Teacher Modeling," and "Shift in SE." The themes that emerged from these codes were grouped based on the interventions they aligned with and compiled with example In Vivo quotations. The themes and corresponding data that emerged from reflections on journaling are displayed in Appendix I, and those that emerged from reflections on morning meetings are displayed in Appendix J.

Cycle 1 journaling. During the first cycle of implementation, the teacher-researchers found that the journaling was beginning to serve as a safe place in which the students could write about the thoughts and feelings they experienced in math without anyone but the teacher reading them. This allowed for an element of privacy that the morning meetings did not provide. By giving female students this outlet to convey the thoughts and feelings that came through on the questionnaire, the teacher-researchers empowered them, letting their voices be heard. This notion that the students wanted their voices heard was supported by the occurrences at the fifth-grade level in which the teachers decided to open up the journaling to voluntary sharing, which many female students took advantage of. As described by Ms. Davis, "A lot of them really wanted to share." This decision to open up the journaling to share-outs was made by the teachers because they "wanted to acknowledge what they [students] were saying," further showing this element of empowerment. Since the teacher-researchers were reading the journal entries written by the students, they were able to gain a deeper awareness of their students' mathematical experiences and factors that may be influencing students' self-efficacy in the math classroom. This consciousness then allowed teacher-researchers to implement changes to remove or ameliorate influences that were having a negative impact on female self-efficacy. This was evidenced by the fifth-grade journal entry in which a female student described how a male peer at her table "was causing her anxiety and stress because this boy finishes early and says things are easy," leading the teachers to move her to a different table which had an immediate, visible impact on her mathematical experiences. For some students, the journaling did not prove to be as beneficial, especially in the lower grades. In the younger grades, some students struggled to get started in their reflections and tended to write less in comparison to oral reflections during morning meetings. Thus, at this point in the study, the journaling appeared to serve as a beneficial outlet for some students, while it had limited or no benefits for others.

Cycle 1 math-focused morning meetings. The math-focused morning meetings both positively impacted the classroom setting and led to new insights and stronger awareness among teachers. Using scaffolding techniques, such as beginning with more general prompts to "open up the conversation," the teachers were able to establish the morning meetings as a safe place for students, specifically female students, to voice their thoughts and feelings. As described by Ms. Davis and Ms. Turner, the girls were "sharing a lot more in the morning meeting," and it was "overwhelmingly girls sharing." The morning meetings also allowed the female students to reflect on their physiological states in math, as students identified "what happens when they are becoming anxious like, 'My hands get sweaty and it's hard to breathe.'" At the fifth-grade level, the teachers also shared that it seemed as though the "girls had given a lot of thought prior to this about their feelings about stress in math," and the morning meetings gave them a chance to voice this. The students were no longer being silenced in a male-dominated subject. In addition to empowering the female students by giving them a voice, the students were also empowered by prompts that led to classroom changes, such as the prompt that asked the students to design a stress-free classroom. Emancipatory research and activism requires the inquirers to re-envision the context as one that is liberatory as opposed to oppressive; designing this vision of a stress-free classroom allowed female students to engage in this feminist work (Gronick, 2007). Ms. Davis reacted to the student responses in the focus group explaining, "And we are going to try to do some of these things, one, because they're good suggestions, and, two, because we want them to know that we're listening." The morning meetings also helped teachers target their goal of desensitizing mathematical experiences by having students share out their struggles, even those typically perceived as being strong at math, which normalizes this struggle. Three of the classes also used a prompt that asked the students to consider "what is the worst that could happen" if they answer a math problem incorrectly, which led to conversations about perceived threats that were worrying students, such as not finishing in time, and the ability to address these concerns. Three of the classes also used a prompt that asked students to share out how they feel when others students call out that they are done or that a task was easy. This led to impactful conversations that began to shift the power dynamics in the classroom. The students who exhibited these behaviors in the classroom, which the teacher-researchers described as being the male population, were quiet in these conversations and the "females were very vocal" about the effects these behaviors have on their thoughts and emotions about their own capabilities when working on a math task. The teacher-researchers expressed that following this conversation, they noticed that students stopped calling out that they were done with a math task or that the task was easy. Not only had the females been empowered through voice, but the males engaged in reflective practices from the perspectives of females and changed their actions because of these worldviews, a step toward male feminism (Hesse-Biber, 2012).

The morning meetings also led to new insights among the teachers. The conversations strengthened teachers' awareness of the females' tendency to compare themselves to peers, resulting in increased stress and anxiety. Speed often came up in these conversations, as female students described that they will just write down an answer because they see their classmates finishing. Interestingly, while both genders shared out effective and ineffective coping strategies, the female students tended to share out effective coping strategies more often than the males, yet the teacher-researchers were not seeing the females apply these strategies during math situations in which they experienced negative physiological states. This led to the idea that the females needed more direct support in the actual application of such strategies. Along this same theme, the teachers also noticed that the verbalizations shared out in the morning meetings tended to be more positive when the topics were general. Similar to what we found on the questionnaires in regard to reflections on innate ability versus effort, the females seemed to have more positive views of math in general, explaining that math is "like a puzzle, it's all pieces working together and using strategies to try to solve something bigger," and they were aware of possible coping strategies, yet the structures were not in place to support the female students in internalizing and applying these views and mechanisms.

Two of the emerging themes in regard to the morning meetings did communicate drawbacks that are important to be aware of. The public format of the morning meetings seemed to inhibit some students from sharing their private feelings or ideas, especially in response to more personal topics. Additionally, because the meetings were peer-driven, the students were able to build off of each other's ideas; however, this also led the conversation in different directions which may have prevented some students from sharing their ideas on the initial topics or topics that arose throughout.

Cycle 1 general reflections. In addition to the intervention-specific themes that emerged, general patterns were identified that spanned across interventions. These themes are presented in Table 4.8.

As discussed during the development of the action plan, the teacher-researchers found overlaps in the interventions being employed and at times decided to integrate the math-focused morning meeting discussions, or a derivation of these meetings, with journal reflections. Sometimes, the students would first complete the journal entries and the teacher-researchers would then open up the topic for whole-group discussion, and in other instances, the students would engage in a morning meeting discussion and then journal about what they gained from this discussion or share additional ideas. Both integrations were beneficial, as the former allowed students time to reflect on their thoughts before engaging in discussion and the latter allowed students time to reflect on the messages from the whole-group meeting.

In this first cycle of the interventions, it became increasingly apparent to the teacher-researchers that, as with most instructional practices, what would work for one student would not necessarily work for others. Students, including those within the female gender, often had opposite views of what would create a less stressful math environment and what strategies would best help them cope during times of struggle. As mentioned above, this was also evident in the morning meetings and journaling in that some students preferred to share their thoughts aloud in the morning meetings, whereas others preferred the privacy of the journal.

Table 4.8
Reflection on Cycle 1: General

Emerging Theme:	**Frequency Count:**	**Example In Vivo Quotes:**
The effectiveness of specific interventions was influenced by **individuality and diversity.**	5	• "They had a lot of conflicting opinions about what would make a stress-free classroom." • "We also specifically talked about a lot of coping strategies and a lot of them brought up opposites, like a lot of people like to do something physical, like exercise or running around, and others like to be in a quiet place. Some like music, and some like no music. Some like to take a break, some don't like to take a break. Some like to stay focused and just finish, whereas others like to take a break in between. So the coping was different and we talked about how we all learn differently."
Integration of intervention strategies occurred frequently.	4	• "We also did open it up to sharing, I don't know how we feel about that but we did ask if anybody is willing to share what they wrote in their journals to share out, and I would say a lot of them really wanted to share..." • "...had them share coping strategies during the morning meeting, and then their journal prompt was, 'What coping strategies that you heard do you think would help you?'" • "And, it gives them a chance to reflect on what their classmates said."
Interventions need to be connected to the mathematical setting rather than only being discussed in **isolation**.	4	• "We did the question about if you struggle on a task or problem in math what's the worst that could happen, and it initially started out a little negative but not even that negative. In fact, the first person who shared said, 'I know that nothing's really going to happen, it's just that in my head, I have some doubts.' But then it went on this track about all that they know, that they learn from their mistakes, and even though it doesn't feel good, they learn, and there's more brain activity going on, and all that stuff they learned from the start of the year, it all came back to them. And they said their brain is being challenged so it's going to help them to recall, so then it all ended on a positive. So they know all of this, but they just have to keep on reminding themselves about it when they start to feel negative." • "And keeping that awareness. You know, if it's just a one-time talk and then months later, you know."

Another theme that emerged was the need to connect the interventions to the actual mathematical contexts. The female students were able to identify coping mechanisms and verbalize the benefits of mathematical struggle and making mistakes in the morning meeting discussions; however, the females did not appear to apply these strategies and mindsets in their moments of struggle on the questionnaires, and the teacher-researchers did not observe them applying these strategies and mindsets in the classroom setting. In line with critical PAR, which seeks to bring about change in daily contexts, the teacher-researchers also pointed out the importance of not allowing this focus on physiological states in math to be "just a one-time talk" but rather, keeping these discussions ongoing throughout the year.

Revisions to the action plan. At this point in the focus group, we reflected on the conversations we had engaged in and the teacher-researchers' experiences in the first cycle, identifying the strengths and weaknesses of the interventions applied thus far in order to make revisions for the next cycle. The teacher-researchers continuously shared out how most females were able to identify coping mechanisms, but the teachers were not seeing the students actually transfer these strategies and apply them in moments of need. Instead, the female students would often just shut down when they encountered problems they perceived to be challenging or would avoid the tasks entirely. The students were succumbing to the societal marginalization cultivated through math anxiety and self-doubt that are most commonly linked to oppressed groups (Frankenstein, 1992). A proposed solution to this finding was to coach into the coping strategies in the moment, rather than only discussing them in isolation. The teacher-researchers' reflections were recorded on chart paper and are displayed in Figure 4.1.

As described in the previous chapter, I took on a supportive role in synthesizing the teacher-researchers' reflections on the need to support females in applying coping mechanisms during moments of emotional arousal with the generated ideas included in

Reflections / Adjustments for Cycle 2

- Most students have been able to identify signs that they are entering into negative physiological states.
- It has been helpful for students to hear that they are not the only ones struggling.
- It has been helpful for students to hear how behaviors like calling out "I'm done" impact others.
- Most students seem to be able to identify coping strategies, but they are not actually applying these strategies in the moment when they are feeling stressed or anxious. Students will shut down instead of applying coping mechanisms.
- Teachers may need to coach into the coping mechanisms in the moment.
- It would be helpful to have one-on-one conversations with students to see what is working for them and what is not working.

Figure 4.1 Teacher-researchers' reflections on Cycle 1 and resulting revisions for Cycle 2

their developed action plan. When I met with the teacher-researchers the following day, I introduced them to what was temporarily titled the "I-C-? Toolkit," with the "I" serving as the initial for "identify" (i.e., identify negative physiological states), and the "C" representing "cope" (i.e., cope with negative emotions and thoughts) (see Appendix V). The question mark represented a stage that had not yet been termed, but referred to the problem-based coping strategies discussed in the action planning focus group. The purpose of this last stage is to ensure that the students begin to ease into the problem after applying coping strategies to calm their negative thoughts and feelings, rather than reverting back to the negative physiological states. This question mark was eventually changed to an "A" for "act," as termed by the teacher-researchers. I introduced the toolkit to the teacher-researchers, one phase at a time, connecting the steps to parts of the brain that we teach our students through the school's social-emotional program, *Jesse Lewis Choose Love Movement*. The goal would be for the students to 'identify' when the 'numbat brain' is aroused by negative thoughts and emotions, and move to the 'human brain' to 'cope' with and calm these negative feelings, followed by easing into the problem through the 'act' strategies, rather than resorting to the 'lizard brain' and shutting down or avoiding the mathematical experiences, as is common among our female students with low math self-efficacy. Drawing on the discussions and reflections students had already engaged in through morning meetings and journaling, the teachers would work with their classes to develop these ICA Toolkits based on the signs of negative physiological states particular to their students, coping strategies that students find to be beneficial, and group-generated acting strategies to be used in easing into the problem (see appendix W). After I introduced the toolkit, the teacher-researchers were asked to share out their thoughts regarding whether or not they thought this would benefit their female students and be practical in the classroom setting. While elaborations on this discussion will be shared in analyses of the third sub-question, Table 4.9 contains the emerging themes relevant to the modification of classroom practices.

As the teacher-researchers began to discuss the implementation of the ICA Toolkit, they brainstormed methods of rolling out the toolkit in order to increase its effectiveness. All of the teachers agreed that they should model how to use the toolkit with sample problems that might be perceived as challenging, showing students how to differentiate between appropriate and inappropriate coping and acting strategies based on the context, problem type, and student's needs. Further, drawing on their experiences in the first cycle, the teacher-researchers identified the need to coach into the toolkit and coping and acting strategies during the actual mathematical situations in which they would be relevant.

Table 4.9
Reactions to the Introduction of the ICA Toolkit

Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
Teacher modeling was a key strategy discussed for teaching interventions.	9	• "I'm thinking of putting a really hard problem on the board for myself and saying, 'I don't get this. I have no idea what to do. I can't do this,' and then after having introduced all three I would say okay well let me identify. I'm stating that I can't do this and I'm feeling frustrated, I'm feeling upset, let me cope. I'm going to read my poem, take a deep breath... okay let me start by circling the numbers in the problem and see what I have to work with, and just kind of showing them how they can break apart each step and ease into it."
Teachers predicted that **coaching** would need to be a key part of the implementation of the ICA Toolkit.	3	• "They are going to need some coaching in terms of what is the right coping strategy and what is the right like attack strategy because it's going to be different for different types of problems, different settings." • "...if a student is trying to tear their paper apart, maybe we need to tear the paper too and show them what that looks like, and the student might see, 'Wow, this is what I'm doing.'"
Reflecting on the insights gained from journaling and morning meetings, teachers noted that the coping strategies in the ICA Toolkit would be **different from student to student.**	3	• "So, would you do different scenarios?" - "Yeah, that's a good idea." - "Well, if you're going to model it, I think you would probably want to model the thoughts, like speak out loud, "Okay, this is this type of problem, so maybe this strategy would work, whereas this strategy wouldn't really help me in the same way."" - "Yeah, and also trying different coping strategies. Like for some, the breaths may not work, but going for a short walk around the room." - "Right, we don't all cope the same way."
Teachers will need to **help students make appropriate choices** to meet their needs.	3	• "...there are a lot of kids in our class that have a very difficult time differentiating between a coping strategy and a distraction and for some of them a certain coping mechanism isn't going to help them in any way and it will actually be detrimental to other kids." • "I think the problem is that you would have this conversation with everyone, but for some students, especially the boys, it's not stress, it's lack of focus, but they're going to want to take part in these things, too, but for different reasons. They're not really experiencing stress, they're experiencing other issues." • "I think that's part of teaching into it and the coaching. I mean just like anything else we do, if the students are not using it appropriately, then we have that conversation with them and maybe that piece is not available to that student anymore. I mean because it could really be beneficial to other kids and so I think we just need to teach them how to use it in the right way."

Reflections on Cycle 2

In Cycle 2, the teacher-researchers continued to implement math-focused morning meetings and journaling, and they began to roll out the ICA Toolkit. In addition to the core interventions of the math-focused morning meetings, journaling, and ICA Toolkit, the teacher-researchers also decided to supplement these interventions by bringing in a female mathematician to share her experiences with the class and how she overcame negative physiological states in math, as well as continuing to support the home connections. Connecting the work being completed in the classroom to the students' home environment, the teacher-researchers also provided a handout to parents that offered 'strategies and tips' to promote perseverance through coping mechanisms, such as the ICA Toolkit, and positive mathematical self-beliefs that would confront parent-held stereotypes and gender role beliefs that may be passed down to their daughters. In fifth-grade, the teachers asked students to reflect on the handout and write down whether or not any of the recommendations would benefit them.

During Cycle 2, I met with each teacher, or pair of teachers in the case of the collaborative classes, to reflect on the success of the interventions mid-cycle and offer support or any necessary guidance. In these meetings, I also introduced a "Look-fors Checklist" in order to support teachers in identifying whether or not changes were occurring in the manifestations of math self-efficacy among their female students (see Appendix K). As discussed in their reflections after Cycle 1, in this second cycle, the teacher-researchers also decided to begin collecting data from students through informal one-on-one discussions in the classroom setting to better gauge the effectiveness of the interventions for each of the female students.

Many of the themes that emerged in Cycle 1 in relation to journaling and math-focused morning meetings continued to emerge through the interviews and focus group in the second cycle, and a new code in relation to journaling was derived: "Journaling - Aversion to Writing." The addition of the ICA Toolkit and supplemental strategies also prompted the need for new codes, both those specific to these interventions and codes that applied across interventions. These new codes included: "Student-Teacher Relationships," "Seriousness," "Internalizing the Toolkit," "Comfort in Impermanence," "Mathematician - Difficulty Understanding," and "Mathematician - Lacked Benefit." As with the previous cycle, these codes led to emerging themes that were categorized according to the intervention(s) they referred to. Example quotes and frequency counts were also recorded. The themes corresponding to journaling, math-focused morning meetings, and the ICA Toolkit, as well as the data from which they emerged, are presented in Tables 4.10–4.12. The themes pertaining to supplemental intervention strategies are displayed in 4.13.

Cycle 2 journaling. In Cycle 2, the finding that journaling provided students with a safe place to reflect on their mathematical experiences not only continued, but became more prominent. The teacher-researchers observed that the "students who didn't share out much in morning meetings were the ones who wrote a lot in their journals." Even students who disliked writing pointed out the benefit of the privacy of the journal, such as the female student who told her teacher, "I'd rather talk, but I don't want others to know my feelings." This response highlighted the dominant masculine view of mathematics in which feelings must be hidden. Students also communicated to their teachers that the journaling helped them to reflect on their feelings and express their thoughts.

Table 4.10
Reflections on Cycle 2: Journaling

Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
Journaling provided students with a **safe place** to share their thoughts and feelings.	6	• "...for some students, they like to be able to express their thoughts and feelings in the journal instead of saying it aloud in morning meetings." • "The students who didn't share out much in morning meetings were the ones who wrote a lot in their journals." • "One [female] said, 'I'd rather talk, but I don't want others to know my feelings...'" • "...for those who didn't want to share to the group, it at least gave them a private space to jot down their feelings."
Journaling evoked negative responses from students who **disliked writing and/or found it difficult**.	13	• "...another [female] wrote, 'I like the journaling, but my hand hurts and I hate writing, but I don't want anyone else to know my feelings.'" • "...one [female] said, 'It doesn't really help because writing makes me tense...'" • "... they really do struggle with writing about and expressing their thoughts" • "...writing is a very stressful thing for them to overcome. One was trying to explain to me that talking about it is more comfortable for her because it's hard for her to write it down." • "Journaling, as I mentioned before, I don't think has been the best or easiest thing for the third-graders. They had mentioned they had a hard time writing down their thoughts and feelings and would rather vocalize it or talk to the teacher or someone about them."
Journaling fostered **effective self-reflection** among students.	2	• "...one girl wrote, 'I can see my feelings about math and it helps me express thoughts,...'"
Journaling increased **teacher awareness** of practices that influence self-efficacy, leading to teachers **implementing changes** based on student reflection.	5	• "We started using the flexible stools more often, more flexible seating options." • "...they also very much expressed how they wanted open windows and fresh air coming into the classroom (in response to designing a math classroom with less stress), so we've tried to make sure that that's available."
Journaling increased **teacher awareness** of female students' attention to **speed** in math and its impact on physiological states.	3	• "They also kept coming back to time; they said it stresses them out to have a partner who moves quicker than them because they feel like they need to keep up." • "...they don't like to feel rushed..."
Journaling **empowered** students by giving them a voice.	1	• "...we have a lot of students who want to read theirs to the class."

The teacher-researchers reflected on their own classroom practices based on student journal responses, leading them to implement environmental changes, such as offering more flexible seating options and opening the windows to bring fresh air into the classroom. These were both shared as features that would make math more stress-free, features that the teacher-researchers expressed they had never thought of in relation to student stress, increasing their critical consciousness. While the notion of speed came up often in the math-focused morning meetings in Cycle 1, the teacher-researchers noticed that this concern began to surface in the students' journals in Cycle 2. This continued to increase teachers' awareness of the element of time as a cause of anxiety for females, allowing teachers to engage students in conversations about time being unimportant in math and to be cognizant of anxiety in regard to time in setting up partnerships, an area that students linked to this concern. As with Cycle 1, the fifth-grade teachers continued to find that their students, especially females, wanted to read their journals aloud to the class, showing the sense of empowerment and voice journaling gave these students. Another pattern that became stronger in Cycle 2 was the limited journal responses produced by part of the student population, across genders. The teachers were also better able to evaluate the reasoning behind these limited responses, which was that a number of students dislike writing or find it difficult. Students often expressed that the actual act of writing stresses them out, and therefore, the journaling did not help them to reflect on or cope with negative physiological states in math because it made them "tense." These perspectives were only shared by students in third and fourth grade.

Cycle 2 math-focused morning meetings. Further supporting the analyses from Cycle 1, the students continued to voice their self-reflections relating to math during the morning meetings, and the teacher-researchers noticed that students were "more willing to at least acknowledge and express the fact that they're experiencing these feelings," bringing increased femininity into the classroom (Hesse-Biber, 2012). These reflections also led teachers to realize how profound these feelings of angst are for some students, even expressing being stressed about a math assessment over the weekend. The teacher-researchers found that the math-focused morning meetings had started to meet their goal of having the students act as a support system for each other in decreasing or working through negative physiological states in math. Not only did this become apparent during the morning meetings, but the teachers also saw a change in student dynamics during the math class, which they attributed to these morning meeting discussions. In the morning meetings, students discussed the behaviors they could exhibit that would help others, such as encouraging peers through “pep talks” or avoiding calling out that they are finished or that they found an activity to be easy, shared strategies that they found beneficial, which other students then began to apply, and disclosed to others that they were feeling frustrated, stressed, or anxious in math, showing each other than they are not the only ones experiencing these struggles. Ms. Quade articulated how the power dynamics of the math classroom had shifted, explaining:

> I do feel that I've seen a change in the boys in terms of… they had been very positive in themselves, but like overly confident in some ways, and I feel like they have kind of turned it down a bit in the class. I think for them, hearing some of the females’ perspectives and understanding their feelings in the class, especially when they're calling out that they’re done or if they're saying things are easy or they're showing how they got through something quickly, I think they have calmed down a bit and really more so respected the girls going to get a whiteboard or going to get a piece of paper or asking for some assistance.

Table 4.11
Reflections on Cycle 2: Math-Focused Morning Meetings

Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
The morning meetings provided a **community atmosphere** that allowed students to support each other in overcoming negative physiological states in math.	11	• " I think they are really more open to sharing their feelings and strategies, and I have seen students starting to use strategies that have been shared during the math meetings, so I think that's been the strategy that has shown the most success." • "In the past, they have been working together in math, but now, I see a lot more talking about their actual feelings, like this kind of discussion about what they're feeling or their struggles in the pairs." • "...now if they finish something, they might quietly raise their hands, or come up to me, or if there was a partner having trouble, they would try to explain it, rather than just saying like, "Why don't you get this?" And I feel like, for the boys, they're a bit more open to maybe giving them the space to figure it out, or even offering a hand to help them, but not in such a forceful way." • "...some of the boys who were maybe inadvertently, or not knowingly, causing the girls to have some anxiety because they are so confident in themselves, have actually become more aware of their behaviors."
The morning meetings were **peer-driven.** Student responses were guided by the responses of their peers, and thus, individual reactions were not always verbalized.	1	• "Student responses led the conversation in new directions, so many students never shared their input on the initial topic or prompt."
Since the **morning meetings were public**, students seemed to hold back personal thoughts or feelings.	1	• "...there are definitely those students who are less willing to share out."
Students effectively **verbalized self-reflections** on their physiological states.	2	• "...they did express some anxieties that they were feeling going into the assessment, and it was a Monday, so they were talking about feelings they were experiencing over the weekend, and it was surprising how much they had been thinking about it because you think like Monday morning, it might not be the first thing on their minds, but it did seem to be on their minds." • "...the students, in general, have reached a point in which they're more willing to at least acknowledge and express the fact that they're experiencing these feelings."
When the **ICA Toolkit was rolled out in small-group morning meetings**, students who did not share out in the whole-group meetings began to express their thoughts and feelings.	1	• "I think it was better to identify the signs of stress and anxiety as a small group rather than the whole group. Students who don't typically share out in morning meetings were actually inputting a lot more than usual."

Because the females made their worldviews known, the male students began to shift their class. Continuing with this shift in power dynamics, teachers also expressed how these meetings, in conjunction with the ICA Toolkit, were able to normalize the use of tools in math, whereas in the past females were often embarrassed to use tools to help them. One teacher described, “It has now just become part of like well this is how we do math.” As in Cycle 1, the same shortfalls of morning meetings came up in Cycle 2, one being that the meetings are public in the classroom, and this can sometimes dissuade students from wanting to share their personal thoughts and feelings, and the second being that the peer-driven nature of the morning meetings caused the conversation to go in many different directions, which while being a benefit at times, also made it challenging for all students to have the opportunity to respond to the original topic. One alteration that appeared to help address the former was the use of small-group morning meetings in rolling out the ICA Toolkits. The teachers who used this method reported that “students who don't typically share out in morning meetings were actually inputting a lot more than usual."

Cycle 2 ICA Toolkit. During this initial cycle in which the ICA Toolkit was introduced, the teacher-researchers already noticed student application of the toolkit. This was viewed as a momentous improvement for female students who would previously shut down in math when they encountered negative physiological states. The teacher-researchers found that the females were more self-aware and identified signs of stress and anxiety, which then prompted their use of coping and acting strategies. Students applied the coping and acting strategies they had generated during the toolkit rollout.

Table 4.12
Reflections on Cycle 2: ICA Toolkit

Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
Students utilized the ICA Toolkit as an **effective coping mechanism** when they experienced negative physiological states in math.	28	• "So, using the toolkit together, they are able to identify signs that they're feeling stressed or anxious, and then cope using their coping strategies, and then because of that, they've been able to move onto the 'Act' stage after we talked through it together…'" • "…the other strategies they said were taking brave breaths, and I have definitely seen more of this, and the other was to get a blank piece of paper or a whiteboard, and I think that's the strategy I have seen the most of." • "…the other little girl said, 'Using the toolkit makes me think about how I can power through, and it shows that my teacher believes in me because she showed me this toolkit.'" • "We did see them apply some of those strategies during the assessment, like writing affirmations to themselves..." • "We had an assessment that Friday, and while the students didn't necessarily directly say that they were using the toolkit, there were students who asked if they could go get a whiteboard or a blank sheet of paper to break down the problem, and these are students who would normally just shut down or go right to raising their hands and saying, 'I don't get it,' without even trying." • "...they took out their toolkits, and they referred to them..." • "I was just happy that they had these strategies to work through it, you know, that they felt more confident about it." • "…I think in general, there is still a lot of self-doubt. They still kind of focus on that initial response of "I can't do it," but then again, through coaching, we're now able to bring it to their awareness and use the toolkit… they're able to get through it." • "They also seem to be more in tune in the older grades with being able to pull out the toolkit when necessary."
Teachers realized the need for increased **one-on-one coaching** to guide students to use the toolkit when during negative physiological states in math and eventually internalize it.	11	• "...a lot of students are identifying and they know that they're feeling stressed, and they know what they should be doing to cope, but then actually putting those things together and doing it has needed to be coached a little more." • "A lot of them also just still need that coaching where they're not doing it on their own yet, like on the test." • "She really just needed me to sometimes read the problem aloud to her, and then from there, she was able to work through it. So for her, she is slowly building her confidence, and she just still needs that extra support, but she didn't at any point get into that full-on panic mode that she has done in the past."
Transfer requires that strategies are not only taught in **isolation.**	1	• "I was also surprised to see how many coping strategies they had, especially since they aren't actually applying them in the moments when they should be."

These strategies included taking "brave breaths" (stemming from the *Choose Love* and *Zensational Kids* programs utilized by the school), moving to a new spot in the room, writing affirmations to themselves, taking out a whiteboard or blank paper to break down the problem, utilizing math manipulatives, and highlighting the problem. The female students were utilizing the ICA Toolkit to take control of their experiences in the math class. During both assessments and classroom tasks, students used the ICA Toolkit explicitly, as well as implicitly. Some students directly identified that they were using the toolkit, while others applied the strategies without explicitly referring to the toolkit. Ms. Nelson explained, "… these are things that they hadn't done in the past on their own. So even though they weren't necessarily pulling the toolkit out, I was seeing a lot of them using the strategies." The teacher-researchers also engaged in discussions about the shifts in student mindsets that they were seeing. While some students still expressed initial self-doubt or feelings of angst, the teachers found that the female students were better able to "work through" these initial states and "felt more confident." This notion was directly expressed by a female student during a one-on-one conversation with a teacher, in which the student also verbalized an underlying message that being taught the toolkit provided her: "Using the toolkit makes me think about how I can power through, and it shows that my teacher believes in me because she showed me this toolkit." Ms. Quade reacted to this statement, "Of course I do!" The emotion in the teacher's voice as she retold this story to the team revealed both her disbelief and how distraught she was that the student had not known this. Combatting a society that does not believe in female math potential, this student's empowerment allowed her to see that her teacher believed in her potential.

While Ms. Davis and Ms. Turner observed that the female students in fifth-grade were more often able to independently draw on their toolkits when they experienced negative physiological states, teachers in younger grades, particularly third grade which is where most of the codes within this theme emerged from, realized that some students needed coaching in order to apply the toolkits. In discussing this need for additional coaching, Ms. Davis responded to Ms. Quade, “Right, and they are only in third grade, so they need more of that support and scaffolding." There was one instance in which this direct coaching was used at the fifth-grade level. Ms. Davis explained:

> I did sit with one student who was crying, and we took brave breaths together, and like made a joke of it, and she was able to enter back into the task more effectively than if she hadn't done that, but she didn't do it independently. So there is definitely coaching needed, I mean every kid is different.

One-on-one coaching was used more often in the lower grade levels, as it was described that “students are identifying and they know that they're feeling stressed, and they know what they should be doing to cope, but then actually putting those things together and doing it has needed to be coached a little more." At the third-grade level, Ms. Quade reflected on her coaching experience with one female student during a “check-in” assessment:

> During the check-in, one girl just completely turned her chair around and was facing the opposite direction of her check-in sheet. She literally would not even look at the paper. So, I went over and said, “How are we feeling?” and she said, “Frustrated,” and I said, “Okay, so how do you think we could deal with this frustration?” and she said, “Well, I could take a brave breath,” and so we did the brave breath together, and then she said, “Well, now I'm going to go get a whiteboard,” and so she got her whiteboard and for the whole rest of the test she did it completely on the whiteboard.

Ms. Quade went on to describe how she later asked this student if she wanted to take a break for snack, but the student made the decision to continue working through the assessment. This relates to the theme that began to emerge in the first cycle and continued to be reflected upon in the second cycle, that teachers need to help students make direct connections between the strategies they are teaching students for identifying and coping with negative physiological states and the actual application of those strategies in the moment.

Cycle 2 supplemental interventions. Both the visit from the mathematician and the home connection 'strategies and tips' sheet resulted in mixed success, with the most beneficial impact being at the fifth-grade level. Students at the lower grade levels expressed that they had trouble understanding the mathematician due to the higher-level language and vocabulary that she used. However, there were two females at the younger grade levels who did communicate an impact of desensitization, as they found it beneficial to hear about the struggles of both the mathematician and her sister and how they were both able to eventually overcome those struggles. On the other hand, two fourth-grade females "also described that hearing how the mathematician struggled with fractions actually made them more nervous about learning fractions," an outcome that we did not expect. At the fifth-grade level, both female and male students were highly engaged in the discussion with the mathematician. A variety of fifth-graders, across genders, asked questions throughout her visit, such as, "Do you have any tips if you are annoyed or stressed on a math problem?" or "How do you feel when you make a mistake? I'm sure you feel stressed but do you have any other feelings?" Multiple fifth-graders also took the initiative to record notes on what the mathematician was saying. As for the ‘strategies and tips’ sheet that was sent home to parents as part of the teachers’ desire to form a home connection aligned to the interventions being implemented in the classroom, the third- and fourth-grade students and parents did not provide any feedback directly relating to this sheet. Ms. Davis and Ms. Turner decided to attach an assignment to this sheet in which the students were asked to review the sheet with their parents and then write down whether or not they thought any of these strategies would be useful for them. This in turn ensured that the parents received the information and provided the fifth-grade teachers with insights into these conversations between the students and parents. One female student shared how her mother “had no idea that kids were experiencing anxiety in math and she was happy to know that” while the daughter had “thought everyone knew that,” and other students reflected on how “as a family, they're going to try to share more about the mistakes they make together, take brave breaths, and avoid using phrases like 'I'm a math person' or 'I'm not a math person.'" Across grade levels, the ‘Bedtime Math’ app, which was optional for students to use, proved unsuccessful because the students were not taking the initiative to use it. As predicted during the development of the action plan, there was not enough follow through because it was difficult for students to fit this into their already busy schedules.

Cycle 2 general reflections. A new insight that emerged among the fifth-grade teachers was the unexpected seriousness with which the students viewed and applied the interventions. Ms. Turner articulated, “The students have been taking all of the interventions seriously. I am pleasantly surprised to see that none of the students have been joking about the strategies or making fun of them. They have been really serious about it."

Table 4.13
Reflections on Cycle 2: Supplemental Interventions

	Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
Mathematician Visit	Students expressed that it was **difficult to understand** the language used by the mathematician.	3	• "Most of the students said it was difficult to understand her because they didn't understand the words she was using." • "The female mathematician visit was good, but a little hard for them to understand."
	The mathematician's expression of her own struggles helped to **desensitize negative mathematical experiences** for students.	2	• "One female did express that it was helpful to hear that even though you don't understand something the first time, after it is presented in a different way, you might get it." • "One girl mentioned that she enjoyed hearing the mathematician talk about her sister because the sister struggled and it taught my student that she shouldn't give up because in the end, the girl was able to learn and continue going. She said because she kept trying, she was able to get somewhere in life, and if you don't keep trying you won't be able to get anywhere."
	The mathematician's expression of **her own struggles** with specific content made some female students more **anxious** about these topics.	1	• "Two females also described that hearing how the mathematician struggled with fractions actually made them more nervous about learning fractions."
	The mathematician visit was **more successful with older students.**	2	• (5th grade) "They really seemed to be engaged. They asked great questions and were even taking notes" • "I think the female mathematician at the fifth-grade level was really great."
Home Connection	**Few students tried** the Bedtime Math app.	4	• "...they said they were too busy." • "I think they are so busy outside of school, that it's probably difficult for them to add another thing to their list, or at least at this point in the school year."
	Fifth-grade students in the study and their parents responded positively to the "Strategies and Tips" sheet regarding math self-efficacy that was sent home.	6	• "...we got really great feedback in terms of what surprised them, or what stood out to them, or something that they wanted to try out at home." • "The mom was really surprised, she had no idea that kids were experiencing anxiety in math and she was happy to know that, and her daughter said, 'Oh really, I thought everyone knew that!'" • "...some examples of things we got back from them were that as a family, they're going to try to share more about the mistakes they make together, take brave breaths, and avoid using phrases like 'I'm a math person' or 'I'm not a math person.'"

The fifth-grade teachers also realized that the interventions were positively impacting their relationships with the students. Ms. Davis explained:

> I feel like I have such a close connection to this class because of these interventions that we have been working through together. I think they really like that people are interested in what they are feeling, and we are actually doing something about it.

Due to the departmentalized structure of the fifth-grade classes, Ms. Davis was able to clearly see this shift in relationships because it was realized in comparison to her other math sections. While the other teachers had become more aware of their students' emotions and thoughts in math, which undoubtedly impacts relationships, they had not yet explicitly described this change in their relationships with the students. However, as described above, there was the instance in which the third-grade female student described a shift in her relationship with Ms. Quade, as she explained that she realized her teacher believed in her because she taught her the ICA Toolkit. Both of these themes continued to emerge in Cycle 3.

Cycle 2 shifts in manifestations of self-efficacy. Self-efficacy impacts participation in versus avoidance of an activity, perseverance and sustained effort versus premature withdrawal from a task, visualizations and an expectancy of failure versus success, the presence versus absence of negative affective responses, perceived ability versus inability to cope with stresses triggered by a given activity, and the application of coping mechanisms and thought regulation when negative physiological states are encountered versus allowing these emotions and thoughts to overpower the individual (Bandura, 1977/1993).

Reflections on Cycle 2: Shifts in manifestations of self-efficacy
• "...one said 'surprisingly' she did not feel anxious, and she's one who is normally stressed out and anxious in math, and she said, 'Surprisingly no,' she was not anxious, and she mentioned that she wrote inspirational quotes on her paper, and we did notice that." (collaborative teacher:) "And it's important to note that she's a student who normally does give up on assessments, and she did not at any point ask for help or give up." (collaborative teacher:) "Yeah, she seems helpless a lot." (collaborative teacher:) "And she did not vocalize any sort of helplessness on this assessment, so that's an improvement, you know, in terms of her own self-efficacy." • "on a recent assessment that we had, I noticed a lot less of the immediate raising their hands for the teacher." • "I didn't see that panic on the faces of a lot of them that normally do have that panicked expression." • "I have seen more perseverance with tasks and assessments." • "The initial verbal reaction is what stands out in my class, I mean maybe because it's verbal so it's out there, but it's that same idea of it's just immediate before they're even giving themselves a chance. And I am noticing it a little less now." • "And I am seeing more perseverance." • "...the entire population is now more willing to use a tool to help them and they're not as embarrassed." • "I've seen a lot less helplessness..." • "...less helplessness, less raising their hands initially. We also just took an assessment and, overall, they displayed that they were more confident." • "We had an assessment that Friday, and while the students didn't necessarily directly say that they were using the toolkit, there were students who asked if they could go get a whiteboard or a blank sheet of paper to break down the problem, and these are students who would normally just shut down or go right to raising their hand and saying, 'I don't get it,' without even trying." • "...during the test, there was less of the immediate shutting down as soon as they see a problem, which constantly happened on previous assessments. The students also seemed to persevere more." • "There was one student in particular who constantly asks questions throughout the test because she is so hesitant to try out the problems, and she didn't ask any questions throughout the entire test this time." • "And she did raise her hand, and you could tell she was a bit anxious, but she wasn't as panicky as she normally is. She really just needed me to sometimes read the problem aloud to her, and then from there, she was able to work through it. So for her, she is slowly building her confidence, and she just still needs that extra support, but she didn't at any point get into that full-on panic mode that she has done in the past" • "...whiteboards have been used by a lot of them in the math period, and that has been shown to eliminate some of their stress and anxiety in working on tests and also just class work' • "they are able to identify signs that they're feeling stressed or anxious, and then cope using their coping strategies, and then because of that, they've been able to move onto the 'Act' stage after we talked through it together" • "In terms of acting on a strategy, I think that has been a big improvement, at least like trying something." • "On the first assessment, before coaching, the collaborative class did not do as well as the non-collaborative class. But, on this assessment after the coaching, they did slightly better."

Figure 4.2 Shifts in mathematical self-efficacy after Cycle 2.

All of these manifestations of self-efficacy were reflected on during Cycle 2 in both the classroom setting and teacher interviews and focus groups. Figure 4.2 captures the shifts in manifestations of math self-efficacy the teacher-researchers observed among their female students from the start of the study to the conclusion of Cycle 2. While some of these manifestations are more directly discussed in the teacher reflections, the interconnectedness of these manifestations makes it difficult to attach each shift observed in the classroom to a specific manifestation. For example, a conversation between the collaborative fifth-grade teachers, Ms. Davis and Ms. Turner, points to a case in which multiple shifts in manifestations are presented:

> Ms. Davis: ...and she's one who is normally stressed out and anxious in math, and she said, "Surprisingly no," she was not anxious, and she mentioned that she wrote inspirational quotes on her paper, and we did notice that.
>
> Ms. Turner: And it's important to note that she's a student who normally does give up on assessments, and she did not at any point ask for help or give up.
>
> Ms. Davis: Yeah, she seems helpless a lot.
>
> Ms. Turner: And she did not vocalize any sort of helplessness on this assessment, so that's an improvement, you know, in terms of her own self-efficacy.

In this case, the student expressed a decrease in the negative affective responses she typically experiences in math, and this change in affective response, along with the application of the coping mechanism of writing inspirational quotes to herself, was complemented by increased perseverance she displayed on this math assessment as opposed to her usual behavior of premature withdrawal. In terms of affective responses, teacher-researchers found that some girls who once expressed helplessness and panic were no longer displaying these emotions in stressful math situations, such as taking an assessment, while others still verbally or nonverbally communicated negative physiological states, but these were not as severe as they had been in the past, such as the female who “was a bit anxious, but she wasn't as panicky as she normally is.” It is unclear whether these shifts in affective responses were due to the proactive interventions intended to desensitize mathematical experiences and normalize struggle, such as the math-focused morning meetings and journaling, or resulting from the reactive response of utilizing the ICA Toolkit, which thereby also strengthens students’ perceived coping abilities. In some cases, the teachers did explicitly refer to the coping strategies used, such as the self-affirmations or using a whiteboard, which would point to the latter, but in other cases, the teachers noticed shifts in affective responses without describing observations of coping mechanisms. Increased perseverance also came up often, as teachers described, "I have seen more perseverance with tasks and assessments,” and, “…there was less of the immediate shutting down as soon as they see a problem, which constantly happened on previous assessments. The students also seemed to persevere more." This may be due to shifts in affective responses and how the students seemed to be “more confident,” or their visualizations of success rather than failure. The shift in perseverance could also be prompted by the coping strategies that the students are now able to apply when they encounter struggles that would typically produce negative physiological states. The positive impact that the teacher-researchers were witnessing, which they attributed mostly to the morning meetings and ICA Toolkit, as well as the journaling in the upper grades, led them to decide to extend the study into a third cycle to allow more time for the application of these interventions, as well as the opportunity for additional coaching, especially in the younger grades. The teacher-researchers also wanted to be able to engage in more one-on-one conversations with the female students to better evaluate the effectiveness of the interventions.

Reflections on Cycle 3

The final cycle of the study lasted nine days. The data and emergent themes from these meetings are presented in Tables 4.14-4.16. The students were also asked to complete post-intervention questionnaires at the conclusion of the cycle. These questionnaires included the same questions from the initial questionnaire that targeted physiological states, with the math question being altered slightly so that the correct answers would be different. The profession-matching activity was also included since the teacher-researchers found vicarious experience to be the second most influential source of self-efficacy, and I wanted to see if this was indirectly impacted in any way. Further, a question was added to the post-questionnaire that asked the students to reflect on the interventions that had been employed throughout the study and describe whether or not they found any of these interventions to be beneficial.

Cycle 3 journaling. During the Cycle 3 teacher interviews, themes described in the previous cycles continued to materialize. Only one new theme emerged, stemming from data that sparked the new code, "Open Journaling," described in Appendix J. Journaling continued to serve as a safe place for students to express their thoughts and emotions relating to math, and one student even described that she prefers to write down her feelings because "when she is talking to someone, she doesn't always tell the truth." Other students expressed that they were aware that their teachers were reading the journals and "liked it because they felt that their teachers could then help them." In terms of self-reflection, a new insight that appeared in this cycle was that one of the female students described that she liked the journaling because it allowed her to see how she was progressing in her coping abilities. She realized that her earlier entries focused on stress progressing in her coping abilities. She realized that her earlier entries focused on stress and anxiety, while her later entries focused more on coping strategies. Through conversations with female students, the teachers began to realize the students' desire for journaling to be less structured. Students often saw journaling as an assignment due to the prompts that they were asked to respond to, and they wanted more freedom to write about any math topics and to be able to take out the journal whenever their thoughts and emotions prompted it. As in past cycles, the students who disliked writing continued to express that the journaling did not help them.

Table 4.14

Reflections on Cycle 3: Journaling

Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
Journaling provided students with a **safe place** to share their thoughts and feelings	4	• "...those students liked the journaling because they could share their own personal feelings." • "They also like being able to express things that are personal that they might not want to express in a morning meeting." • "One student said it feels better to write it down instead of talking to someone because when she is talking to someone, she doesn't always tell the truth." • "They knew the teachers were seeing it, and they were okay with that and liked it because they felt that their teachers could then help them."
Journaling evoked negative responses from students who **disliked writing and/or found it difficult**.	2	• "...didn't like the journaling, but I think that is because she also doesn't like writing."
Students expressed a greater interest in **open journaling**, such as journaling that was open-ended as opposed to a particular prompt or having the autonomy to access their journal at any point during the math class.	2	• "We used the prompts and the students said it felt like an assignment. I did tell the students in the beginning that I wanted this to become theirs, so they weren't restricted only to the prompts, but that is how they felt." • "...they wanted easier access to them. They wanted to be able to write in them after a test."
Journaling fostered **effective self-reflection** among students	1	• "One of our female students expressed that she likes the journaling because it allows her to look back on progress she made. In the beginning she was only talking about stress and anxiety, and as she continued, her entries focused more on coping strategies."

Cycle 3 morning-meetings. The continuation of the math-focused morning meetings strengthened the community atmosphere that was established in the morning meeting setting as well as the math class. Sharing out the struggles students were experiencing and the different strategies that helped them “promoted respect for one another” and developed an understanding of the individuality and diversity in the classroom. The students joined together in combatting the inequities present in the math classroom. Additionally, disclosure of struggles helped to desensitize math experiences as students realized that they were not the only ones who were experiencing struggles, and vocalizing strategies allowed others to hear strategies peers were using that might work for them. One student remarked that “most conversations about stress you have with adults, so it was nice to have these conversations with peers because you can get strategies from people who really understand what you are going through." Because the females were provided this opportunity to voice their thoughts and feelings, the students also realized the impacts that their actions can have on others’ learning, which in turn led to the decrease of behaviors that harm others’ learning and an increase in supportive behaviors, such as helping a peer work through a problem. This shifted the power dynamics in the classroom, as female students who were previously feeling rushed or anxious as a result of the behaviors of the males expressed that these emotions had decreased since the boys had changed their behaviors. The teacher-researchers also found the meetings to be beneficial in strengthening their own awareness of the students’ thoughts and emotions. The finding that some students did not want to share in this public forum did, however, continue, as some females expressed “that while they like to hear others’ ideas, they don’t like to express their own feelings."

Table 4.15

Reflections on Cycle 3: Math-Focused Morning Meetings

Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
The morning meetings provided a **community atmosphere** that allowed students to support each other in overcoming negative physiological states in math.	18	• "We had a lot of students express that they liked the morning meetings because they like to hear what others have to say and they are able to learn strategies that might work for them too," • "...just based on the amount of sharing we have done, there has been more awareness that everyone struggles at some point and everyone does math differently no matter what skill they are on." • "It opened their eyes to seeing that some of the things they do actually cause stress for other classmates. They are more aware that their actions have an effect on everyone in the room." • "One girl said that most conversations about stress you have with adults, so it was nice to have these conversations with peers because you can get strategies from people who really understand what you are going through." • "It seems as though the students accept that other students are feeling stressed and anxious about math, which has in turn promoted respect for one another." • "They definitely recognize that we see things in different ways. The morning meeting discussions have definitely illuminated this"
Morning math meetings **empowered female students** to have control over their experiences and gave them a **voice in the classroom**.	3	• "I had students speak out in conversations that I thought would be more quiet, and that surprised me. Students sharing feelings who normally wouldn't have, opened up others to do the same." • "We have a few girls who didn't openly talk about their math thinking, but now have been very vocal about talking about stress and anxiety in the class. It has been really exciting to hear more of their voices." • "By expressing how they felt, students were able to see how this was having a negative impact on others and they stopped doing this."
Interventions increased **teachers' awareness**.	2	• "It was good for them, and for me, to see what others are thinking." • "It was beneficial for them and me to hear, and it helps me to alleviate their stress."
Interventions led to changes in classroom **power dynamics**.	7	• "They know two students who they all think are really good at math, and going back to those conversations, they were ones that always said, 'I'm done,' and they were also ones who said they never really considered what that would do, saying that aloud." • "The males have stopped doing this and have even helped to give a direction if someone was stuck, rather than saying, 'Don't look at my paper.'" • "One girl also expressed how she doesn't feel rushed anymore because the boys have mostly stopped saying, 'I'm done.'
Morning meetings promoted the **desensitization of negative feelings** relating to math experiences.	2	• "It made them feel better that they were not the only ones struggling." • "...through morning meetings and discussion, they are more aware that they are not the only people feeling stress and anxiety when it comes to math."
The **public** nature of the meetings caused students to hold back personal thoughts.	1	• "...we also had several females say that while they like to hear others' ideas, they don't like to express their own feelings"

Cycle 3 ICA Toolkit. Reflections on Cycle 3 highlighted the ongoing success of the ICA Toolkit in prompting students to self-reflect and then employ coping and acting strategies when experiencing negative physiological states. The toolkit was especially successful among female students, and in the conversations Ms. Quade had with her third-grade students, all females expressed that the toolkit had been "beneficial because it

Table 4.16
Reflections on Cycle 3: ICA Toolkit

Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
Students utilized the ICA **Toolkit as an effective coping mechanism** when they experienced negative physiological states in math.	14	• "One of our female students expressed how she uses the toolkit a lot and she likes the coping strategies of taking a break or doodling about her feelings." • "All the girls found the toolkit to be beneficial because it gave them strategies to use and get back to the problem." • "...they are more aware, like thinking, 'I am feeling this way, and now I need to cope,' rather than just shutting down or giving up." • "...when they see other students getting tools to help them, they don't see it as abnormal as they did earlier in the year." • "...they are actually taking action now. At least now, the ones who have the toolkit, are actually doing something about it now rather than just sitting there and letting the stress or anxiety overpower them." • "...students expressed that they had started to use the strategies listed in the toolkit on their own, not so much explicitly from the toolkit, like taking it out and looking at it. They said they used the strategies of taking deep breaths or a break to calm down and then refocus." • "...most reported that they have been using the toolkit." • "...brave breaths and having something to squeeze helped them to cope; this was very consistent across the girls." • "...no one said they didn't get it right away, as I would have expected in the past. All of the girls, during this introduction of perimeter, asked to use a whiteboard to help them break down the problems." • "They are much more often taking action, like getting a whiteboard or drawing it out."
Teachers realized the need for **one-on-one coaching** to guide students to use the toolkit when during negative physiological states in math and eventually internalize it.	5	• "…really liked having the teacher coach her through it." • "students' abilities to cope have increased overall; it's not fully there, and definitely still needs coaching when they reach that point of being totally stressed out or anxious" • "If we talk about it, that helps, but they still need a reminder."

gave them strategies to use and get back to the problem." At the fourth-grade level, Ms. Nelson and Ms. Holt illustrated the steps a female student took:

> …we also had another female student who was becoming stressed, almost in tears, and she was able to identify what was going on in her body and decided to use the coping strategy of taking a break to get a drink of water and then moving to another space in the room that would be more calming.

The teachers did continue to express that some students need additional coaching to employ the toolkit, and one fifth-grade student actually verbalized in her conversation with the teacher that "she really liked having the teacher coach her through it [the toolkit]."

Cycle 3 general reflections. Just as the fifth-grade teachers described in the previous cycle that they were pleasantly surprised by how seriously the students were viewing the interventions, Mr. Erikson described that although his fourth-grade class can often be "silly," he was "really impressed" with their behavior during the morning meetings, as "they were supporting each other and building off each other's ideas and taking it seriously."

Cycle 3 shifts in manifestations of self-efficacy. "For the majority of the students, we have seen a change." Ms. Nelson's verbalization captures the evaluations reported across grade levels. These shifts have taken different forms across the female population. For some females, these shifts were observed through increased perseverance and decreased task avoidance. Teachers expressed that they had "not seen nearly as much shutting down" or "refusing to take on the tasks." Other students conveyed shifts in their affective responses and outcome expectancies. The teacher-researchers found that the females were “feeling more positive about their abilities” and were less nervous, stressed, or anxious. Ms. Holt expressed, “There have also been less meltdowns. There used to be so many meltdowns, but I see fewer meltdowns now,” and Ms. Quade stated, “There is less crying, putting heads down, or avoiding looking at the problem." While some students are still experiencing negative physiological states in math, the teachers have observed an increase in their coping abilities, reporting that “they are better able to work through it.” At the fifth-grade level, Ms. Davis was able to compare her observations of the class in the study with her other math sections, and she described that during a recent assessment, no female students in the class in focus shut down or said, “I can’t do this,” while these behaviors did continue across her other three sections. Ms. Davis affirmed that the females in the study were “now the least helpless and used to be the most helpless.” The data regarding shifts in manifestations of math self-efficacy among females are displayed in Figure 4.3.

Post-questionnaire data. As in the pre-questionnaire, students were provided with a pre-algebraic math task and asked to reflect on the thoughts and feelings experienced in completing the task. In comparing the pre-questionnaire and post-questionnaire results, across all grade levels, the number of females who responded with “problematic” (negative views of self; frustration; anxiety; states of confusion; focus on the perceived challenge of the task) thoughts and feelings decreased from 29 females to 19. “Non-problematic” responses (expressed perseverance or coping behavior; “confidence” in or positive views of math abilities; focus on perceived ease of the problem; focus on processes used to solve) increased among females at each grade level. The number of females who expressed “non-problematic” responses increased from 16 to

25. In the fourth- and fifth-grade classes, all females communicated at least one “non-problematic” response. The male population displayed smaller shifts, moving from 17 “problematic” responses to 16, and decreasing “non-problematic” responses from 27 to 25.

Reflections on Cycle 3: Shifts in manifestations of self-efficacy
• "For the majority of the students, we have seen a change." • "...not seen nearly as much shutting down among the students. No one has come up to us and said, “I can't do this,” whereas I do have that in other classes. They are feeling more positive about their abilities, and their resilience has definitely improved. We don't have anyone shutting down or refusing to take on the tasks. On the assessment task yesterday, we didn't have anyone saying they couldn't do it, but I did have that in other classes." • "The students’ abilities to cope have increased overall; it’s not fully there, and definitely still needs coaching when they reach that point of being totally stressed out or anxious, but they are more aware, like thinking, “I am feeling this way, and now I need to cope,” rather than just shutting down..." • "...when they see something they don't know, they are still sometimes having the self-doubt and saying “I don’t get it,” but it has decreased, and they are better able to work through it." • "There have also been less meltdowns. There used to be so many meltdowns, but I see fewer meltdowns now. Their awareness of being able to express their feelings is heightened, and they are working more slowly and realizing that it is okay to take your time and that if you don’t finish, that is okay." • "I have three girls who, anything that’s new, they immediately shut down before they even have a shot to try something. I don’t know that it has gone down significantly. The frequency is similar, but they are working through it better." • "In the recent assessment, a lot of students felt they were less nervous or anxious before or during the assessment in comparison to previous assessments. Usually, the hands shoot up immediately, but I received fewer immediate questions during the test." • "She said she didn’t like math before but it is growing on her now." • "We think that students are starting to feel as though there isn’t such a thing as a 'math person.'" • "One student has been expressing herself by saying, “I’m frustrated,” which is huge for her..." • "Visually, the girls are less stressed and anxious. There is less crying, putting heads down, or avoiding looking at the problem." • "they are now the least helpless and used to be the most helpless.” • "One of our female students expressed that she likes the journaling because it allows her to look back on progress she made. In the beginning she was only talking about stress and anxiety, and as she continued, her entries focused more on coping strategies."

Figure 4.3 Shifts in mathematical self-efficacy after Cycle 3.1

In addition to a decrease in negative responses and increase in positive responses, the descriptions written by the students on the post-questionnaire appeared to be less severe in comparison to those presented on the pre-questionnaire. Whereas there were five fifth-grade females who expressed strong negative views of their math capabilities on the pre-questionnaire, such as, "You're horrible," “"You're bad at math," and "Maybe I'm not smart enough," no fifth-graders expressed these negative views of self on the post-questionnaire. The females also communicated strong positive views on the post-questionnaire, such as, “I can do this! I am smart! I am good at math! There is no such thing as a math person! I really understand this!" "This is a picture of me being positive and me believing in myself. I was thinking to myself growth mindset sayings and persevering and not just sitting there," "I was confident and didn't doubt myself," "I am confident in myself that I can do it," and "Growth mindset; I will do it; I can do it; determined; strong." Contrary to the fixed views of math ability expressed by these female students on the pre-questionnaire, the post-questionnaire demonstrated a disruption of this societally-promoted idea that math is an innate ability, typically associated with men (Steele, 2010; Frankenstein, 1992).

While the student reflections on the thoughts and feelings experienced in completing the math task provide valuable insights into changes in mathematical experiences and the resulting physiological states that may have occurred as a result of the employed interventions, it was also important to gather students’ direct feedback about which, if any, interventions they found to be beneficial. Appendices P and Q display this feedback provided by the females. Overall, the ICA Toolkit and Morning Meetings were found to be the most beneficial, with 58% and 48% of the female population selecting these as beneficial strategies, respectively. Interestingly, journaling was selected by 29% of the total population, but it was the top choice among fifth-grade females. Only two fifth-graders out of the entire female population described the mathematician visit as being beneficial, and no students described the 'Bedtime Math' app as being beneficial.

The reflections from the students confirmed the analyses made by the teacher-researchers throughout the study. The teacher-researchers found that the students benefitted from the morning meetings and ICA Toolkit across grade levels, and recognized that the journaling was successful in fifth-grade, but was not as successful in the lower grades. Key themes that stood out in teacher reflections on morning meetings were the desensitization of mathematical experiences by normalizing struggle and the development of a supportive community. These themes were also described by the students. Student reflections on the normalization of struggle included, "It makes me feel a little better because it means that I'm not the only one struggling," "I didn't realize that people felt that way, so now I know," and "It was cool to see that I was not alone when feeling stressed and anxious and seeing that other people experience it too and that I'm not an oddball." Students also expressed that the morning meetings led to peers altering their behaviors to be more supportive of others, strategy discussion that allowed them to learn new ways to overcome struggles, and the ability to express their feelings, such as the student who wrote, "It made me spill out all of the negativity that I had." The females also reflected on the benefits of the ICA Toolkit in enabling them to work through mathematical situations in which they experience struggle. Such reflections included, "It listed things that make me feel comfortable in math," "When you are stuck on a problem and you are getting stressed out you can look at your ICA Toolkit so you can feel normal again," and "The ICA strategy helped me the most. Usually I forget how to deal with my anxiety when I'm stressed but now I can always see it." With regard to journaling, the girls described how it was helpful in reflecting upon their thoughts and feelings about math: "Makes me get to talk to myself about what I feel," and "It's good to have it organized on a paper instead of in your head." The students also communicated that they viewed the journal as a safe place where they could write their “more private feelings.” However, they also expressed that they would like to have more flexible access to the journals. Some students who did not select the journal as being beneficial did reflect on why they did not like journaling, which connected back to their aversions toward writing, as well as how they thought the morning meetings accomplish the same goals.

As mentioned above, we did include the profession-matching question in the post-questionnaire to gather data on whether or not the source of vicarious experience in relation to gender biases was indirectly impacted at all. The data displayed in Appendix R conveys that the fifth-grade findings remained the same while there were slight decreases in the number of females placed into STEM professions in the other three classes.

Supporting Teacher Inquiry

At the outset of this study, my initial goal in working with the teacher-researchers was to inspire within them a motivation to investigate and effect change in the unjust disparities in mathematical self-efficacy across genders. My own entrance into this study was sparked by the epiphanic moment that I experienced as a fifth-grade math teacher, outlined in the first chapter, and my aim was to create a similar authentic epiphanic moment for the teacher-researchers. However, in order for this enlightenment and the unfolding of the study to be successful, I needed to enact some pre-teaching. Once the research team was selected, I provided each teacher-researcher with a brief packet that concisely explained through text and graphic organizers what self-efficacy is, its derivation from human agency theory, the impacts of self-efficacy, and the sources that influence self-efficacy development (Bandura, 1977/1989/1993). This packet also included a brief homework assignment in which the teacher-researchers were asked to generate one example of each source of self-efficacy. The teachers had 15 days to review the literature and complete the assignment, while I administered the student questionnaires. In the week leading up to the first focus group, I also sent the teacher-researchers an optional cloze activity that reviewed key concepts of self-efficacy to serve as a refresher, as well as a reminder to complete the reading material.

When the teacher-researchers arrived for the first focus group, I began with an overview of the current research on female self-efficacy and participation in STEM fields, with the intention of beginning to spark a sense of shock among the teacher-researchers. We then moved to an activity in which the teacher-researchers read aloud the examples they developed as part of their assignment, while their colleagues were asked to determine which source of self-efficacy was surfacing. This allowed the teachers to strengthen their understandings of self-efficacy and allowed me to collect data on whether or not their understandings were secure enough to move into the study and address any misconceptions they had. The subsequent activity also met these intentions, as the teacher-researchers were provided with example student quotes and were tasked with categorizing these quotes according to the source of self-efficacy being displayed. However, in this activity, the teacher-researchers were placed into two groups to begin to build a sense of community among the researchers. Actual quotes from the student questionnaires were also embedded into this activity, but the teachers were not made aware of this because I wanted these quotes to help prompt epiphanic moments for the teachers once they were provided with the questionnaire data. Both of the introductory activities conveyed that overall, the teacher-researchers had accurate understandings of the notion of self-efficacy and its sources.

Through monitoring charts, I recorded notes as the teachers worked through and reported out on these activities, which were then coded according to the patterns I identified and categorized into emerging themes within and across the coded data. The teachers provided accurate examples of sources of self-efficacy, sorted quotes according to the self-efficacy source that was most influential, connected sources of self-efficacy to their own prior practices and experiences, identified keywords and defining features for each source, and verbalized challenges in source identification, such as the overlaps that often occur between sources.

Continuing to lay the reflective foundations for the study, I provided teachers with a mini-questionnaire intended to mimic pieces of the student questionnaire so that the teachers could better relate to the students' experiences that they would soon be analyzing (see appendix Y). After completing the mini-questionnaires, the teacher-researchers were asked to share out their responses to the open-ended questions, which were recorded on chart paper. This activity also supported the development of trust, collaboration, and camaraderie among the group, as teachers shared personal thoughts and emotions experienced as they completed challenging math problems and reflected aloud on the mathematical experiences of their pasts. The themes that emerged from the share-out foreshadowed the themes that would later emerge from the student data collected throughout the study. The female teachers expressed that in completing the questionnaire math problems, they experienced negative physiological states and focused on the perceptions of others, such as, "I'm the only teacher who only teaches math, and I teach the highest grade level of math, so I was thinking, 'It will look really bad if I can't do this.'" As described by Bandura (1993), the social consequences of failure impacted the teachers' abilities to stay on task and work through the problems because they were plagued with negative thoughts and self-doubt. On the other hand, Mr. Erikson experienced what he referred to as "enjoyable anxiety" and "was very focused on the correct answer." These same patterns were prevalent in the responses from the student questionnaires, as the females more often expressed negative physiological states and compared themselves to others, whereas the males were more often focused on how to solve the problem and described "brain warriors defeating the question." In reflecting on prior experiences, female teachers described teacher practices that damaged their math self-efficacy and the importance of ownership over the supports being provided, mirroring the reflective practice the teachers would later engage in as they critically viewed their own instructional practices, as well as the teachers' decision to empower females to voice the changes to classroom practices that would support their self-efficacy growth. Inherent within feminist-infused critical inquiry is that the inquirers undergo change through self-critical reflection (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012). Engaging the teacher-researchers in these opening activities was successful in sparking self-reflection and connecting to the experiences of the students.

Easing the teacher-researchers into the questionnaire data, I began by providing general quantitative overviews, such as "Out of the 31 female respondents for questions two and three, 15 students expressed feelings of frustration, anxiety, or negative self-views in math; out of the 35 male respondents for questions two and three, five students expressed feelings of frustration, anxiety, or negative self-views in math," which prompted verbal and nonverbal communication of shock and surprise. The qualitative data was then presented. The teacher-researchers were provided with time to review each data set independently before being asked to share out about the patterns they noticed, what stood out to them, questions they had, and the source of self-efficacy that appeared to be most influential in the responses. This dialogue was recorded and transcribed.

In coding the data obtained from each conversation, as well as all future focus groups and interviews, I utilized the procedure described in sub-question B of first completing a cold read through the lens of the current sub-question and then reading through the text again looking for verbalizations that contained "impacting nouns, action-oriented verbs, evocative word choices, clever or ironic phrases, similes and metaphors," or repetition (Saldaña, 2009, p. 75). The patterns found in the units of meaning were used to develop the codes. A combination of In Vivo coding and open coding was used to develop these codes, displayed in the codebook, Appendix M (Guest et al., 2012). From these codes, themes emerged. Some codes directly transformed into themes, some themes were developed through a combination of data from connecting codes, and some groups of coded data branched out into multiple themes (Guest et al., 2012). Appendices S, T, and U contain the data collected from the focus group dialogue and teacher interviews. These data will be referenced throughout the presentation of findings on Sub-question C.

As described above, my main objective for the first focus group was to cultivate epiphanic moments for the teacher-researchers that would serve as a catalyst for their interest and investment in the study, as well as begin to prompt change in the way they saw their classroom practices and the lived experiences of their female students

(Charmaz, 2017; Denzin, 2016). This was accomplished early on in the focus group and continued to build as further data was presented. The emotional responses experienced by the teachers were conveyed through comments such as, “I’m like shocked at the severity," “That’s incredible," "Like I can't believe that you would go into that much detail about it's that stressful and painful to you," and “...this is devastating.” The teacher-researchers also expressed these feelings of shock as they began to look across genders. With the teacher-researchers’ prerequisite knowledge developed, reflection on their prior instructional and personal experiences stimulated, and their investment in the study provoked, the team was ready to define the problem and move into reflexive cycles of participatory action research through feminist-infused critical inquiry.

Characteristics of Feminist-Infused Critical Inquiry through PAR

Critical feminist inquiry requires that researchers view the data collected through a lens of doubt and critique to ensure that the truths of the marginalized populations being studied are driving the interventions, and that the specific problem to be targeted is identified (Charmaz, 2017; Denzin, 2016). Throughout the research process, researchers need to maintain a critical view of themselves and their practices in order to bring to light any assumptions or misconceptions they hold and prompt transformation (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012). Such transformation occurs as result of emergent and reflexive research through critical analyses and questioning, always keeping the marginalized population’s lived experiences at the forefront (Charmaz, 2017; Denzin, 2016; Hesse-Biber, 2012; Merriam & Tisdell, 2016; Shrewsbury, 1987). Moving beyond simply investigating inequities, critical feminist theory promotes action toward social justice (Gannon & Davies, 2012), and thus requires inquirers to take action within the setting, in this case the classroom, through a critical feminist framework (Denzin, 2016, p. 8; Gannon & Davies, 2012). Engaging in this work through PAR supports transformation through collaboration and prompts critical dialogues (Denzin, 2016; Lykes & Hershberg, 2012).

Critical view of data in defining the problem. As the teacher-researchers analyzed the questionnaire data independently and collaboratively, they pointed out occurrences in the data that did not seem to align, such as, "...we were talking about how they overwhelmingly had that negative response even though they were doing well but I was looking at the part where it is question eight, and no one put innate among the girls," and "...we are looking at it through the lens of like whether they put females in the math jobs but could they have not put males in the author and book editor jobs?" These critical views of the data allowed the teacher-researchers to focus in on the data that best represented the factors that appeared to be most influential among the self-efficacy development of their female students. Denzin (2016) affirms that qualitative critical inquiry allows for problem identification through the comparative analyses of lived experiences expressed. Rather than telling the teacher-researchers the source of self-efficacy that we would be targeting, I tasked them with this decision to cultivate their participation in this qualitative inquiry. After each data set was presented, I asked the teacher-researchers to identify the source of self-efficacy that was surfacing and reflect on all data presented thus far to determine which source would be most beneficial to target. Teacher-researchers drew on the keywords and defining features they had identified during the opening activities as they identified sources, referring to physiological states in pointing out, "Or it's like, 'This is challenging,' and then, 'I feel stressed,' you know, or, 'Anxious.'" After engaging in these conversations throughout the focus group, the teachers were confident in the source they would select to target through interventions, describing the negative physiological states experienced as "heartbreaking."

Taking action. Denzin (2016) affirms that data provides the "moral authority" to take action, moving beyond interpretation of oppression to changing the systems that allow and support such oppression (p. 8). The student questionnaire data sparked a motivation among the teacher-researchers to take action in addressing the disparities in math self-efficacy across genders. The teacher-researchers asserted, "This is like a necessity, I mean it really, when you see this kind of data it's…" and went on to question how to act on the problem they had identified:

> And the whole point of why we're here, like how do you help them? She understands that this is how she feels and what's affecting her, that almost sounds like it's a cry for help there, like - *I don't know what to do past that, I know it's a problem. I know it's affecting me* and then we need that next step of okay how do we now recognize the problem and how do we help change it?

In line with critical inquiry, the classroom became a place for activism and change by identifying interventions to positively alter current practices (Denzin, 2016). After the teacher-researchers had posed the question of how they could "help change it," I sent them electronic copies of summary sheets with possible ideas for interventions to target the selected source of self-efficacy in order to spark their brainstorming for the following session. Not knowing which intervention the team would select, I had prepared these sheets for all four sources. Because the summary sheet was digitally shared through

Google Docs, the teacher-researchers were able to add their own ideas if they chose to do so, but I found that the daily responsibilities of teachers did not allow for the time this would have required for most of the researchers. When we met together for the second stage of the action plan development, we began by brainstorming goals that we wanted to target. Through the aforementioned process of having the teachers select and rank the six interventions they thought would be most beneficial, followed by a group share-out, we were able to construct an action plan that aligned with the set goals: the desensitization of negative mathematical experiences by addressing exaggerated perceptions of threat and normalizing struggle, strengthening female students' abilities to identify and self-monitor physiological states, and guiding female students to apply and internalize coping mechanisms to overcome negative physiological states.

In critical qualitative inquiry, it is not only important to take action, but also to evaluate the impact of the interventions employed (Denzin, 2016). Throughout the study, the teacher-researchers analyzed the success of the interventions employed through observations of student behavior and responses during morning meetings, journaling, and daily math classes. After the first cycle, the teacher-researchers also identified the need to engage in one-on-one conversations with students or ask them to journal about the interventions to gain their firsthand perspectives of the benefits of the interventions. Ms. Nelson shared, "It would be helpful to have one-on-one conversations with students to see what is working for them and what is not working." Supporting the teachers in their observations of shifts in manifestations of self-efficacy, I met with each teacher or teacher-pair to introduce them to a "Look-fors Checklist" based on the impacts of self-efficacy identified by Bandura (1977/1989/1993). As teachers shared out changes they had observed in the classroom, I recorded these on the checklist, using this authentic data to model how to use the checklist. Across cycles, the teacher-researchers identified strengths as well as the shortcomings of the interventions, such as:

> We had a lot of students express that they liked the morning meetings because they like to hear what others have to say and they are able to learn strategies that might work for them too, but we also had several females say that while they like to hear others' ideas, they don't like to express their own feelings, so those students liked the journaling because they could share their own personal feelings.

The teachers were also attentive to new insights prompted by the interventions that strengthened the teachers' awareness and understanding of the problem. For example, the teachers noted the more positive views of math that females expressed when discussing math in general in comparison to the more negative views expressed when reflecting on their personal experiences with math.

With the goal of critical inquiry being the transformation of oppressive structures, as the study progressed, the teacher-researchers successfully identified transformations using the tools described above, most often focusing on the changes in manifestations of self-efficacy. The teacher-researchers also reflected on the changes in peer interaction that they observed. Mr. Erikson described a development he noticed in the students' partnership work, explaining, "Like in the past, they have been working together in math, but now, I see a lot more talking about their actual feelings, like this kind of discussion about what they're feeling or their struggles in the pairs." Across grade levels, the teacher-researchers noticed changes in the boys in regard to the behaviors they had previously engaged in that caused anxiety for females and new behaviors they were exhibiting that promoted positive self-efficacy among females. Ms. Quade described, "…for the boys, they're a bit more open to maybe giving them the space to figure it out, or even offering a hand to help them, but not in such a forceful way." Further, the teacher-researchers focused in on individual changes they saw in the female students, describing, "One student has been expressing herself by saying, "I'm frustrated," which is huge for her to identify that."

Emergent critical inquiry and the role of an administrator-researcher. The ongoing critical analysis that the teachers conducted allowed the study to maintain reflexivity. Beginning the study with the source to be targeted and interventions to be employed left open-ended allowed for a truly emergent study to take place with each teacher-researcher taking on the role of an inquirer. The emergent nature of critical inquiry is fueled by inductive analysis (Charmaz, 2017). Asking the teachers to look for patterns in the student questionnaire data and identify sources of self-efficacy that were surfacing prompted this inductive analysis. Patterns the teacher-researchers shared out included, "I think that across the board clearly the males are more confident in 3rd, 4th, and 5th grade..." and "The male [comments] are less severe, some of them are comical, whereas the female comments are intense." The analytical perspectives the teacher-researchers embodied were also demonstrated as they inquired about patterns across grade levels. They viewed the responses to the question set aimed at investigating physiological states as increasing with intensity as the grade levels increased. Ms. Holt captured this trend as she posited:

> I think also looking at Quade's third-grade responses, 'I got *a little* frustrated,' 'I felt *a little* frustrated,' 'I was *a little* scared." It's like, these little hints of feeling

uncomfortable or feeling confused but then fast-forward to fourth grade and fifth grade and it's like, that's where you're seeing this deeper emotional stress level."

The teachers described how in the upper grades, thoughts and feelings were rarely qualified with the term "little," and instead seemed to be more established among the students. While there was not enough conclusive data to support or explain these patterns, the teacher-researchers proposed possible rationale for this trend, such as the increasing complexity of the content, added pressure as the students get older, becoming more self-aware and reflective, or having the language to better illustrate their feelings.

This critical inquiry continued in each focus group, from the development of the action plan to the ongoing reflection on the strengths and weaknesses of the interventions that had been employed in determining revisions to the action plan. Prior to the launch of the study, I envisioned my role as requiring ongoing direct coaching to guide the teachers through the identification, implementation, and revision of effective interventions to support female self-efficacy; however, this was rarely the case. Given the necessary time and resources for critical collaboration and intervention implementation, the teacher-researchers took the lead. I was often on the receiving end of emails, phone calls, texts, and hallway conversations initiated by the teacher-researchers during which they shared with me new ideas they had generated or changes they observed in the classroom.

Over the course of the study, my active role often changed in order to support the unpredictable emergent nature of critical inquiry. After the initial launch, it was necessary that I shifted from the transformational leadership style that I had embraced at the start of the study, in cultivating epiphanic moments that would inspire ongoing teacher investment, to a servant leadership style (Avci, 2015; Insley, Iaeger, Ekinci & Sakiz, 2016). The teacher-researchers' daily responsibilities and limited availability of time precluded them from being able to complete the preparatory work that was essential to the interventions, so I needed to take on these tasks in supporting the emancipatory work the teacher-researchers were engaging in (Insley et al., 2016). This servant leadership role was first necessary when the teachers generated the initial action plan. Since the action plan was entirely emergent, I could not prepare for these interventions in advance. Therefore, once the action plan was generated, I had to have the initial intervention materials ready for the following day. I sifted through literature to develop a collection of math prompts for the morning meetings and journaling, gathered supplies for the student journals, created direction sheets for the 'Bedtime Math' app, and began to reach out to contacts to find a female mathematician who could Skype with or visit the classes. Cognizant of the busy schedules of teachers, taking on these tasks allowed me to support the successful implementation of the interventions. The teacher-researchers did have the freedom to adapt interventions throughout the cycles as they saw fit, staying true to emergent research, and these smaller-scale revisions were typically made independently by the teachers. The results of these adaptations were shared out in the focus groups that followed. For example, the fifth-grade teachers decided to offer students the opportunity to share out their journal reflections with the group, which they found successful because many students wanted to share their thoughts and feelings and this gave them time to reflect before sharing out with the group. After hearing this, additional teacher-researchers began to offer this opportunity to their students.

In addition to revisions made within a cycle, reflections on the success of interventions and critical questioning about the causes of the success or lack of success resulted in larger revisions to the action plan. The largest revision was made between the first and second cycle, and required me to take on a more active role in synthesizing the teacher-researchers' feedback along with the set goals and previously brainstormed interventions in order to develop a comprehensive revised action plan. My increased involvement in the development of the revised action plan at this point was necessary due to the reflective time required, a resource inadequately afforded to American public school teachers, as well as my background knowledge and prior research on self-efficacy and physiological states. The action plan revision was prompted by critical feedback in which the teacher-researchers voiced that while the students were able to identify common signs of negative physiological states and knew some coping strategies, they were not applying these strategies in the moments when these negative states occurred, and therefore, it was not beneficial to try to solely address these negative states in isolation. This finding was supported by the data later collected in the post-questionnaire, as a female student described, "Usually I forget how to deal with my anxiety when I'm stressed." As outlined in sub-question B, this led to the development of the ICA Toolkit. I created the toolkit by drawing on the teacher-researchers' reflections and incorporating the emotional coping and problem-based coping strategies that had been discussed in the first focus group. The goal was to provide students with a clear and concise tool that they could refer to and eventually internalize in coping with negative physiological states in math. At first, I struggled to come up with a term for the third stage of the toolkit, but I then decided to leave this up to the team, providing teacher-researchers with increased ownership in the development of the toolkit. The day after the teachers had shared their concerns regarding the current action plan, we met together again. I introduced the toolkit and prompted the teacher-researchers to determine whether or not this would be beneficial for their students. All teacher-researchers expressed initial interest in the intervention, and pointed out challenges that they foresaw, such as the need to model how to select appropriate coping strategies based on the situation and that "teachers may need to coach into the coping mechanisms in the moment," which allowed this crucial facet of the toolkit, teacher-student coaching, to come from the teacher-researchers.

At the fifth-grade level there was more hesitation in terms of students who do not need the coping strategies using them inappropriately, which led to the vocalization of these concerns among other researchers. In facilitating this conversation, I experienced internal struggle over whether or not to intervene in the conversation or allow the teacher-researchers to work through this concern. I decided to remain quiet and cautiously observe the conversation, as I did not want to overpower the collaborative atmosphere that we had established. One of the teacher-researchers eventually redirected the conversation:

> But I think that's part of teaching into it and the coaching. I mean just like anything else we do, if the students are not using it appropriately, then we have that conversation with them and maybe that piece is not available to that student anymore. I mean because it could really be beneficial to other kids, and so I think we just need to teach them how to use it in the right way.

The other teacher-researchers agreed with this view and acknowledged the need to individually coach into the toolkit with the students who needed it, as well as coaching into its appropriate use with students who may be using the strategies such as taking a break for the wrong reasons.

This internal turmoil occurred at another point in this dialogue during which the teacher-researchers were discussing the use of collaborative group work, as a few females had described that working with others caused them stress, especially in regarding to speed. The conversation began to head in the direction of removing this requirement of group work for students who become anxious as a result of it, which prompted my internal struggle. I feared that the teacher-researchers would implement this “intervention” of removing the requirement of group work, which would not serve as a means of bringing equitable education to female students, but rather, would lower expectations for female students and inhibit their development of the collaborative skills that would be necessary to enter into most sectors of the workforce, especially STEM fields. Again, I waited, literally on the edge of my seat, debating when to intervene. And again, fortunately, one of the teacher-researchers redirected the conversation:

> Well, part of the idea of working with a partner is learning to work with a partner, the whole point of doing all this work, the goal is…You have to work with people… I mean that’s the lesson that they’re learning. I mean not everyone is going to jump in being able to work with everyone immediately, but you’re learning that skill by over and over working with people.

The teacher-researchers collectively agreed with this point, even stating, “Exactly, 100%,” demonstrating the essentiality of this community atmosphere in working through revisions to classroom practices. As an administrator-researcher, I had to balance on a border of when to intervene and when to let the teacher-researchers guide the conversation, an inner struggle prompted by the emergent nature of the study.

Throughout the teacher dialogue on the ICA Toolkit, I could sense from the concerns expressed and facial expressions observed that Ms. Davis and Ms. Turner still held concerns about the implementation of the intervention. Therefore, I met with these fifth-grade teachers after the focus group to ensure that they felt comfortable with the intervention the group had decided to roll out. In this conversation, the teachers expressed the valid concern that I had not considered, that the departmentalized structure of fifth grade made the rollout of the toolkit more challenging from a practical standpoint because they only saw the students during the math class and homeroom. In addressing this issue, as well as the voiced concern of students who do not experience stress and anxiety in math taking advantage of unnecessary coping strategies, I proposed the solution of the teachers asking the students to journal about whether or not they experience thoughts and feelings of angst in math and would want to learn strategies to overcome these thoughts and feelings, and I would teach the toolkit to the students who expressed that they wanted to learn coping strategies in small groups during the 'extension' periods included in their schedule. Removing these challenges significantly increased the teachers' interest and investment in rolling out the ICA Toolkit, which could be visually observed in their facial expressions as well as conveyed through their verbal responses. I also made the other teacher-researchers aware of the procedure being used with the fifth-grade students in case they wanted to use a similar format. Ms. Nelson and Ms. Davis did decide to use a journal entry to plan small-group roll-outs, which they found to be beneficial because students who were typically silent in the whole-group conversations participated in the development of the toolkit.

Once the decision was made to move forward with the toolkit, I again needed to take on a servant leadership role. I wrote a lesson plan that the teachers could choose to use in rolling out the toolkit and printed laminated posters of the ICA Toolkit chart (see Appendix V) to be used in generating ideas with students as well as bookmarks on which students would record the “Identify” signals and “Cope” and “Act” strategies that were relevant to them. I completed these tasks over the weekend so that the toolkit would be ready to be rolled out on the next school day. I found that this servant leadership style was essential in supporting the emergent nature of critical inquiry so that all decisions regarding interventions and revisions to interventions could be authentically based on the data, which was continuously evolving.

Interventions aligned with critical feminist framework. Throughout the study, I continuously reflected on feminist literature to ensure that the interventions being employed aligned with feminist pedagogy. The teacher-selected interventions and student response to interventions conveyed that the emergent layout of the study guided by viewpoints of the oppressed did in fact prompt the development of interventions aligned with feminist pedagogy. A goal of feminist-infused critical inquiry is to create safe places for marginalized groups to challenge oppressive systems and “achieve the gift of freedom; the gift of love, self-caring; the gift of empowerment, teaching and learning to transgress” (Denzin, 2016, p. 14; Weiler, 1991). This was a common theme in the development of interventions and student response to interventions. Teachers selected the intervention of the journal because they thought that the females would “probably feel more comfortable sharing their honest feelings if they know that it’s just like them sharing how they are feeling." This proved successful as students expressed the benefits of having a private place to share their thoughts and feelings. As part of developing a safe place for students, it was also important for teachers to create a more public safe place through the morning meetings so that females could also voice their thoughts and feelings with the group. Digiovanni and Liston (2005) assert that feminist critical pedagogy should "encourage dialogue and place the students at the center of meaning making" (p. 128). The development of these morning meeting communities, in which "students showed that they respected each other's thoughts and feelings by listening while others shared," allowed the females to become "very vocal" and "empowered a lot of the girls, specifically, to have a stronger voice in the classroom." Through these conversations, females were able to verbalize the behaviors of other students, particularly the males, that cause them stress and anxiety, learn that other students in the classroom were also struggling with these thoughts and feelings, and gather strategies that they could apply when they encounter negative physiological states in math.

Through the morning meeting conversations, the teachers and students were able to foster the understanding that the students are not only responsible for their own successes, but also the success of their classmates, aligning with feminist pedagogy (Shrewsbury, 1987). This realization led to the changes in student behavior described above in which the boys stopped calling out when they were done or found a problem to be easy and took on a new role in supporting females if they were struggling, rather than saying, "Don't look at my paper." The conversations also led to increased awareness among both teachers and students of the diverse experiences of individual students. This again aligns with feminist pedagogy which promotes the notion that diverse learners have diverse experiences (Shrewsbury, 1987). Students realized that different people see things in different ways and need different strategies to help them. The teachers also became aware of the conflicting opinions of strategies and environmental changes across students, which was addressed through the individual ICA Toolkits that students developed according to their own experiences and strategies that they found beneficial.

A prominent theme in student reactions to the morning meetings was that these conversations allowed them to see that they are not the only ones who experience struggles in math. Uncovering assumptions and engaging in dialogue about these assumptions is a key feature of feminist pedagogy (Shrewsbury, 1987). At the end of the third cycle, a collaborative pair of teacher-researchers reflected, "We think that students are starting to feel as though there isn't such a thing as a 'math person,'" demonstrating the impact that classroom dialogue and interventions had on student misconceptions in regard to their capabilities in math.

Bringing the lives of the marginalized to the forefront. At the heart of feminist-infused critical inquiry is an ongoing commitment to keeping the voices of the oppressed at the forefront of the study. This was made possible through the qualitative framework. Through feminist critical inquiry, inquirers empower marginalized students by giving them a voice and responding to those voices, placing an emphasis on the interpretations of marginalized populations, female students in this case, and their lived experiences (Denzin, 2016; Hesse-Biber, 2012; Merriam & Tisdell, 2016; Shrewsbury, 1987). Beginning with the student questionnaires allowed student voice to guide the study, and hearing the exact quotes from the students strengthened the connection between the inquirers and the oppressed. As teachers-researchers analyzed and discussed the data, they quoted students responses, such as, "The girls talked about in fifth grade how this is going to impact your future, for example, 'You're never going to get anywhere in life; your life is hopeless.'" The teachers continued to empower the female students by bringing their voices to the forefront of the classroom environment through the math-focused morning meetings and acting upon the ideas that were shared out. Focusing on the lived experiences of individual female students as opposed to data that only provides quantitative overviews allowed for the evaluation of inequities in instructional practices that are often overlooked (Denzin, 2016). During the analyses of the student questionnaire data, teacher-researchers expressed, "...I don't want to make it about one person here but if I'm thinking about this, like to me, this is devastating," and "…I know it's not just about one child, but like, to see that even one kid in the building is feeling that…" These remarks allowed me to coach into this notion and clarify that the conversation can be about one child because if even one child is facing marginalization in the classroom, then we have the responsibility as educators to address it. Moving ahead to the final focus group, impacting the life of one child was viewed with more value, as Ms. Quade shared:

> Even that one girl is now sticking out to me so much, that now her mom knows that she might be coming home from school anxious about math, and I think that's huge even for one person, for that parent to be more aware of what her child is going through…

Also in this focus group, Ms. Davis pointed out, "...but even if one student uses them, it helps," demonstrating how the teacher-researchers' mindsets had shifted to placing a stronger value on one student's lived experience.

Table 4.17
Teacher-Researcher Interview Responses: "Is There Anything Else You Would Like to Share?"

Ms. Quade	"It has been such an honor to be a part of this study and this research is so important. I learned through this that students go throughout the day feeling stressed and anxious and through this experience I was able to learn more about when and why they have these feelings. Because of this experience I was able to make positive changes to my classroom. It's incredibly important to give students the opportunity to express how they are feeling, verbally and in writing their journal, and that is something I want to continue."
Mr. Erikson	"I am glad I was a part of this. I think it was helpful for me. We do like the *Choose Love* social-emotional curriculum, and we talk about feelings, but we don't do that as much in class as I feel now that we should, even just giving them an outlet to talk more freely. It was beneficial for them and me to hear, and it helps me to alleviate their stress. And, it was nice to know they could be honest and felt comfortable doing that."
Ms. Nelson	"…just the awareness of how many kids are experiencing this, and it is so overlooked, and they obviously aren't able to advocate for themselves, so we need to advocate for them."
Ms. Holt	"This was very eye-opening. I think it really helped me to reflect on things I was saying and even how my nonverbal or body language impacts students. It made me reflect on myself as the person who is supposed to be allowing you to make mistakes and encouraging you, and as much as I say it, there are other factors that play into that."
Ms. Davis and Ms. Turner	This has been a great experience for not only the students, but also for us as teachers. We both feel like we have become more aware of looking for signs that students are feeling stressed, anxious, or otherwise marginalized. Fighting the power dynamic in the math classroom is certainly a worthwhile fight.

Transformation through critical self-reflection. Attending to female students' worldviews, teacher-researchers were able to critically self-reflect on their instructional practices and misconceptions they held. Engaging teachers in data analysis and empowering them to make decisions that guided the study successfully led to critical self-reflection and transformation, as is the goal of critical inquiry (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012). Hearing the female students express the stress and anxiety they were experiencing in math and the changes that would help reduce these negative thoughts and emotions prompted the teachers to change their classroom practices and environment, which continued beyond the conclusion of the study. During the final interviews, all teacher-researches expressed how they had been transformed through participation in the study in responding to the open-ended question, “Is there anything else you would like to share?” In vivo examples of these reflections are presented in Table 4.17.

Conclusion

The student questionnaire administered at the outset of the emergent study pointed toward physiological states as being the most influential source of mathematical self-efficacy among female students out of the four sources of self-efficacy identified by Bandura (1977). The implementation of the interventions included in the action plan that was generated as a result of the female student data and the resulting student responses to the interventions led to the realization that benefits produced by particular interventions varied across female students, and employing only one type of intervention would not meet the needs of all females experiencing low math self-efficacy influenced by physiological states. The critical inquiry also resulted in the finding that attempting to address negative physiological states solely in isolation would fail to address these negative affective responses in most students; direct coaching in the math setting was often necessary. Of the interventions employed, the math-focused morning meetings and ICA Toolkit proved to be the most beneficial among female students across grade levels. While journaling had limited benefits in third and fourth grade, this was one of the most successful interventions for fifth-grade females. The female mathematician visit was largely unsuccessful in the lower grades and only showed limited success in fifth grade. With regard to strategies for home connections, the introduction of the ‘Bedtime Math’ app did not show any success across grade levels, and the ‘strategies and tips’ sheet developed for parents showed success at the fifth-grade level and lacked evidence of success in the lower grades. Across grade levels, positive shifts in manifestations of math self-efficacy among female students emerged as teacher-researchers observed decreased negative affective responses, decreased task avoidance, increased perseverance, and increased application of coping mechanisms. Post-questionnaire data and student input gathered through one-on-one conversations with teachers and journaling supported these observations. The emergent framework of the study fostered feminist-infused critical inquiry by supporting teacher development of necessary background knowledge, allowing student voices to spark teacher investment in the study, empowering the teachers to direct the study based on analyses of data that kept student voices at the forefront of the study, and shifting leadership styles and supportive roles based on the evolving needs of the study.

Chapter 5

Discussion, Conclusions, and Recommendations

Problematic mathematical self-efficacy levels among female students and manifestations of these low self-efficacy levels in the local context prompted the current study. Task avoidance, low perseverance, passive behaviors, negative affective responses, and negative self-beliefs in math among female students, as well as a deficit view of their gender in relation to math, demonstrated the current inequities in mathematical experiences across genders as well as implications for future math participation. The purpose of this study was to (a) uncover the most influential source of self-efficacy among elementary-level female students in mathematics, (b) use this knowledge to design and study the impact of gender-focused changes to the classroom-based practice of six elementary-level mathematics teachers who engaged in three cycles of participatory action research, and (c) examine my efforts to support these teachers as they engaged in collaborative inquiry focused on gender-related problems of practice. The research question to be investigated was: *As an administrator-researcher in collaboration with teachers, how can we promote positive self-efficacy beliefs among female students in mixed-gender mathematics classes?* The sub-questions were: *(a) What are the most influential sources of mathematics self-efficacy development among females? (b) How can teachers modify classroom practice to address common gender disparities in mathematical self-efficacy? (c) As an administrator-researcher, what methods are effective in prompting feminist-infused critical inquiry among teachers?*

Engaging in feminist-infused critical inquiry through PAR, six teacher-researchers joined together, with the support of my co-rater and me, to fulfill this commitment to gender equity in math. The use of a student questionnaire at the outset of the study enabled the female students' voices to drive the research, leading the teacher-researchers to collaboratively develop an action plan that would strengthen positive math self-efficacy beliefs across this marginalized group. Through ongoing cycles of implementation and reflexivity supported by focus groups and teacher interviews, the team of teacher-researchers was able to analyze the strengths and weaknesses of the interventions resulting in revisions toward more effective practices for our female students. The developed interventions resulted in positive shifts in manifestations of female self-efficacy, combating the societal and educational gender inequities existing in mathematical learning and perpetuated by the androcentric culture of mathematics (Hesse-Biber, 2012; Frankenstein, 1992).

Physiological States Leading to Gender Inequities

While I entered this study having already recognized disparate levels of mathematical self-efficacy across genders in my school district, both as a teacher and an administrator, it was necessary to hearken the voices of female students to determine which source of self-efficacy was playing the largest role in the development of these beliefs among females. The pre-intervention questionnaire provided to students allowed the teacher-researchers and I to examine the frequency and severity of responses that pointed toward problematic thoughts, feelings, ideas, or beliefs impacting the development of math self-efficacy. Because the questionnaire was strategically designed to stimulate or investigate the manifestations of the four sources of self-efficacy identified by Bandura (1977), the responses shed light on which source was most influential among females: physiological states. Negative physiological states surfaced with high frequency across the female population in comparison to the males and with greater severity. These findings support the tenets of Freire, as described by Frankenstein (1992), that "math anxiety helps sustain hegemonic ideologies," (p. 247) given that these anxieties are more common among particular marginalized populations, especially females. Combating the negative physiological states we uncovered, and thus gender inequities, would require applied consciousness to daily classroom practices that support these societally-cultivated barriers. The direct connection between physiological states and classroom mathematical experiences as well as the frequency and severity of negative responses among females prompted a strong sense of responsibility to act among the teachers and led to the development of the action plan implemented across three cycles.

Toward the end of Cycle One, as the teacher-researchers and I were gaining more insight into the negative physiological states experienced by our female students, the topic of the study came up in our voluntary district staff book club on the text, *Brain Rules: 12 Principles for Surviving and Thriving at Work, Home, and School,* by John Medina (2008). In the chapter on gender, Medina (2008) writes, "Serotonin, key in regulating emotion and mood, is a particularly dramatic example [of biochemical sex differences]. Males can synthesize serotonin about 52 percent faster than females" (p. 229), "…women recall more emotional autobiographical events, more rapidly and with greater intensity, than men do" (p. 233), and "Females have more anxiety" (p. 231). Two of the teacher-researchers were members of this book club and pointed out how these notions stood out to them in relation to the study. The connections discussed, which were then communicated to the rest of the team in the next focus group, centered on the biological implications of emotional arousal among females and mathematical experiences. As a group, we pondered the interactions between the biochemical reality that females tend to experience emotions with greater intensity and have more anxiety, and math being a subject that is often met with anxious thoughts and feelings (Furner & Duffy, 2002; Frankenstein, 1992). Prior research has determined that females synthesize serotonin at lower rates than males, and low serotonin levels are associated with higher rates of anxiety (Geddes, 2016; Nishizawa et al., 1997). Further, females tend to have stronger memories of situations that are emotionally arousing in comparison to males (Canli, Desmond, Zhao, & Gabrieli, 2002). Therefore, although males and females are provided with the same mathematical tasks in class, when working through these tasks, females may be experiencing anxious states often associated with math (Furner & Duffy, 2002) with greater intensity, consistent with the findings of the present study. They are also more likely to have stronger recollections of these stressful mathematical experiences. As identified by Bandura (1977), these negative physiological states result in negative self-efficacy beliefs. Ignoring this interaction between emotions and mathematical experiences caters to male biology and disregards female biology in the math classroom plagued with perfectionist, product-focused values that heighten stress and anxiety.

Another rationale that has been proposed with regard to the increase in negative physiological states experienced by females in math is the influence of stereotype threat. Females continuously receive messages from society informing them of their appropriate gender roles, including the assumption that males are mathematically superior (Harro, 2013; Hill et al., 2010; Steele, 2010). Therefore, when faced with mathematical situations, females tend to experience increased negative physiological states due to the internalized belief that they cannot or should not be successful (Harro, 2013; Hill et al., 2010; Steele, 2010). Harro (2013) describes that we “become our own oppressors from within” (p. 50). This assertion builds on the postulate of Freire (1968) that we begin to accept and participate in our own oppression: since society tells females they are inferior in the field of mathematics, they begin to embody this characteristic. Females engage in self-doubt and visualizations of failure, representing physiological impacts on self-efficacy (1977/1989). This phenomenon was observed in the pre-intervention questionnaire when the female students expressed negative physiological responses and views of self prompted by a math task. The females performed at an accuracy level similar to that of the males on this task, yet the males did not demonstrate these negative states or self-concepts. Given that the female and male student participants were also less likely to place females in STEM professions, and the math role models selected by the girls were less likely to be female as the students increased in age, it is evident that the students are receiving and internalizing biased views of gender in relation to mathematical success. These internalized biases turn mathematical experiences into triggers of negative physiological states among our female students.

Contradictions and Hidden Experiences

The above disparities in mathematical experiences across genders are often hidden due to a lack of attention to females’ inner thoughts and feelings in relation to math and outward expressions that present contradictory worldviews. In the context of the study, the female participants often described positive views of mathematics when speaking about the subject generally, but when asked to reflect on personal experiences, these views became more negative. On the pre-intervention questionnaire, the majority of female students described the importance of effort and that "NOBODY is born smart or dumb, everyone is just born" when speaking about others in relation to math, yet in reflecting on their own experiences in completing a math task, these same female students expressed negative views of their own capabilities, such as describing themselves as "horrible" or "not smart enough." As we moved into the first cycle of the action plan, we also found that female students were able to identify typical signs of stress or anxiety and coping mechanisms that could be applied in overcoming these states, yet approximately half of the female population showed no signs of applying these coping mechanisms on the pre-intervention questionnaire, and they rarely applied these strategies during class, as observed by the teacher-researchers who reflected on female students' tendency to prematurely give up on or avoid challenging tasks. Because we often fail to give female students opportunities to reflect on their physiological states in math or voice their thoughts and feelings, these contradictions hide the realities of female experiences; we think the girls are okay, but in reality, as described by Mr. Erikson, they are "cry[ing] for help" on the inside.

Growth Mindset Versus False Growth Mindset

Growth mindset ideology closely aligns with the notion of self-efficacy and has been promoted as a district initiative in the context of the study over the past three years (Dweck 2006/2017). Dweck (2006/2017), who coined the terms 'growth mindset' and 'fixed mindset,' affirms that some individuals possess fixed evaluations of their capabilities in a given area, viewing these skills as being innate, while others attribute success in a particular area to effort. This aligns with the concept of self-efficacy, which describes the perceptions one holds of her capabilities in performing a given behavior and links innate perceptions of ability to lower levels of self-efficacy (Bandura, 1977/1986/1993). In recent years, misconceptions and misapplications of growth mindset ideology have led Dweck (2016) to reflect on what she refers to as a false growth mindset. False growth mindset is the adoption of growth mindset ideology at a surface level, simply stating that an organization embraces growth mindset beliefs without actually analyzing whether or not the organization's practices align with and support this belief system. Environments that promote growth mindsets embody a risk-taking atmosphere and work to decrease peer competition, characteristics that are often lacking in organizations that claim to uphold growth mindset beliefs (Dweck, 2016). Dweck (2016) also describes that even when a growth mindset culture is truly embraced, situational triggers can still elicit fixed mindset beliefs among members of the community that produce a sense of "insecurity" (p. 3). To address this issue, some organizations that promote growth mindset culture have started to encourage their employees to reflect on these triggers and engage in self-talk to overcome them (Dweck, 2016).

This phenomenon of false growth mindset as well as the importance of developing a risk-taking environment absent of competition and in which individuals are empowered with the tools to overcome situational triggers directly aligns with the findings from the present study. While the educators in our district do encourage students to take risks in math, it was made clear through the pre-intervention questionnaires and reflections during morning meetings and journaling that the female students did not feel comfortable taking risks in the math classroom; rather, they demonstrated exaggerated perceptions of threat and a view of mathematical experiences as stress-inducing and exacerbated by peer comparison. In reflecting on the pre-intervention questionnaires, the teacher-researchers also expressed that they were surprised by the number of students who focused on test scores, grades, and college acceptances in evaluating whether or not someone was successful in math, facets that increase the competitive nature of mathematical experiences. These underlying conditions of the math environment preserve the exclusionary culture of mathematics that has been developed at the macro level and is reinforced at the micro level in our classrooms (Frankenstein, 1992). Even at the ages of nine through eleven, the male students' outward self-praise of their mathematical endowment, boasting about how easy a task was or how quickly they completed it, behaviors consistent with the gender roles society impresses upon males (Frankenstein, 1992; Hackman, 2013), were oppressing female students' self-efficacy development. However, the interventions implemented by the teacher-researchers targeted these conditions. Math-focused morning meetings helped to decrease the competitive culture of the math classroom and made male students aware of the impacts they were having on the female learning experience, resulting in shifts in their behaviors in the classroom. Journaling allowed females to reflect on triggers of negative physiological states in math and made teachers more conscious of the students' gendered experiences. Further, the ICA Toolkit provided females with strategies to employ when faced with situational triggers of negative physiological states, much like the organization cited by Dweck (2016). While our district has placed effort into embracing growth mindset ideology, developing this cultural mindset requires us to address the underlying characteristics of the math class that inhibit female students from truly internalizing positive beliefs in their capabilities.

Implications

While the current study focused on four classes, it is likely that the negative physiological states identified among female students and the impact on female math self-efficacy extends across classes in the school and district, especially at the upper elementary level in which the study took place. The present research points to the need to investigate and address disparities in female self-efficacy across math classes as opposed to maintaining the assumption that all students are being provided with the same mathematical experiences. Such assumptions lead to inequities in teaching and learning and the promotion of androcentric math culture (Frankenstein, 1992).

In continuing activism toward social justice in the four classes that participated in the study as well as additional classes in the district, it is essential that district educators attend to the overarching themes of the study. These key takeaways include: (a) mindsets and coping mechanisms that promote positive self-efficacy development cannot be taught solely in isolation, (b) females still hold negative societally-imposed assumptions and misconceptions about math that need to be addressed, (c) females need to be given a voice in the classroom so that their male counterparts and educators are aware of girls' true mathematical experiences, and (d) fostering a critically conscious math community helps shift power dynamics and strengthen peer support.

Professional development for educators and classroom interventions are necessities in applying the above takeaways to the education of our female students. An overview of the findings that emerged from the study will be shared with the staff in the present context through a faculty meeting. The teacher-researchers who participated in the study will present their experiences and the sparked critical consciousness that led to transformations in their classrooms. Following the faculty meeting, a Google Form will be sent out, asking teachers to indicate their interest in learning specific interventions that we found to be beneficial in working toward gender equity in the math classroom. Teachers will be encouraged to consider not only their own classroom experiences but also what they are not seeing, what is occurring in the minds of their female students, as the teacher-researchers in the study were “shocked” and “devastated” to learn the realities of their own students’ thoughts and feelings during mathematical experiences. While all teachers will eventually be required to participate in professional development guided by the findings from this study, I decided to begin this work with teachers who are invested in this social action. This investment would help strengthen the positive rollout of reflections on gender inequities and female self-efficacy as well as aligning interventions, hopefully inspiring others to become invested as the positive impact begins to gain increased acknowledgment across the school district (Rowan & Miller, 2007).

The next step will be to develop a small-scale version of the questionnaire that includes grade-appropriate questions pertaining to physiological states and vicarious experiences as a means of providing teachers with these crucial insights into their students’ thoughts and feelings pertaining to math. These would be used at the start of the school year in the form of a student survey, just as the teachers often provide students with surveys about topics such as their interests, extracurricular activities, and reading habits. These surveys would prompt deeper reflection among the teachers, just as it did for the teacher-researchers in the study, and would help teachers launch conversations in morning meetings or develop journaling prompts.

At the start of the school year, interested teachers will participate in professional development on the interventions that the team found to be successful in targeting the above inequities in the mathematical experiences of our female students. These professional development sessions will be conducted during the teachers' grade level professional learning communities or through after-school workshops. Whenever possible, the sessions will be led by the teacher-researchers from the study, as all participants expressed interest in turnkeying their experiences and learnings to their colleagues. The interventions recommended will include morning meetings, launching the ICA Toolkit, and journaling. Not only will we present teachers with the implementation methods that we found successful, but we will also provide teachers with strategies for future implementation that the teacher-researchers anticipate will strengthen the impact of the interventions, as conveyed during their final interviews in which I asked each teacher-researcher to describe whether or not they would implement the interventions in the future and what revisions they would make.

Because there is limited research that specifically ties physiological states as a source of self-efficacy to math, we looked to interventions that have shown success in addressing math anxiety in hopes that they would be beneficial for our female students in strengthening their math self-efficacy by either reducing negative physiological states or helping students to better cope with and overcome such states. The preventative measures often referenced in literature as being beneficial in limiting the development of math anxiety, such as encouraging students to work in groups, celebrating a variety of pathways for problem-solving, and focusing on overarching conceptual knowledge as opposed to rote computation, represent features of math instruction that had already been at the heart of our curricular approaches to math instruction, a shift that we began three years ago (Furner & Berman, 2003). However, the low self-efficacy and expressions of angst in math that we observed among our female students were continuing to present in our classrooms, and often even heightened as we shifted toward more complex conceptual problem-solving. We were in need of additional interventions that would address this phenomenon.

One of the practices recommended by Furner and Duffy (2002) is to provide students with opportunities to discuss their feelings in relation to math. Further, Griggs et al. (2013) determined that *Responsive Classroom* techniques, a central component of which is morning meetings as a class community, decreased the link between math anxiety and math self-efficacy. In the study conducted by Griggs et al. (2002), there was not a significant increase in math self-efficacy as a result of the *Responsive Classroom* techniques, and there was not a significant initial variance between self-efficacy among males and females (Griggs et al., 2013). Although our main goal was to increase self-efficacy, we still decided to employ math-focused morning meetings, as we did want to reduce the impact of anxiety on self-efficacy, and we also wondered if we would see a different impact on levels of self-efficacy in our context since we did have disparities in self-efficacy among genders, consistent with prior research (Dowker et al., 2016). Based on the teacher-researchers' observations of the impact of morning meetings and the post-questionnaire responses from students, the morning meetings were determined to be beneficial for female students with low self-efficacy. These meetings allowed for the desensitization of mathematical experience through the normalization of struggle and attention toward the identification of exaggerated threat in relation to math. As an additional benefit that was realized, students were able to learn strategies for working through negative physiological states by listening to the strategies utilized by their peers. Further, the empowerment of females by giving them a voice enabled them to impact the power dynamics of the classroom and elicit change. Therefore, morning meetings is an intervention that we will recommend to teachers in the setting of the study. Mr. Erikson described, “I would definitely keep the math meetings going. It has clearly been beneficial for them, and it’s good for me to hear their thoughts. We don't spend enough time talking about their feelings." The teacher-researchers also identified revisions they would make to morning meetings in the future, the strongest-held of which would be to begin the implementation of the math-focused morning meetings at the start of the school year. This would allow these meetings to become a central piece of the classroom community and routines and could prevent the development of negative physiological states in math throughout the year or could reduce the frequency and severity of such states that may already be experienced by students. For teacher-researchers who had math scheduled toward the end of the day, they also suggested that it may be more beneficial to move these math-focused meetings closer to the math block in order to help bridge the gap between addressing these thoughts and emotions in isolation and the actual application of beneficial strategies and mindsets in math settings that may elicit struggle. These suggestions will be shared with the teachers during their professional development sessions as well.

The second of the two most impactful strategies we identified, with the first being the math-focused morning meetings, was the development and utilization of the ICA Toolkits. Although these toolkits emerged directly from the study based on the identification of the hindrance of instruction in isolation and the need for a tangible device to help female students work through struggle when experiencing emotional arousal in math, the toolkit does support prior suggestions made by Tobias (1987) for the reduction of math anxiety. Tobias (1987) affirms that the reduction of math anxiety requires the recognition of feelings of anxiety and panic in math followed by coping strategies, such as breathing techniques, positive self-talk, and visualizations of success, also supported by Bandura (1993). Like Tobias (1987), we found these identification and coping strategies to be advantageous for females who demonstrated manifestations of low self-efficacy, but we also included a third stage of problem-focused strategies aimed at helping students to access the problem rather than reverting back to states of angst. Across grade levels, the toolkits were found to be beneficial. Based on observations and student reflections, we learned that the toolkits helped students to become more aware of signs that they were becoming stressed or anxious and then work through those thoughts and emotions followed by easing into the problem rather than shutting down as they had often done in the past. Thus, we will recommend this intervention to educators across the school setting. Along with recommending that teachers employ the ICA Toolkits, it is also important to emphasize the importance of coaching into the toolkits in applicable moments. Not only did the coaching support the application of the toolkit, but students also expressed that they liked having their teachers coach them through it. Eventually, once the students internalize the use of these strategies, the coaching could slowly be removed. The rollout of the toolkit was conducted through two different methods in the study; two classes developed the toolkit as a whole class, and two classes developed the toolkit in small groups with students who expressed feeling anxious or stressed in math and wanting to learn strategies to work through these states. The latter found benefits in the small-group rollout because students who did not share as much in the morning meeting setting expressed their thinking more in the small-group setting, and coping mechanisms were only taught to the students who would benefit from them, reducing the inappropriate use of the strategies. However, the other two classes also found success in the whole-group rollouts that they employed. At this time, we cannot suggest one method over the other. As with the morning-meetings, we do recommend launching the toolkits at the start of the school year so that the toolkits would become natural facets of the classroom community. Additionally, Mr. Erikson, Ms. Nelson, and Ms. Holt identified that they would have found a more prominent place in the classroom to display their class-developed toolkits to serve as a stronger visual reminder as students are learning to apply the toolkits. We would also recommend more explicit instruction on the "Cope" and "Act" stages, as the teacher-researchers reflected on the need to teach the "language piece" of the toolkit such as how to ask for help as an "Act" strategy or making students "more aware of the tools they can use." Further, it was recommended by Ms. Nelson that the ICA Toolkit be viewed as a working document that could be updated throughout the year as students identify additional signs of negative physiological states in math that apply to them or "Cope" and "Act" strategies that they find beneficial.

Finally, we would suggest that morning meetings and the ICA Toolkits are supplemented with the opportunity to journal about thoughts and feelings relating to math, especially at the upper grade levels. In the younger grade levels, the journaling may need to be more scaffolded, such as selecting from a set of provided emotions with supporting visuals (e.g. emoji faces) and emphasizing the ability to draw how they are feeling, as students in the younger grades expressed a dislike of writing, often because they find it difficult or it makes them "tense." Teachers may also want to consider making the journaling optional for students who are interested in this method of reflecting on or sharing with the teacher their thoughts and feelings, or using journaling as a coping strategy that students could employ as needed. This freedom to journal as needed, as well as journaling in the absence of set prompts, was expressed by students as a revision that would help them to benefit from this intervention to a greater extent. Although journaling was not viewed as beneficial by a large number of students in third and fourth grade, to remove this intervention entirely, an intervention that some females expressed as a place to write down their "more private feelings," may be taking voice away from students who need it and are not yet ready to verbalize their thoughts and feelings in the whole-group setting. Such an action would be contrary to critical inquiry and feminist ideology (Denzin, 2016; Shrewsbury, 1987). As with the above interventions, we also recommend that journaling be introduced at the start of the school year so that it becomes integrated into classroom routines. Another adaptation to consider would be to use the journals as a means of brainstorming ideas prior to sharing out in the whole-group morning meetings or as a method of reflecting after these meetings. When these were integrated during the study, teacher-researchers found the integration of the two interventions to be beneficial for students in preparing their ideas and reflecting on the ideas of others.

As for the home connections, while we do still believe that there should be practices in place to communicate to parents the strategies being employed in the classroom and provide strategies that can be used in supporting their children through mathematical struggle at home, we do not have enough evidence on the benefits of this home connection and how best to develop it. The teacher-researchers did propose that the ‘Bedtime Math’ app may be more successful if it is launched at the start of the school year so that students see it as an integral piece of the learning process, but we do not have evidence to back up this postulation. Having a female mathematician visit the classroom to discuss her experiences with mathematical struggles and how she overcame them, while unsuccessful in the younger grades, may be beneficial if strategically implemented, especially given the implications of stereotype threat on physiological states described above. As we have had visits from authors in the past who were able to connect with students in a way that was meaningful, we did not anticipate the barriers that would be present in relation to the students being able to understand the mathematician. In reflecting back, this finding is not surprising, as the authors are typically those who write texts geared toward children, whereas a mathematician may not have as much prior experience in communicating with children. If employed in the future, more research and preparation should be applied in finding a mathematician who would be able to relate to the students and training her in strategies for strong, grade-appropriate communication.

Engaging Teachers in Critical Reflection Grounded in Feminist Ideology

The current study illuminated techniques that would be beneficial to employ in future participatory action research grounded in feminist-infused critical inquiry, or on a smaller scale, in turnkeying the findings and recommendations from the study to educators. The pre-teachings on self-efficacy was essential to the effective execution of the study, as this background knowledge framed the way in which the teachers analyzed the data and allowed them to better evaluate factors impacting their students' self-efficacy. Not only would similar pre-teaching be necessary in analogous studies, but it is also crucial in professional development on strategies for improving female self-efficacy in math. Teachers first need to have a well-developed understanding of what self-efficacy is before they can work to strengthen it among female students. Cultivating epiphanic moments at the start of the study is what elicited the teachers' motivation to act and sense of responsibility to address the inequities experienced in their classrooms. Likewise, sparking these influential moments, such as through the math-focused surveys at the start of the year, as described above, is essential in prompting teacher investment in the interventions to be employed. The emotional investment expressed by the teachers in the study, conveyed the importance of this buy-in, as the interventions likely would not have been as successful as they were without the dedication and commitment to social action among the teachers. As described by Rowan and Miller (2007), buy-in is necessary in order for the effective transformation of instructional practices to occur. This sense of investment in the study was also strengthened through the empowerment of the teacher-researchers. Rather than selecting the source of self-efficacy to be targeted and the interventions to be employed, I purposefully left these decisions to the teachers who would be working directly with the students. This not only provided teachers with ownership over the study, but it also helped to reduce or eliminate any barriers of positionality. In turnkeying these interventions to teachers beyond the classrooms included in the study, it is essential that the teachers are given ownership in the application and further development of the interventions and the ability to modify these interventions to best suit their students' needs.

Taking on this emergent format for the study led me to the realization as the study progressed that I needed to be flexible and adapt to the leadership style required at each phase of the study. The cultivation of epiphanic moments and motivating teachers to join me in this journey necessitated a transformational leadership style at the outset of the study. While the impact of this leadership style continued to inspire teacher critical inquiry and action throughout the study, my active role transitioned to a servant leadership style as I enabled the teachers to determine the directions of the study and I needed to serve as their support system in preparing materials in a timely manner (Avci, 2015; Insley et al., 2016). This strengthened the flow of the study without lapses in time between cycles of intervention implementation. As we extend this pursuit of social justice beyond the walls of the four classrooms included in the study, it will be necessary to maintain this flexibility in taking on a transformational leadership style at the launch of this critical reflection but then moving to a servant leadership style to ensure that the teachers are fully supported in making these revisions to their classroom practices. As noted in the prior chapter, the nature of education in American public schools often inhibits this essential critical reflexivity toward social action as teachers are not provided with necessary resources, particularly the availability of time; however, if educational leaders serve as supports in strategically carving out this reflective time and taking on preparatory tasks to support intervention implementation, then teachers are better able to apply their professional knowledge and expertise toward these pursuits of equity.

Conclusion

Through feminist-infused critical inquiry, the current study engaged teacher-researchers in PAR aimed at taking action against gender marginalization in math. The drastically disproportionate rate at which females enter the STEM fields in comparison to males points to inequities in our society and educational systems that we have the responsibility to address (Hill et al., 2010). In the context of the current study, the manifestations of low math self-efficacy displayed by our female students and the connection Bandura (1993) asserts between self-efficacy and participation, perseverance, and career pursuits, point to the need to address these disparities in self-efficacy across genders in order to promote equitable mathematical opportunities. By allowing the voices of our female students to drive the study, we were able to identify physiological states as an influential source of self-efficacy development among our female students. The identification of this source enabled us to develop interventions that successfully targeted negative physiological states in math. Through this work, we recognized and addressed the need for instruction on mindsets and coping mechanisms to take place directly in the relevant settings, the examination of and attention to societally-developed misconceptions held by female students, ongoing female voice in the classroom, and the development of critically conscious and empathetic math communities. As educators, it is our responsibility to continue to develop and apply these interventions not only with the students included in the present research but with all female students educated in the setting of the study. Through professional development that centers on critical reflection on gender inequities in math, and is supported by school leadership, the positive developments in female self-efficacy observed in the study can be realized across female students in the district experiencing problematic levels of math self-efficacy. Such critical reflection and inquiry produce change within the inquirer (Denzin, 2016). Based on the reflections of teacher-researchers throughout the study, and especially their final reflections, all teacher-researchers communicated a movement toward increased critical awareness of their female students' mathematical experiences and the inequities that exist in the classroom. As opposed to solely investigating these disparities, the teacher-researchers took action and altered their instructional practices, impacting the lives of female students and bringing increased gender equity to math classes that have been plagued with androcentric culture. Freire (1974) describes conscientization, the deep critical reflection necessary to understand the world, as occurring with inseparable praxis. The pursuit of gender equity in mathematical education is a commitment to our female students that we must uphold through engagement in conscientization and action toward social justice.

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Appendix A

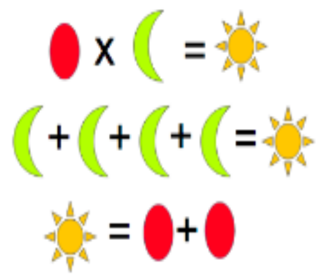
Student Pre-Intervention Questionnaire

Number ______ Grade ______ Teacher ____________ Gender: Female / Male

Student Questionnaire

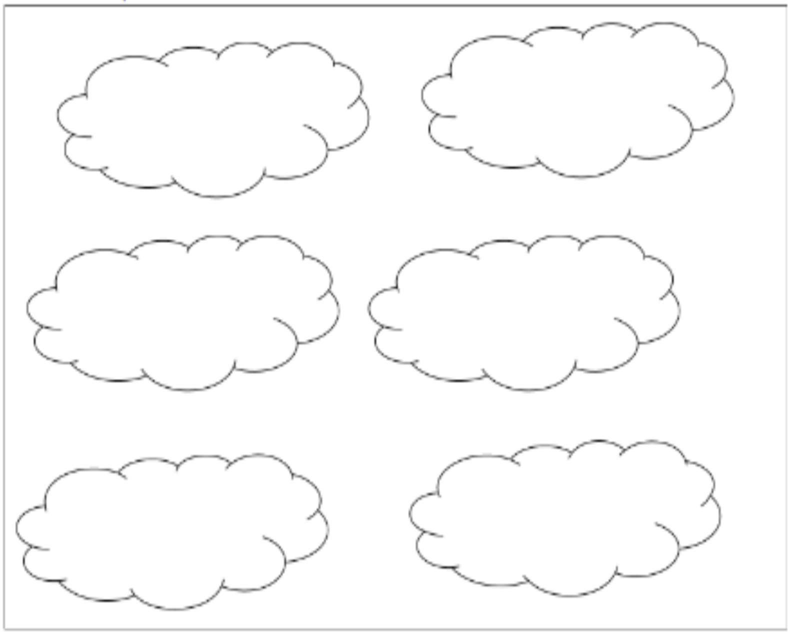
1) Try the math problem below. After seven minutes, you will be asked to continue on through the questionnaire, but it is okay if you did not finish the problem.

Find the value of each shape. Each shape has a different value 1-9.



Record your answers here:

2) In the thought bubbles below, write down the thoughts that were going through your mind when you were working on the math problem above. You do not have to use all of the bubbles. You can also create more bubbles if you need them.



3) Draw a picture that shows how you felt when you were working on the math problem on the previous page (you may use stick figures if you would like). Describe the picture below.

4) Think about the thoughts and feelings you just described. Do you experience similar thoughts and feelings in your math class? Explain why you do or do not experience these thoughts and feelings.

5) **First**, read the description of each job listed below. **Then**, look at the photos of different people. Each photo is labeled with a letter. Write the letter of the photo next to the job that you think the person in the photo has.

Engineer: ________ **Engineer:** Someone who invents, designs, or builds machines, engines, or other works of technology	Author: ________ **Author:** Someone who writes novels, poems, essays, or other types of text
Secretary: ________ **Secretary:** Someone who helps another person with scheduling appointments, making phone calls, and taking notes	Computer Programmer: ______ **Computer Programmer:** Someone who uses coding to create computer software, or the programs that a computer runs on
Mathematician: ________ **Mathematician:** Someone who uses math to solve real-world problems	Architect: ________ **Architect:** Someone who designs buildings
Book Editor: ________ **Book Editor:** Someone who reads a written text and decides if it should be published or someone who proofreads and edits an author's work	Librarian: ________ **Librarian:** Someone who works in a library and helps visitors find information and texts

6) Look at how you matched the photos of the people to their professions. Why did you match the people to their professions in the way that you did? Explain.

____

____

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____

____

____

7) Think about the people you see in the world who are good at math. These could be people in your family or community, characters you see on television, famous people that you have learned about, or even students in your school. Describe each person below. Try to think of **at least two** people. Use the example to help you:

Example:
If this is a person you know, describe how you know the person. If this is someone you have never met or if it is a fictional character, describe where you have seen or heard about the person.

_________He is my brother.____________________________________

Is the person an adult or child? ____child______ Is the person a boy or girl? _____boy______

How else would you describe this person? ____He works hard in school______________________

Person #1: If this is a person you know, describe how you know the person. If this is someone you have never met or if it is a fictional character, describe where you have seen or heard about the person. ____ Is the person an adult or child? ______________ Is the person a boy or girl? _____________ How else would you describe this person? ____________________________________
Person #2: If this is a person you know, describe how you know the person. If this is someone you have never met or if it is a fictional character, describe where you have seen or heard about the person. ____ Is the person an adult or child? ______________ Is the person a boy or girl? _____________ How else would you describe this person? ____________________________________

Person #3:
If this is a person you know, describe how you know the person. If this is someone you have never met or if it is a fictional character, describe where you have seen or heard about the person.

____

Is the person an adult or child? _______________ Is the person a boy or girl? ______________

How else would you describe this person? ____

8) Think about the people you just described. How did they become good at math? Were they born this way?

____

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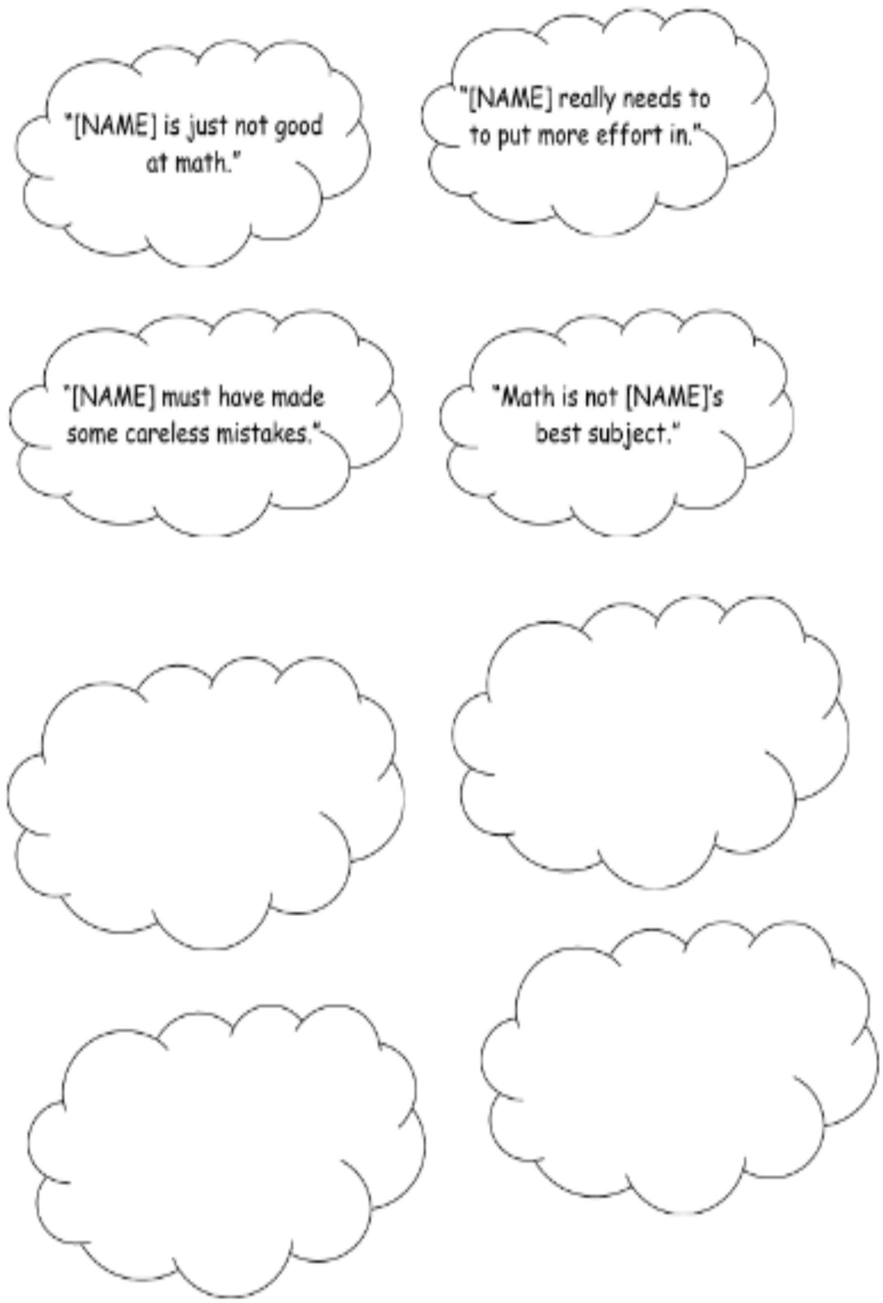
9) Think about someone at home who is important to you. Do they think you are good at math? How do you know?

10) Think about someone in school who is important to you. Do they think you are good at math? How do you know?

11) If you received a low score on a math test, what thoughts do you think would be going through your teacher's mind? You can choose from the thought bubbles below by circling them or create your own using the blank bubbles. You may choose more than one thought bubble if you would like. As you read each thought bubble to yourself, insert your own name where it says "[NAME]." Do not actually write your name in the thought bubbles.



12) Think about your math classes before this year. Think about your math class this year. Have you been successful in math? What makes you think this?

13) If you have struggled in math in the past, do you think this means that you will struggle with math in middle school grade? Explain your thinking.

14) How confident are you that you can be successful in math? Explain.

15) How successful will you be in your high school math classes? Why do you think this?

16) If there is anything else you want to share about your thoughts or feelings about math, you can write them here.

Student Assigned Number ____________

17) ***Retell Activity - Researcher form to be added onto the corresponding questionnaire***

Say to the student – "I am going to read you a short story. After reading the story, I am going to ask you to retell the main details of what happened in the story."

Read the story aloud to the student

After a class of students completed a series of math problems in school, their teacher announced that the student who was most successful on the math problems would be given the opportunity to participate in a county math competition. The teacher announced the student with the highest score. The student went on to compete in the county tournament and won. Then, the student was asked to go on to the state level, and the student beat all of the competitors at this level as well. The school hung up a banner congratulating the student on becoming the state math champion.

Say to the student – "Can you retell the main details of what happened in the story?"

Record of student retell:

After a class of students completed a series of math problems in school, their teacher announced that the student who was most successful on the math problems would be given the opportunity to participate in a county math competition.

The teacher announced the student with the highest score.

The student went on to compete in the county tournament and won.

Then, the student was asked to go on to the state level, and the student beat all of the competitors at this level as well.

The school hung up a banner congratulating the student on becoming the state math champion.

Circle the description that applies to the student's retell:

The student did not use pronouns in the retell.

The student used male pronouns in the retell.

The student used female pronouns in the retell.

Other____

Appendix B

Breakdown of Data for Pre-Intervention Questionnaire, Question 5

Female Student Respondents					
	Number of students who place 0 out of 4 females in STEM	Number of students who place 1 out of 4 females in STEM	Number of students who place 2 out of 4 females in STEM	Number of students who place 3 out of 4 females in STEM	Number of students who place 4 out of 4 females in STEM
Quade:	0	7	3	1	0
Erikson:	3	4	0	0	0
Nelson/ Holt:	1	3	2	0	0
Davis/ Turner:	3	4	0	0	0

Male Student Respondents					
	Number of students who place 0 out of 4 females in STEM	Number of students who place 1 out of 4 females in STEM	Number of students who place 2 out of 4 females in STEM	Number of students who place 3 out of 4 females in STEM	Number of students who place 4 out of 4 females in STEM
Quade:	2	3	3	0	0
Erikson:	1	7	2	0	0
Nelson/ Holt:	0	3	5	0	0
Davis/ Turner:	2	5	2	0	0

Female Student Respondents					
	Number of students who place 0 out of 4 males in STEM	Number of students who place 1 out of 4 males in STEM	Number of students who place 2 out of 4 males in STEM	Number of students who place 3 out of 4 males in STEM	Number of students who place 4 out of 4 males in STEM
Quade:	0	1	3	7	0
Erikson:	0	0	0	4	3
Nelson/ Holt:	0	0	2	3	1
Davis/ Turner:	0	0	0	4	3

	Male Student Respondents				
	Number of students who place 0 out of 4 males in STEM	Number of students who place 1 out of 4 males in STEM	Number of students who place 2 out of 4 males in STEM	Number of students who place 3 out of 4 males in STEM	Number of students who place 4 out of 4 males in STEM
Quade:	0	0	3	3	2
Erikson:	0	0	2	7	1
Nelson/ Holt:	0	0	7	6	1
Davis/ Turner:	0	0	2	5	2

Appendix C

Student Snapshots: Low Self-Efficacy

	Gender: Female Grade: 3	**Gender: Female Grade: 3**	**Gender: Female Grade: 4**	**Gender: Female Grade: 5**
Question #1	Correct	Incorrect	Correct	Correct
Question #2	"I do not get it"	"I thought it was very confusing"	"Oh no" Drew scared face "Ugh, I probably got this wrong" "What!" Hmmm"	"I stink at math" "I probably need Kumon" "If I can't do math, my life is hopeless" "I feel sorry for all the teachers who spend extra time helping me" "MATH = Mental Abuse To Humans"
Question #3	"I felt confused and stressed"	"Confused... I was feeling very frustrated."	"locked in a pitch black room with the paper... I am yelling for help... I am locked in a pitch black room for the rest of my life"	"I felt a rush of worry and I thought I couldn't do it"
Question #4	"Yes, because sometimes I felt stressed, and then I get confused, and when I'm confused, I feel stressed."	"Sometimes I get confused and frustrated in math class but most of the time I don't"	"I experience these thoughts especially when we start a really hard unit and I don't get one thing. I am known to get stressed out"	"Yes because math is stressful... I see everyone zipping through problems"
Question #5	***Females placed in STEM:*** 1 ***Males placed in STEM:*** 3	***Females placed in STEM:*** 2 ***Males placed in STEM:*** 2	***Females placed in STEM:*** 0 ***Males placed in STEM:*** 4	***Females placed in STEM:*** 1 ***Males placed in STEM:*** 3
Question #6	N/A	N/A	N/A	N/A
Question #7	***Males Identified:*** 0 ***Females Identified:*** adult ; adult **Mixed:** 0	***Males Identified:*** adult ***Females Identified:*** child; teacher **Mixed:** 0	***Males Identified:*** dad, teacher ***Females Identified:* 0** **Mixed:** Scientist	***Males Identified:*** adult; kid **Females Identified:** 0 **Mixed:** 0

Question #8	"When they did college they were learning how to be a teacher"	"They became good at math by working hard in school and persevering."	"became good at math" "loves math" "adding up things for patients"	"Went to a good college so he's like a genius" "studies like I do but still is smarter and understands math better."
Question #11	Math is not [NAME]'s best subject	"[NAME] doesn't understand this subject"	"I will work on this with [NAME]" "[NAME] and I will need to work on this a little bit more"	[NAME] is just not good at math. "Poor kid won't get anywhere in life" "She can't do math! Her life is hopeless." "[NAME] must need some serious help" "[NAME] needs Kumon or Mathnasium"
Question #12	N/A	"I don't think I am very successful because I don't have enough perseverance."	"I have been successful...because I have improved a lot from kindergarten."	"No because I don't get it."
Question #13	"Yes, because I struggled K-3 and I think I will struggle in fourth grade."	"Yes, I definitely will because every year is harder and harder."	"I think I will struggle in math next year... Trying new things in math is sometimes hard for me."	"Yes 100% because it's going to get harder and I'll get lost."
Question #14	"Not that confident because I get stressed when I do math."	"Not very confident because math is hard."	"I am not too confident but a little confident. I think this because I let myself down and say I can't do it a lot."	"0%... I just have trouble understanding the strategies even though I get the problem right doing it my own way. It mixes up my brain."
Question #15	N/A	"I will be terrible."	"I think I will improve grade by grade and might be a little successful. I think this because math is a little hard for me."	"5%...I'll be older and things MAY change."
Question #16	N/A	"I don't like math."	N/A	"MATH = Mental Abuse To Humankind"
Retell:	Male pronouns	Male pronouns	Male pronouns	Male pronouns

Appendix D

Student Snapshots: High Self-Efficacy

	Gender: Male Grade: 3	Gender: Male Grade: 4	Gender: Female Grade: 4	Gender: Male Grade: 5
Question #1	Incorrect	Correct	Correct	Correct
Question #2	All process-focused	"It was easy" "All I had to do was calculate"	All process-focused	All process-focused
Question #3	"Me thinking what the numbers could be" in reference to a picture of a boy smiling	"Thinking... writing... done" [reference to picture drawn]	"It was confusing because the #'s went up to 9"	"I felt good and less challenged. I thought it was easy"
Question #4	"Yes I do cause sometimes I'm stuck and do not know what to do so then I have to think a lot."	"The only thing that slows me down is slow partners"	N/A	"I do because the work is fun and ok"
Question #5	***Females placed in STEM:*** 0 ***Males placed in STEM:*** 4	***Females placed in STEM:*** 2 ***Males placed in STEM:*** 2	***Females placed in STEM:*** 2 ***Males placed in STEM:*** 2	***Females placed in STEM:*** 2 ***Males placed in STEM:*** 2
Question #6	N/A	N/A	N/A	N/A
Question #7	***Males Identified:*** friend; friend ***Females Identified:*** 0 **Mixed:** 0	***Males Identified:*** Dad ***Females Identified:*** 0 **Mixed:** 0	***Males Identified:*** 0 ***Females Identified:*** Mom, math consultant ; friend **Mixed:** 0	***Males Identified:*** friend ***Females Identified:*** Mom's coworker **Mixed:** 0
Question #8	"His grandpa told him" (in reference to student who knew multiplication in second grade)	"He worked very hard throughout his life no matter what happened"	"became good at math maybe by their parents, teachers"	"studied... learned math instead of being born with it"
Question #11	[NAME] must have made some careless mistakes	N/A	[NAME] must have made some careless mistakes	[NAME] really needs to put more effort in

Question #12	"I was always good at math and I am still doing well."	"I have. My dad has taught me a lot."	"Now I know how to do multiplication and stuff like that, which I couldn't do in 2nd grade."	"Yes I have because last year I had trouble but this year not as much."
Question #13	"Maybe but probably not because like I said I have always been good at math."	"I have not struggled with math in the past so I don't think I will struggle in fifth grade because all you need to do in my opinion is adapt to the situation and frankly, that is easy for me. One of the most easiest parts in learning for me is to adapt."	"Probably but not all the time because sometimes people just make mistakes."	"No because each year your brain grows."
Question #14	"I am really confident because I'm good at math, but I could do bad."	N/A	"Very confident because over the years I have learned a lot."	"Very confident."
Question #15	"Yes because like I said a lot I am really good at math (not trying to brag)."	N/A	"Very successful because of how much I have learned from different teachers."	"I think pretty good."
Question #16	N/A	"Math is very easy for me. It's relaxing."	N/A	N/A
Retell:	Male pronouns	Male pronouns	Did not use gender-specific pronouns	Did not use gender-specific pronouns

Appendix E

Focus Group Protocols and Prompts

Focus Group 1A: Analyzing Student Questionnaires

- Welcome to the research project
- Present statistics of female participation in STEM fields
- Teacher-researchers share their homework examples and colleagues respond with the source of self-efficacy being described
- Teacher-researchers sort quotes based on the source of self-efficacy displayed
- Teacher-researchers complete mini-questionnaire to mimic student questionnaire
- Teacher-researchers share out questionnaire responses
  - Prompt: What do you find interesting about our responses?
  - Prompt: How do you think these responses will be similar to or different from student responses?
- Teacher-researchers review the blank student questionnaire
  - Prompt: What are you wondering?
- Provide summary quantitative statistics
  - Prompt: What stands out to you?
  - Prompt: How is this similar to or different from your own responses?
- Present each source-specific question set followed by:
  - Prompt: What stands out to you?
  - Prompt: Are there any patterns you are noticing?
  - Prompt: What questions do you have?
  - Prompt: What source of self-efficacy seems to be surfacing?
  - Prior to presenting levels of accuracy for Question #1, prompt: How many males and females do you think answered the question correctly?
- What source of self-efficacy do we want to target?

Focus Group 1B: Generating the Action Plan

- Provide teacher-researcher quotes from the first focus group
- Develop sub-goals to target
- Teacher-researchers pick the top six interventions they think would be beneficial to their female students and rank them
- Prompt: What interventions did you select and why?
- Prompt: What should we include in our action plan?
- Prompt: How will we know if the intervention is having an impact?

Focus Group 2: Reflections on Cycle 1 and Revisions for Cycle 2

- Review sub-goals and action plan
- Prompt: What morning meeting prompts have you used thus far? Why did you select these prompts?
- Prompt: What journaling prompts have you used thus far? Why did you select these prompts?
- Prompt: What patterns did you find in the student responses during morning meetings? How do these relate to the patterns from the questionnaire?
- Prompt: Have any of our goals been addressed by the morning meetings?
- Prompt: Is there any additional information about the morning meetings you would like to share?
- Prompt: What patterns did you find in the student journal responses? How do these relate to the patterns from the questionnaire?
- Prompt: Have any of our goals been addressed by the journaling?
- Prompt: Is there any additional information about the journaling you would like to share?
- Prompt: Do our planned goals need to be revised?
- Prompt: Does our action plan need to be revised?
- After presenting the ICA Toolkit – Prompt: Do you think this could work in your classroom? Do you think this will be beneficial for your students? Does anything need to be changed?

Focus Group 3: Reflections on Cycle 2 and Revisions for Cycle 3

- Prompt: Thinking about the goal we set, how have our interventions aligned with these goals?
- Gallery walk of ICA Tookits followed by a share-out on any reflections from the gallery walk
- Direction: Using words and/or pictures fill in the person-outline to capture the manifestations of self-efficacy express by your students at the start of the study.
    - Prompt: Who would like to share out?
- After posting a concept splash on the board of interventions employed and the manifestations of self-efficacy from the Look-fors Checklist, prompt: Reflecting on the interventions employed and the manifestations we have been attending to, what insights do you have from this cycle?
- Prompt: Do we need to make any revisions to the action plan?

Appendix F

Generating the Action Plan

Intended impacts on mathematical experiences to address low female self-efficacy			
Emerging Themes:	**Intervention / Change in Classroom Practice Referenced:**	**Frequency Count:**	**Example In Vivo Quotes:**
Student Self-Reflection	Journaling	4	• "...makes you more in tune." • "I like the idea of having it happen throughout the lesson because I think that sometimes if they feel stuck or frustrated at the beginning, they sometimes won't stop themselves or take the time to think and reflect on it" • "...the opportunity to talk about their feelings or frustrations or if they want to use a new strategy.." • "...quick stop and jot."
Creation of a Safe Place	Morning Meeting	1	• "common issues that are coming up and we'll talk to them about it."
	Journaling	5	• "...it is private." • "...they probably feel more comfortable sharing their honest feelings." • "...sometimes too, you don't want to say how you're feeling, so it's easier to write it."
Peer Support	Strategies for helping peers	4	• "...work in a lot of pairs or small groups, so it would make sense if one of the interventions was working together." • "...how they can help each other..."
	Morning Meeting	1	• "...a prompt that we discuss as a group."
Attainment of Coping Mechanisms	Problem-based coping strategies	8	• "...self-monitoring strategies, like we teach them these problem-solving strategies that they have in their back pocket for when they struggle." • "...break apart a problem when they first get it to help not only recognize but cope with those anxieties." • "...now that they're writing about these anxieties, how can they work on coping with them..."
	Calming Techniques	2	• "I think I like Zensational kids." • "...some sort of movement might be helpful."

Desensitization of mathematical experiences	Bedtime Math	4	• "...we have the math menu, and that is something we could add to it."
	Journal	2	• "...part of your prompt is, 'If I don't get this one the first try, what is going to happen?'"
	Skype Female Mathematician	1	• "...Skype with the female mathematician might be good obviously because our girls didn't see females in that role."
	Morning Meeting	8	• "...we have to be the ones to show them...I felt so accomplished because it was something I was, you know, afraid of, and I finally did it." • "...normalizes it." • "...perceived threat. I don't know why but it's just jumping out at me." • "...I like that idea of, "Well what is the worst thing that could happen?" to kind of normalize the struggle." • "...okay that they're having these anxieties and how it's a normal part of your brain functioning. • "And sharing that whole journey with the kids, though, is what it's all about." • "...persevere through difficulty, and grit, and understanding that not everything happens immediately, and instant gratification is not it"
Constructing interventions for effective and efficient implementation			
Emerging Themes:	**Intervention / Change in Classroom Practice Referenced:**	**Frequency Count:**	**Example In Vivo Quotes:**
Practicality	Morning Meeting	3	• "...homeroom period that lends itself to it." • "...we do this every day anyway..."
	Bedtime Math	1	• "we have a math menu"
Grade Specific	Journaling	3	• "And I don't think it has to be identical across the board." • "I don't know if mine will come out saying like, 'My feelings are this,' but if it could be more prompted like, 'So far in the task, how have you been feeling about your...'" • "...certain symbols..." - "...smiley face, middle, frown..."
Integration of multiple interventions	Journal	2	• "I kind of coupled the math journal and writing about anxieties because they seemed like the same." • "perceived threat... and I think that this can maybe go along with the journal, like maybe part of your prompt is, 'If I don't get this on the first try, what's going to happen?'"
	Morning Meeting	1	• "Yeah, you can do that in a lot of different ways. It can even be part of your morning meeting."
	Problem-based coping strategies	2	• "...problem-based strategies...fed into the self-monitoring piece."
Home Connection	Bedtime Math	2	• "...Bedtime Math..." • "I like the idea of some sort of home connection."

Appendix G

Morning Meeting and Journaling Prompts used in Cycle 1

	Morning Meeting Prompts	Journaling Prompts
Quade	• Pretend that you have to describe mathematics to someone. List all the words or phrases you could use. • If math were a color, an animal, a piece of music, or type of food what would it be? • How do you know when you are becoming anxious, stressed, or fearful? What are the signs? • When someone calls out "I'm done" or "That was easy!" in math, how does that impact others? • What's the worst that could happen? If you struggle on a task or problem in math today, what's the worst that could happen? • Describe how you feel in a math class.	• We are going to learn about two step learn problems today. How do you feel? • Think about the conversations we have had about math. Does everyone feel confident in math? How does this impact your own feelings about math?
Erikson	• Pretend that you have to describe mathematics to someone. List all the words or phrases you can think of that you could use. • When someone calls out, "I'm done!" or "That was easy!" in math, how does that impact others? What could we say/do instead? • If you could design a stress-free math class, what would it be like? • *What's the worst that could happen?* If you struggle on a task or problem in math today, what's the worst that could happen?	• Yesterday we learned how to use the area model to solve division problems. How have your feelings changed from the beginning of the lesson yesterday to today? Use the following starters to help you. • Yesterday I was feeling _________ because… Today I feel ______ because… My feelings changed because….
Nelson/ Holt	• Pretend that you have to describe mathematics to someone. What are some words or phrases that you would use? • If math were a color, an animal, a piece of music, or type of food what would it be? • When someone calls out, "I'm done!" or "That was easy!" in math, how does that impact you? • How do you know when you are becoming anxious, stressed, or fearful? What are the signs?	• Yesterday we learned to divide using the area model. In your journal, please write about your feelings when we first started yesterday vs. how you feel about it now. • At the beginning of the lesson yesterday I was feeling__________ because... I'm feeling _________________ now because... My feelings changed because... • As you were learning area models, how were you feeling? Did your feelings change? If so, How?

	• *What's the worst that could happen?* If you struggle on a task or problem in math today, what's the worst that could happen? • What do you do to deal with nervousness right before a math exam?	As I learned how to use area models I was feeling _________________. My feelings changed because ______________.
Davis-Turner	• Pretend that you have to describe mathematics to someone. What are some words or phrases you can think of that you could use? • If math were a color, an animal, a piece of music, or type of food, what would it be? Explain your answer. • When someone calls out in math, "I'm done! Or "That was easy!", how does that impact others? What could we say/do instead? • Some of you have described feeling anxious or fearful in math at times. Do you have any strategies that you can suggest to your classmates for coping with stress in math class? • If you could design a stress-free math classroom, what would it look like? • If you struggle on a task or problem in math today, what's the worst that can happen?	• How do you know when you are beginning to experience feelings of fear, stress, or anxiety in math? List the signs. • In our math discussions, has anyone shared a strategy for coping with fear or anxiety in math that you might use when you experience these feelings? • Describe what this picture means to you: (displayed a picture of an iceberg with the term "Success!" visible above the water with a label stating "What people see" and terms such as "failure," "disappointment," and "hard work" below the water with a label stating "What people don't see.") • Respond to the following quote: "When everything seems to be going against you, remember that the airplane takes off against the wind, not with it" – Henry Ford

Appendix H

Sub-Question B Codebook

Code: Comfort in Impermanence
Definition: When female students were faced with math problems they perceived as challenging, they displayed more comfort in working with these problems on whiteboards or blank scrap paper, whereas they were more hesitant or refused to attempt these problems on the task sheets or assessments.

Code: Continuation of Home Connections
Definition: Although home connections proved unsuccessful, there is a desire among teachers to implement interventions pertaining to home connections in the future with revisions.

Code: Continuation of ICA Toolkit
Definition: Based on positive student response to and utilization of the ICA Toolkit, there was a strong desire among teachers to implement the ICA Toolkit in the future.

Code: Continuation of Journaling
Definition: Based on the displayed benefits of journaling, there was a desire among teachers to implement journaling in the future.

Code: Continuation of Mathematician Visits
Definition: Although the mathematician visit was not as successful as anticipated, there is an expressed desire among teachers to attempt this intervention in the future.

Code: Continuation of Morning Math Meetings
Definition: Based on student engagement in and response to the Morning Math Meetings, there was a strong desire among teachers to implement these meetings in the future.

Code: "Coping Strategies"
Definition: Interventions selected with the intent of helping students to overcome negative physiological states in the moment as opposed to only targeting these states in isolation which has not proven successful

Code: "Desensitization"
Definition: Actions taken to desensitize mathematical experiences by addressing exaggerated perceived threats and normalizing struggle

Code: Effective "Coping"
Definition: Students identify or apply effective coping mechanisms.

Code: Effective Student Self-reflection
Definition: Data from interventions show that students are able to effectively self-reflect in identifying negative thoughts and feelings and monitoring progress.

Code: Emergent
Definition: Teachers altered classroom practices and environment based on revelations from implemented interventions including student expression of experiences.

Code: "Empowerment" and "Voice"
Definition: Empowering students to have control over their experiences and giving them a voice in the classroom

Code: Future Revision - Emergent
Definition: In the future, teachers would implement additional practices that emerged as a result of the interventions focused on in this study.

Code: Future Revision - ICA Explicit Instruction
Definition: In the future, when rolling out the ICA Toolkit, teachers would more explicitly teach into the 'Coping' and 'Act' strategies.

Code: Future Revision - ICA "Prominence"
Definition: In future implementation of the ICA Toolkit, teachers would be more intentional in making sure that the toolkit is a prominent visual support for students.

Code: Future Revision - Journaling Scaffold
Definition: At the third-grade level, the teacher expressed that in the future implementation of journaling, she would scaffold toward more abstract prompts by first beginning with more concrete prompts.

Code: Future Revision - "Open" Journaling
Definitions: In the future, teachers plan to make journaling more open by allowing students to choose what mathematical reflections to write about in their journals and allowing students to have ongoing access to the journals.

Code: Future Revision - "Small Group" ICA
Definition: In the study, the two collaborative classes rolled out the ICA Toolkit in small groups. One teacher who rolled out the ICA Toolkit as a whole group expressed that he may want to roll out the toolkit in small groups in the future. The other teacher who rolled out the toolkit as a whole group expressed that she would make this decision based on the student needs in the future.

Code: Future Revision - "Start of Year"

Definition: Teachers expressed wanting to implement the interventions at the start of the school year in the future so that they become a natural part of the classroom community.

Code: Future Revision - “Working” Toolkit
Definition: In the future, it may be beneficial to present the ICA Toolkit as a working document that could be added to throughout the year as students identify new signs of negative physiological states or develop new coping and acting strategies.

Code: Grade-Specific
Definition: Necessary modifications to interventions based on grade level

Code: “Home Connection”
Definition: Connecting the work being done in the classroom to students’ home experiences and why this is necessary

Code: Individuality / Diversity
Definition: As opposed to a one-size-fits-all approach, factors that induce or reduce negative physiological states vary from student to student. Classroom practices should embrace student differences in a positive light.

Code: Ineffective “Coping”
Definition: Students apply ineffective coping mechanisms.

Code: Ineffective Student Self-reflection
Definition: Data from interventions show that students need additional support to self-reflect in identifying negative thoughts and feelings and monitoring progress

Code: “Integration”
Definition: Teachers integrating interventions together where they saw possible overlaps

Code: Internalizing the Toolkit
Definition: Students utilized strategies from the ICA Toolkit without directly referring to the toolkit.

Code: Isolation/Disconnect
Definition: Evidence that practices need to reach beyond teaching strategies in isolation and/or students’ views about math differ when thinking about math in general versus thinking about their personal connections to math

Code: Journaling - Aversion to Writing
Definition: Students’ dislike for writing impacted their views of journaling as a strategy for coping or self-reflection. Since these students dislike writing, both the physical act of handwriting and the act of transferring their ideas to written form, they disliked writing in their journals, which often led to limited responses.

Code: Journaling Limited

Definition: Analysis of journal entries by teacher-researchers shows that student responses are limited, lacking elaboration and depth

Code: Mathematician - "Difficult Understanding"
Definition: Students expressed difficulty understanding the vocabulary and language used by the mathematician.

Code: Mathematician - Lacked Benefit
Definition: The responses collected from teachers and students conveyed that the visit from the female mathematician was not as helpful as we had anticipated.

Code: Morning/Math Meeting - Peer "Driven"
Definition: In Morning/Math Meetings, student responses are guided by the responses of their peers who shared out prior, and thus, individual reactions that may stray from the current focus of the dialogue are not always verbalized.

Code: Morning/Math Meeting - Public
Definition: Because Morning/Math Meetings are public verbalizations of thoughts and feelings, students may be holding back their personal thoughts and feelings that they want to keep private.

Code: One-to-one "Coaching"
Definition: Individualized coaching may be necessary to help students identify negative physiological states and employ coping mechanisms in the moment.

Code: "Ongoing"
Definition: The interventions cannot simply be implemented once or a few times, they need to be an ongoing practice in the classroom.

Code: "Open" Journaling
Definition: Students expressed a greater interest in open journaling, such as journaling that was open-ended as opposed to a particular prompt or having the autonomy to access their journal at any point during the math class.

Code: Peer "Comparison"
Definition: Peer comparison influences physiological states. This often overlaps with 'speed.'

Code: Peer "Support"
Definition: Employing interventions in which peers support each other

Code: "Power Dynamic"
Definition: Changes in classroom power dynamics as a result of employed interventions

Code: Practicality
Definition: Teacher reflection on the practicality of interventions

Code: Relatability
Definition: Making interventions relatable for students

Code: Risk of Lowered Expectations
Definition: In adjusting classroom practices to decrease the impact of negative physiological states on self-efficacy, there may be a tendency to lower expectations for these students. Lowering expectations would be a disservice to these students; rather, students need to develop the strategies that will allow them to successfully achieve the set expectations.

Code: Role Model Disclosure
Definition: Discussion of teachers and other role models sharing personal experiences and mathematical struggles

Code: Safe Place
Definition: Students need a safe place to express their thoughts and feelings

Code: "Scaffolding"
Definition: Use of scaffolding techniques to ease students into the intervention strategies

Code: "Seriousness"
Definition: Students are approaching the interventions with a serious viewpoint. Rather than joking about or making light of the interventions, students are considering and applying the interventions with sincerity.

Code: Shift in SE
Definition: Evidence shows a positive shift in manifestations of math self-efficacy.

Code: "Speed"
Definition: The impact of speed on physiological states and methods of decreasing this relationship

Code: Student Self-Reflection
Definition: Need for student self-reflection in identifying negative thoughts and feelings and monitoring progress

Code: Student-Teacher "Relationships"
Definition: The intervention implementation fostered stronger positive relationships between the teachers and the students in the classes included in the study.

Code: Teacher "Awareness"
Definition: Interventions bringing about a change in the teachers' awareness of practices that influence self-efficacy and of the experiences of their students

Code: Teacher "Modeling"
Definition: Teachers model how to employ the coping mechanisms that are introduced.

Appendix I

Reflections on Cycle 1: Journaling

Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
Journaling provided students with a **safe place** to share their thoughts and feelings.	2	• "...could have been a better journal entry or an interview because that's also a very personal thing to share, and we didn't get that many students sharing out for that response either."
Journaling increased **teacher awareness** of practices that influence self-efficacy, leading to teachers **implementing changes** based on student reflection.	2	• "...we had one girl who specifically said that someone at her table, because we did this as a journal entry, and she said someone specifically at her table was causing her anxiety and stress because this boy finishes early and says things are easy. So we were like, we have to do something about this, so we moved her to a different table, and instantly she was so much happier."
Journaling was **limited** among some students in comparison to their oral share-outs.	3	• "...for the journals, it really took a lot longer for them to get the pencils moving."
Students in **younger grades struggled** more with journaling.	3	• 3rd grade: "I think I get the most information in the morning meetings as opposed to the journals, and it could just be age-wise they are able to verbally express themselves more so than writing down how they're feeling." • 5th grade: "They were very into it."
Journaling **empowered students** by giving them a voice, which was enhanced when students were given an opportunity to share (voluntarily) their responses	5	• "...we wanted to acknowledge what they were saying." • "We also did open it up to sharing... I would say a lot of them really wanted to share, so that took longer too." • "...gives them a chance to reflect on what their classmates said."

Appendix J

Reflections on Cycle 1: Math-Focused Morning Meetings

Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
Responses shared out tended to be **more positive** when the topics and dialogue were **more general** as opposed to topics and dialogue that focused on personal experiences, and personal connections to negative physiological states were avoided at times.	2	• "...when they weren't thinking about themselves and they were just describing math, their responses were very positive; a lot of them described it as problem-solving and it's like a puzzle, it's all pieces working together and using strategies to try to solve something bigger. It was much more positive. I saw the biggest shift on day three when they had to reflect on themselves, and that's when more of the anxiousness and stress came out, but that was not given as an answer at all for the more general overview of math..." • "A lot of the statements were like, 'You can feel,' not, 'I feel.' 'You can feel shaky and get red,' but not, 'I get this way.'"
Morning meetings reversed **power dynamics** in the classroom, allowing the voices that are typically marginalized to be heard.	3	• "It was interesting to hear the students who don't call out. In my class you generally know who are the students that do call out 'I'm done,' and those students didn't speak first. So it was interesting to see them, and most of those students didn't speak out in this conversation." • "...some students were very quiet during that and were kind of listening in...the next two days...I got like a little thumbs-up if someone was done or a quiet hand, but I haven't heard anyone verbally expressing that they finished something early because I think that was probably the most powerful conversation we had, really expressing that 'this really does not make me feel good, and I'm already feeling anxious, and just knowing that you are done quicker than me is not making me feel happy.'"
Morning meetings increased teacher awareness of **peer comparison** and its impact on physiological states.	4	• "...'knowing that I might be at a different part of the problem than someone else and then that makes me feel that I just have to hurry up and even though I may not understand what I'm supposed to be doing, I have to put something down so that I'm done.'" • "'Well, it stresses me out when I see someone else finishing faster than me...'"
Morning meetings increased teacher awareness of female students'	3	• "...open to saying, 'It makes me feel rushed,' or, '...stressed,' or, '...anxious,' 'knowing that I might be at a

attention to **speed** in math and its impact on physiological states.		different part of the problem than someone else and then that makes me feel that now I just have to hurry up and even though I may not now understand what I'm supposed to be doing, I have to put something down so that I'm done.'" • "...they still had that discussion of like, 'Well, it stresses me out when I see someone else finishing faster than me,' or 'Why don't I get it immediately like this person does?' So, it was almost more internalized."
Some students, especially females, **effectively verbalized self-reflections** on their physiological states.	5	• "...able to identify what happens when they are becoming anxious like, 'My hands get sweaty and it's hard to breathe.'" • "...both brought up negative feelings, like stress, frustration." • "...girls had given a lot of thought prior to this about their feelings about stress in math..."
Students shared **both effective and ineffective coping** mechanisms.	3	• "...girls just deal with it more internally or sometimes will say like, 'I don't get it.'"
Female students verbalized effective coping strategies more frequently than male students.	2	• "...girls who did share were the ones who shared their coping strategies, versus the boys were okay sharing their feelings of frustration or anxiety, but they had no coping strategies to share."
Morning meetings promoted the **desensitization** of negative feelings to mathematical experiences	8	• "...interesting conversation because they also got to hear how other students feel, and even though they're strong at math, they do experience frustration as well." • "They know that there's no huge repercussion for not understanding or getting something wrong, but they still had that discussion of like, 'Well it stresses me out ...' • "...they might be aware but kind of sharing and having that ability to hear others' struggles is hinting at that desensitization. They're normalizing struggle because we are seeing that our peers are having the same struggle and the teachers are having the same struggle." • "...taking the time to come together to really hone in on that has been beneficial." • "I think bringing awareness to it is something to celebrate."
Morning meetings **increased teachers' awareness** of practices that influence self-efficacy	4	• "I think I get the most information in the morning meetings..."
Since the **morning meetings were public**, students seemed to hold back personal thoughts or feelings.	6	• "…that's also a very personal thing to share, and we didn't get that many students sharing out for that response either." • "...maybe they just didn't participate in that one as much because it is so personal."
The morning meetings were **peer-driven**. Student responses were guided by the responses of their peers who shared out prior, and thus, individual reactions that may have	4	• "...drove our conversations to kind of build off each other." • "changes the direction of the conversation at times. Like the first one was very open but the conversation moved as they each talked about something and it kind of led to something else."

diverged from the current focus of the dialogue were not always verbalized.		
Female students could verbalize coping strategies but **needed coaching to apply** them.	3	• "So they know all of this, but they just have to keep on reminding themselves about it when they start to feel negative." • "...the boys didn't share any coping strategies for stress, the girls shared many."
Teachers disclosing their own math struggles helped to desensitize negative mathematical experiences for students.	2	• "Specifically with area models, I was truly having a struggle learning it, and I honestly shared that with them. I told them it took me hours, and I'm still checking myself, and I shared that piece."
Morning math meetings became a **safe space** in which female students felt comfortable sharing their thoughts and feelings.	3	• "The girls in general were a lot more willing to share their ideas." • "...girls sharing a lot more in the morning meeting. It is overwhelmingly girls sharing..."
Scaffolding techniques helped to ease students into the morning math meeting by creating a safe space.	3	• (prompts) "...intended to be not all that personal and just to get them comfortable about starting to talk." • "...for them to think more generally and just open up to the conversation."
Teachers noticed an increase in student **empowerment and voice**.	5	• "I think that's an example of how the girls in your class really just wanted to get these feelings heard." • "...girls sharing a lot more in the morning meeting. It is overwhelmingly girls sharing..." • "They were really excited about that one because it was like, what are things we could do to change what's happening, and they had some great ideas."

Appendix K

Look-Fors Checklist for Monitoring Shifts in Manifestations of Math Self-Efficacy

Look-fors Checklist

<table>
<tr><td rowspan="6">Coping ability:
Are students using the ICA Toolkit?</td><td>Date:</td><td>Date:</td><td>Date:</td><td>Date:</td></tr>
<tr><td># of stu.:</td><td># of stu.:</td><td># of stu.:</td><td># of stu.:</td></tr>
<tr><td># of fem.:</td><td># of fem.:</td><td># of fem.:</td><td># of fem.:</td></tr>
<tr><td>Student / Teacher prompted</td><td>Student / Teacher prompted</td><td>Student / Teacher prompted</td><td>Student / Teacher prompted</td></tr>
<tr><td><u>Outcome:</u>
After ICA, stu. completed task
After ICA, stu. continued to struggle with angst
Stu. did not complete ICA
Other:</td><td><u>Outcome:</u>
After ICA, stu. completed task
After ICA, stu. continued to struggle with angst
Stu. did not complete ICA
Other:</td><td><u>Outcome:</u>
After ICA, stu. completed task
After ICA, stu. continued to struggle with angst
Stu. did not complete ICA
Other:</td><td><u>Outcome:</u>
After ICA, stu. completed task
After ICA, stu. continued to struggle with angst
Stu. did not complete ICA
Other:</td></tr>
<tr><td>Notes:</td><td>Notes:</td><td>Notes:</td><td>Notes:</td></tr>
<tr><td rowspan="3">Action initiation:
Are students self-starting when given tasks?</td><td>Observation:</td><td>Observation:</td><td>Observation:</td><td>Observation:</td></tr>
<tr><td colspan="4">Is this a change from prior to the study?</td></tr>
<tr><td colspan="4">Additional notes:</td></tr>
</table>

<table>
<tr><td rowspan="3">Perseverance/ Resilience

Are students giving up when they face a challenge?</td><td>Observation:</td><td>Observation:</td><td>Observation:</td><td>Observation:</td></tr>
<tr><td colspan="4">Is this a change from prior to the study?</td></tr>
<tr><td colspan="4">Additional notes:</td></tr>
<tr><td rowspan="3">Affective
Are students showing signs of stress/ anxiety?

[emotional response (ex: crying), verbal expression, hesitation, concern of social implications]</td><td>Observation:</td><td>Observation:</td><td>Observation:</td><td>Observation:</td></tr>
<tr><td colspan="4">Is this a change from prior to the study?</td></tr>
<tr><td colspan="4">Additional notes:</td></tr>
<tr><td rowspan="3">Outcome expectancy:
How do students view future capability? (likely conveyed through verbal expression) Innate? Fixed? Effort-based? Positive? Negative?</td><td>Observation:</td><td>Observation:</td><td>Observation:</td><td>Observation:</td></tr>
<tr><td colspan="4">Is this a change from prior to the study?</td></tr>
<tr><td colspan="4">Additional notes:</td></tr>
</table>

Appendix L

Cycle 2 Semi-Structured Interview Prompts

What journaling prompts did you use in Cycle 1? What journaling prompts did you use in Cycle 2?

Reflecting on the journal entries completed in Cycle 2, as well as those from Cycle 1, do you have any new insights? Are the students finding journaling to be beneficial?

What morning meeting prompts did you use in Cycle 1? What morning meeting prompts did you use in Cycle2?

Reflecting on the morning meetings completed in Cycle 2, as well as those from Cycle 1, do you have any new insights? Are the students finding the meetings to be beneficial?

Did the students find the visit from the mathematician to be beneficial? Did it change their views of math in any way?

Have any of the students tried out the Bedtime Math app? Have students found the app beneficial?

How did you roll out the toolkit? Did you teach it to specific students or the whole group? When was it introduced?

Have the students been using the toolkit?

Have you see any shifts in self-efficacy among your students?

Is there anything else you would like to share?

Appendix M

Sub-Question C Codebook

Code: Accurate Source Identification
Definition: Teachers accurately identified examples of sources of self-efficacy or sources that surfaced in the student data, including overlaps that can occur between sources of self-efficacy.
Connection to Feminist-Infused Critical Inquiry: The specific problem is defined (Denzin, 2016).

Code: Assumptions and Misconceptions
Definition: Teacher-researchers reflected on their prior assumptions and misconceptions.
Connection to Feminist-Infused Critical Inquiry: Inquirers identify misconceptions and assumptions they hold (Denzin, 2016).

Code: Autonomy
Definition: A female teacher-researcher expressed the role that having ownership over the supports she was provided strengthened her openness to these supports.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Classroom Transformation
Definition: Teacher-researchers identify positive transformation in their classroom as a result of the interventions employed.
Connection to Feminist-Infused Critical Inquiry: The goal of critical inquiry is to transform marginalizing structures and empower the oppressed (Charmaz, 2017; Gannon & Davies, 2012).

Code: Collaboration
Definition: Teachers built upon each other's ideas relating to self-efficacy and interventions, introducing connecting ideas, providing possible rationale, or challenging each other's ideas.
Connection to Feminist-Infused Critical Inquiry: Collaborative relationships prompt transformation (Lykes & Hershberg, 2012).

Code: Community
Definition: Teacher-researchers identified the need to build a community in which students help each other to strengthen their math self-efficacy.
Connection to Feminist-Infused Critical Inquiry: In a classroom community that aligns with feminist pedagogy, students view themselves as being responsible not only for their own success, but also the success of their classmates (Shrewsbury, 1987).

Code: "Confidence"
Definition: A female teacher-researcher reflected on the positive relationship between her confidence in math and success in math.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Critical Analysis of Data
Definition: Teacher-researchers viewed the data through critical lenses.
Connection to Feminist-Infused Critical Inquiry: The process of analysis is approached with a sense of doubt and critique (Charmaz, 2017).

Code: Critical Self-Reflection
Definition: Teachers reflected on their own instructional practices in relation to the sources of self-efficacy to critically analyze how they intentionally or unintentionally impact student self-efficacy.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Diverse Experiences
Definition: Teacher-researchers highlighted the diverse experiences of students in their classrooms.
Connection to Feminist-Infused Critical Inquiry: Feminist pedagogy promotes the notion that diverse learners have diverse experiences (Shrewsbury, 1987).

Code: Emergent Interventions
Definition: Due to the emergent nature of critical inquiry, teacher-researchers are able to adjust the selected interventions based on their analyses of the impact of employed interventions.
Connection to Feminist-Infused Critical Inquiry: Critical inquiry requires ongoing critique and reflexivity (Gannon & Davies, 2012).

Code: “Enjoyable anxiety”
Definition: The male teacher-researcher expressed “enjoyable anxiety” when completing the questionnaire.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Epiphanic and Emotional Responses
Definition: The data prompted emotional responses among teachers and sudden realizations and insights relating to student self-efficacy.
Connection to Feminist-Infused Critical Inquiry: Inquiry is transformative and fosters change within the inquirer (Charmaz, 2017; Denzin, 2016).

Code: Fixed mindset
Definition: The male teacher-researcher expressed a fixed mindset in describing prior math experiences.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Gender Comparisons
Definition: Teacher-researchers compared and contrasted the data collected from females with data collected from males.
Connection to Feminist-Infused Critical Inquiry: Inquiry leads to emancipatory discourse on inequities in the daily lives of marginalized populations (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012; Hesse-Biber, 2012).

Code: Individual Importance
Definition: Teacher-researchers engaged in dialogue about the value of one student’s lived experience.
Connection to Feminist-Infused Critical Inquiry: The realization of the importance of each individual life impacts the evaluation of inequities and instructional practices (Denzin, 2016).

Code: Inquisitive
Definition: Teacher-researchers asked critical questions based on the data and responses to interventions.
Connection to Feminist-Infused Critical Inquiry: The emergent nature of the study prompts critical questions (Charmaz, 2017; Hesse-Biber, 2012).

Code: Intervention Analysis
Definition: Teacher-researchers implement interventions and evaluate the success of these interventions through classroom observations and student interpretation.
Connection to Feminist-Infused Critical Inquiry: Inquirers employ interventions as a form of activism and evaluate their impact (Denzin, 2016).

Code: Intervention Identification
Definition: Teacher-researchers identify interventions to employ in the classroom to bring about change for marginalized female students.
Connection to Feminist-Infused Critical Inquiry: The classroom becomes a place for activism and change by identifying interventions to current practices (Denzin, 2016).

Code: "Keywords" & Defining Features
Definition: Teachers identified keywords or defining features that typically signal particular sources of self-efficacy.
Connection to Feminist-Infused Critical Inquiry: The specific problem is defined. (Denzin, 2016).

Code: Motivation to Act
Definition: Teacher-researchers expressed their motivation to take action in strengthening female self-efficacy in mathematics.
Connection to Feminist-Infused Critical Inquiry: The data provides the "moral authority" to take action, moving beyond interpretation to prompting change in the lives of the oppressed (Denzin, 2016, p. 8; Gannon & Davies, 2012).

Code: Patterns
Definition: Teacher-researchers looked for patterns across the data and responses to interventions.
Connection to Feminist-Infused Critical Inquiry: The emergent nature of critical inquiry is fueled by inductive analysis (Charmaz, 2017).

Code: Perceptions of others
Definition: Female teacher-researchers reflected on how the perceptions of others impacted their own behaviors and mindsets.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Personal Experience
Definition: Teachers reflected on their personal mathematical experiences and connected these experiences to the sources of self-efficacy and self-efficacy development.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Physiological States
Definition: Female teacher-researchers expressed that they experienced negative physiological states when completing the sample teacher mini-questionnaire.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Prior Experience
Definition: Teachers reflected on their prior experiences with students and parents and connected these experiences to the sources of self-efficacy and interventions to strengthen positive math self-efficacy among females
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Product focused
Definition: The male teacher-researcher expressed a focus on getting the correct answer on the questionnaire.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Safe Space for Progress
Definition: Teacher-researchers planned to create safe spaces for students that would allow students to critically reflect on their experiences in order to overcome the barriers females face in developing positive math self-efficacy.
Connection to Feminist-Infused Critical Inquiry: Critical inquiry seeks to create safe places for marginalized groups to challenge oppressive systems and "achieve the gift of freedom; the gift of love, self-caring; the gift of empowerment, teaching and learning to transgress" (Denzin, 2016, p. 14).

Code: Self-doubt
Definition: A female teacher-researchers expressed feelings of self-doubt.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012).

Code: Societal marginalization
Definition: Teacher-researchers reflected on gender marginalization at the macro level.
Connection to Feminist-Infused Critical Inquiry: Inquiry leads to emancipatory discourse on inequities in the daily lives of marginalized populations (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012; Hesse-Biber, 2012).

Code: Source selection
Definition: Teacher-researchers continuously selected physiological states as the sources that stood out to them as being most impactful among females and therefore, the source that we should target. After physiological states, the next most impactful source that the teacher-researchers selected was vicarious experience.
Connection to Feminist-Infused Critical Inquiry: The specific problem is defined. (Denzin, 2016).

Code: Student Assumptions
Definition: Teacher-researchers sought to address the assumptions students held about who can be successful in mathematics and evaluations of success.
Connection to Feminist-Infused Critical Inquiry: Feminist pedagogy requires critical questioning to uncover assumptions and engage in dialogue about these assumptions (Shrewsbury, 1987).

Code: Student Voice
Definition: Teacher-researchers empowered marginalized female students by bringing their voices, lived experiences, and interpretations to the forefront.
Connection to Feminist-Infused Critical Inquiry: Inquirers empower marginalized students by giving them a voice and responding to those voices. Emphasis is placed on the interpretations of female students and their lived experiences (Denzin, 2016; Hesse-Biber, 2012; Merriam & Tisdell, 2016; Shrewsbury, 1987).

Code: Teacher Practice
Definition: Female teacher-researchers reflected on the practices of their own teachers that damaged their self-efficacy in math.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012)

Code: "Tracking"
Definition: Female teacher-researchers expressed the negative impacts tracking systems had on their math self-efficacy.
Connection to Feminist-Infused Critical Inquiry: The study becomes transformative through self-critical reflection, fostering change within the inquirer (Charmaz, 2017; Denzin, 2016; Gannon & Davies, 2012)

Code: Transformative Relationship
Definition: My role allowed me to guide teacher-researchers to view the data in new ways, question patterns in the data, correct misconceptions, and modify classroom practices.
Connection to Feminist-Infused Critical Inquiry: In feminist-infused PAR, "it is through relationships that participants are transformed" (Lykes & Hershberg, 2012, p. 354). These relationships prompted critical discourse focusing on the relevance of self-efficacy in mathematics and gender inequities in our mathematical instruction and practices (Denzin, 2016).

Appendix N

Closing Semi-Structured Interview Prompts

In our study, we have used the following interventions: morning math meetings, journaling, the ICA toolkit, home connections (Bedtime Math app and parent strategies and tips sheet), and the mathematician visit.
Based on your conversations with students, have the students found these strategies to be beneficial?

- Have certain strategies been more impactful than others?

Reflecting on your Look-Fors Checklist, have you observed any changes in the manifestations of self-efficacy (coping ability; action initiation; perseverance/resilience; affective responses/physiological states; outcome expectancy) among your students?

Have the interventions helped:

- to promote respect for others? How?
- to address any assumptions the students might be holding about who can be successful in math?
- students to explore the diverse experiences of different learners?
- to counteract power inequalities that exist in our society?
- to make students more aware that they are responsible for each other's learning?
- students to find their own voices?

Let's think ahead to the start of September; you are about to start a new year of math instruction. Reflecting on what you have learned from this study, are there any adjustments you would make to your classroom practices or instructional strategies you would use that you hadn't used prior to this year?

Is there anything else you would like to share?

Appendix O

Student Pre- and Post-Questionnaire Responses: Questions 2–3

Grade Level, Class Type *Student Count*	**Pre- vs. Post-questionnaire**	**Problematic**	**Non-problematic**
	Female Students		
Grade 3, General Education *Total: 11*	Pre-questionnaire	10 (91%)	4 (36%)
	Post-questionnaire	8 (73%)	5 (45%)
Grade 4, General Education *Total: 7*	Pre-questionnaire	6 (86%)	3 (43%)
	Post-questionnaire	2 (29%)	7 (100%)
Grade 4, Collaborative *Total: 6*	Pre-questionnaire	6 (100%)	5 (83%)
	Post-questionnaire	5 (83%)	6 (100%)
Grade 5, Collaborative *Total: 7*	Pre-questionnaire	7 (100%)	4 (57%)
	Post-questionnaire	4 (57%)	7 (100%)
Total Female Responses:	Pre-questionnaire	29 (94%)	16 (52%)
	Post-questionnaire	19 (61%)	25 (81%)

Cont'd.

	Male Students		
Grade 3, General Education *Total: 8*	Pre-questionnaire	5 (63%)	7 (88%)
	Post-questionnaire	4 (50%)	5 (63%)
Grade 4, General Education *Total: 10*	Pre-questionnaire	4 (40%)	9 (90%)
	Post-questionnaire	2 (20%)	9 (90%)
Grade 4, Collaborative *Total: 8*	Pre-questionnaire	5 (63%)	4 (50%)
	Post-questionnaire	6 (75%)	3 (38%)
Grade 5, Collaborative *Total: 9*	Pre-questionnaire	3 (33%)	7 (78%)
	Post-questionnaire	4 (44%)	8 (89%)
Total Male Responses:	Pre-questionnaire	17 (49%)	27 (77%)
	Post-questionnaire	16 (46%)	25 (71%)

Appendix P

Post-Questionnaire Responses: Interventions Selected as Beneficial Among Female Students

	Morning Meetings	Journaling	ICA Toolkit	Mathematician Visit	Bedtime Math
Quade	2	1	8	0	0
Erikson	5	2	2	0	0
Nelson/ Holt	3	0	4	0	0
Davis/ Turner	5	6	4	2	0
Total:	15	9	18	2	0

Appendix Q

Post-Questionnaire Responses: Female Student Reflections on the Benefits of Interventions

Intervention / Change in Classroom Practice:	Emerging Theme:	Frequency Count:	Example In Vivo Quotes:
Journaling	Students had the freedom to express whatever they were feeling or thinking.	1	• "Journaling to write about our math experiences because I can write whatever."
	Students who disliked writing disliked journaling.	1	• "I don't like journaling because I don't like writing."
	Students wanted to able to choose when to write in it.	2	• "It helps me when my teacher let's me take it out in the middle of the period, but when we're forced to everybody moans."
	Students viewed the journal as a safe place for private thoughts and feelings.	3	"I also liked knowing that only teachers were reading it because some things are a little personal to me." • "I got to write down my more private feelings."
	Journaling helped students to reflect on their feelings.	5	• "Makes me get to talk to myself about what I feel." • "I could get my thoughts and feelings down on paper." • "It's good to have it organized on a paper instead of in your head."
Math/Morning Meeting	Students learned how their classmates were feeling which allowed them to better relate to peers and realize that they were not the only ones feeling this way.	6	• "It makes me feel a little better because it means that I'm not the only one struggling." • "I love doing the morning meeting talk." • "I didn't realize that people felt that way, so now I know." •"It was cool to see that I was not alone when feeling stressed and anxious and seeing that other people experience it too and that I'm not an oddball." • "When I talk about the conversations in math morning meetings I feel like I can go at my own pace."
	Students altered their behavior to be more	2	• "Now people don't say, 'I'm done, out loud."

	supportive of their classmates.		
	Students were able to express their feelings.	2	• "It made me spill out all of the negativity that I had."
	Students received new ideas from their peers.	4	• "I like to see what people do so I can do it." • "It helps to have more ways when they talk about different things I don't do."
Toolkit	The toolkit provides strategies for managing stressful feelings in math.	11	• "Sometimes when I am stressed I use a brave breath." • "It listed things that make me feel comfortable in math." • "When you are stuck on a problem and you are getting stressed out you can look at your ICA Toolkit so you can feel normal again." • "Thinking about happy thoughts helps me overcome negative feelings." • "The ICA strategy helped me the most. Usually I forget how to deal with my anxiety when I'm stressed but now I can always see it." • "ICA helped because when I am feeling stress I know how to identify, cope, and act." • "It helps me think of strategies to calm myself down."
Mathematician	The mathematician was difficult to understand.	1	• "I did not understand her and she did not explain the answer well to the question."
	The mathematician provided a new perspective on math.	1	• "I thought it was cool to see her perspective on math."

Appendix R

Post-Questionnaire Responses: Profession-Matching Activity

	Female Student Responses		Male Student Responses		Total Student Responses	
	Number of females placed in STEM	Number of males placed in STEM	Number of females placed in STEM	Number of males placed in STEM	Number of females placed in STEM	Number of males placed in STEM
Quade: 11 females 8 males	14	28	7	26	19	53
Erikson: 7 females 10 males	6	22	7	29	13	51
Nelson/ Holt: 6 females 8 males	7	13	7	21	14	34
Davis/ Turner: 7 females 9 males	6	22	6	26	13	51
Totals:	33	85	27	102	59	189

Appendix S

Sub-Question C: Reflections on Cycle 1

Emerging Theme:	Frequency Count:	In Vivo Quotes
Teacher-researchers **implement interventions and evaluate the success** of these interventions through classroom observations and student interpretation.	24	• "I think the difference between the first one and the second one was that they had to really defend their answers on the second one whereas the first one was just sort of like listing off words or phrases that had to do with math." • "I saw the biggest shift on day three when they had to reflect on themselves and that's when more of the anxiousness and stress came out, but that was not given as an answer at all for the more general overview of math..." • "...the next two days, because we only did that two days ago, I got like a little thumbs-up if someone was done or a quiet hand, but I haven't heard anyone verbally expressing that they finish something early because I think that was probably the most powerful conversation we had." • "We got some great suggestions. They were really excited about that one because it was like, what are things we could do to change what's happening..." • "...it gives them a chance to reflect on what their classmates said." • "Most students seem to be able to identify coping strategies, but they are not actually applying these strategies in the moment when they are feeling stressed or anxious. Students will shut down instead of applying coping mechanisms." • "It would be helpful to have one-on-one conversations with students to see what is working for them and what is not working."
Due to the **emergent** nature of critical inquiry, teacher-researchers are able to **adjust the selected interventions** based on their analyses of the impact of employed interventions.	5	• "So for the next prompts after that, we always made sure that we had them defend their thinking." • "I think too they are going to need some coaching in terms of what is the right coping strategy and what is the right like attack strategy because it's going to be different for different types of problems, different settings." • "Teachers may need to coach into the coping mechanisms in the moment."
Teacher-researchers **compared and contrasted** the data collected from **females** with data collected from **males**.	6	• "We noticed that the girls seem to have negative or mixed feelings about math, but the boys didn't have any negative feelings when they shared." • "...it was apparent that the girls had given a lot of thought prior to this about their feelings about stress in math, whereas with the boys, it feels like this is the first time they've even considered it before, so their feelings are not as well developed as the girls."

Teacher-researchers planned to **create safe spaces** for students that would allow students to **critically reflect** on their experiences in order to **overcome** the **barriers** females face in developing positive math self-efficacy.	2	• "...open to saying, 'It makes me feel rushed,' or, '...stressed,' or, '...anxious,'"
Teacher-researchers **empowered marginalized female students** by bringing their **voices, lived experiences,** and **interpretations** to the forefront.	6	• "...females were very vocal..." • "So we were like, we have to do something about this, so we moved her to a different table, and instantly she was so much happier." • "Overall it is the girls sharing a lot more in the morning meeting." • "...we want them to know that we're listening." • "They were very into it, so we wanted to acknowledge what they were saying..."
Teacher-researchers **pondered** over findings in the student responses and posed **critical questions**.	11	• "And that one I feel could have been a better journal entry or an interview because that's also a very personal thing to share, and we didn't get that many students sharing out for that response either." • "And it could just be age-wise they are able to verbally express themselves more so than writing down how they're feeling. They can really just get themselves to better speak through it, so I found that to be really interesting." • "...it would be interesting to see like asking it right before they start actually doing math, how that would have impacted their responses versus being so segmented." • "For the kids in your group, would you see this stress and anxiety in your group if they were working independently?"
Teacher-researchers **highlighted the diverse experiences** of students in their classrooms.	3	• "...they had a lot of conflicting opinions about what would make a stress-free classroom."
My role allowed me to **guide teacher-researchers** to modify classroom practices.	6	• "I wonder if even pairing up the journal with the morning meeting, what that would look like. If you gave them the prompt in their journal, and they wrote in their journals first, and then they're sharing out in the morning meetings." • "And the journaling, for some of them, could actually be a coping mechanism, being able to take out that piece of paper and write about it, and even handing it in because for some of these students it sounds like they want to communicate this, and so it gives them that outlet." • "So, for the toolkit, do you think this would help with the transfer of coping mechanisms in the moment, and do you think this could work in your classroom?"
Teacher-researchers identify **positive transformation** in their classroom as a result of the interventions employed.	1	• "I don't know if we have enough evidence at the moment to see if it makes a change in math, but I think bringing awareness to it is something to celebrate."

Teacher-researchers sought to **address the assumptions students held** about who can be successful in mathematics and evaluations of success.	2	• "...sharing and having that ability to hear others' struggles is hinting at that desensitization. They're normalizing struggle because we are seeing that our peers are having the same struggle and the teachers are having the same struggle." • "It has been helpful for students to hear that they are not the only ones struggling."
Teachers **built upon each others' ideas** relating to self-efficacy and interventions, introducing connecting ideas, providing possible rationale, or challenging each other's ideas.	29	• "And keeping that awareness. You know, if it's just a one-time talk and then months later, you know." • "So, would you do different scenarios?" • "Well, if you're going to model it, I think you would probably want to model the thoughts, like speak out loud, 'Okay, this is this type of problem, so maybe this strategy would work, whereas this strategy wouldn't really help me in the same way.'" • "I mean not everyone is going to jump in being able to work with everyone immediately, but you're learning that skill by over and over working with people. Sometimes it will be your best friend, and sometimes it won't be." • "But I think it is a disservice to say, 'Oh well, you just don't have to work with your classmates if you don't want to.'" • "I think that's part of teaching into it and the coaching. I mean just like anything else we do, if the students are not using it appropriately, then we have that conversation with them and maybe that piece is not available to them anymore. I mean because it could really be beneficial to other kids, and so I think we just need to teach them how to use it in the right way." • "Yeah, you're right. Or maybe it's like we said before, some students need certain types of coping strategies that might not be the best for others so maybe that's part of a more individualized conversation."
Teacher-researchers identified the need to build a **community** in which **students help each other** to strengthen their math self-efficacy.	1	• "It has been helpful for students to hear how behaviors like calling out 'I'm done' impact others."

Appendix T

Sub-Question C: Reflections on Cycle 2

Emerging Theme:	Frequency Count:	In Vivo Quotes / Open Coding
Teacher-researchers **implement interventions and evaluate the success** of these interventions through classroom observations and student interpretation.	52	• "I want to debrief about how much of this they've used, and what strategies are helpful and which aren't." • "It was better to identify the signs of stress and anxiety as a small group rather than the whole group. Students who don't typically share out in morning meetings were actually inputting a lot more than usual." • "They seemed to enjoy the *Math Curse* clip, but it didn't really lend itself to deep reflections." • "We actually have been opening it up to anyone who wants to share out about what they wrote, and we have a lot of students who want to read theirs to the class." • "...they were able to really identify what they could do to help others..." • "The students have been taking all of the interventions seriously." • "One girl said that she was a little bit anxious but then she motivated herself and gave some positive self-talk and then she was okay." • "So, some examples of things we got back from them were that as a family, they're going to try to share more about the mistakes they make together, taking brave breaths, avoiding using phrases like 'I'm a math person' or 'I'm not a math person.' Some of them reported their parents sharing certain things that they struggled with in the past and how they overcame that." • "...the mom was really surprised, she had no idea that kids were experiencing anxiety in math and she was happy to know that, and her daughter said, 'Oh really, I thought everyone knew that!'" • "...my group really hadn't been using the toolkit unless I'm providing that reminder to them..." • "...they both said that journaling has not helped, and I kind of had that feeling coming in." • "They have also used the toolkit, but really with my coaching." • "So, the extra coaching does seem to have had an effect." • "I really do think all of the strategies that we have used have really been beneficial." • "...with all of the strategies that we have tried, there haven't been any that I would eliminate."
Due to the **emergent** nature of critical inquiry, teacher-researchers are able to	6	• "...I also wanted to place a larger emphasis on journaling because in the previous morning meetings, the students did not seem to be expressing their own thoughts or ideas as much." • "...but now given the responses, I kind of want to bring them back

adjust the selected interventions based on their analyses of the impact of employed interventions.		and see if they'll talk out more, especially now that we have taken our test yesterday." • "...we've been doing a combination of morning meetings and journaling, just because in our class, it can be difficult to keep everyone engaged in a particular activity..." • "Something I still want to continue doing is, again, I want to coach them to be able to eventually use that toolkit on their own without me having to say, 'Okay, here's the toolkit, let's see what we can do,' and I think that comes over time."
Teacher-researchers **empowered marginalized female students** by bringing their **voices, lived experiences,** and **interpretations** to the forefront.	5	• "I think they really like that people are interested in what they are feeling, and we are actually doing something about it." • "I think just the fact that we are listening to their feelings and understanding where they're coming from makes a difference." • "...they are really more open to sharing their feelings and strategies" • "I think when you give them the power to come up with it on their own, they like that."
Teacher-researchers **compared and contrasted** the data collected from **females** with data collected from **males**.	2	• "And while some of the boys will be very vocal in the journal entry, I've actually seen now the girls are generally sharing a lot more in the morning meetings."
Teachers **reflected on their own instructional practices** in relation to the sources of self-efficacy to critically analyze how they intentionally or unintentionally impact student self-efficacy.	6	• "...so we did make some changes based on that. We started using the flexible stools more often, more flexible seating options." • "...just providing more opportunities for them to come to small group based on their needs as opposed to just working in the groups at their tables." • "But now, for independent days, I've allowed them to take out the lap desks or the pillows and move around the room."
Teacher-researchers **created safe spaces** for students that would allow students to **critically reflect** on their experiences in order to **overcome** the **barriers** females face in developing positive math self-efficacy.	3	• "...for those who didn't want to share to the group, it at least gave them a private space to jot down their feelings."
Teacher-researchers **pondered** over the findings in the student responses and posed **critical questions**.	2	• "I think they are so busy outside of school, that it's probably difficult for them to add another this to their list, or at least at this point in the school year." • "...I think because they're a little bit older, they did initiate some of the coping strategies more than us prompting them to."
Teacher-researchers engaged in dialogue about the **value of one student's lived experience**.	2	• "Even that one girl is now sticking out to me so much, that now her mom knows that she might be coming home from school anxious about math, and I think that's huge even for one person, for that parent to be more aware of what their child is going through, I feel is greater than that negative feedback." • "...but even if one student uses them, it helps."

My role allowed me to **guide teacher-researchers** to modify classroom practices.	11	• "Yeah, and it's hard to break that mindset. I mean once it's ingrained, it's really a lot more difficult to break it." • "...we were talking about this coming into this research, that if the males are feeling more confident and then they're overpowering the females and kind of taking control of the math class, then that's not allowing the females to thrive." • "It could even be a good journal entry because a lot of our journal entries so far have really been focused on themselves, so it might be good to ask them about others, like, 'Have you learned more about your classmates through this experience?'"
Teacher-researchers identified **positive transformation** in their classrooms as a result of the interventions employed.	28	• "...there were students who asked if they could go get a whiteboard or a blank sheet of paper to break down the problem, and these are students who would normally just shut down or go right to raising their hand and saying, "I don't get it," without even trying." • "I feel like I have such a close connection to this class because of these interventions that we have been working through together." • "I have seen more discussion in their partner work in that way. Like in the past, they have been working together in math, but now, I see a lot more talking about their actual feelings, like this kind of discussion about what they're feeling or their struggles in the pairs." • "I didn't see that panic on the faces of a lot of them that normally do have that panicked expression." • "So for her, she is slowly building her confidence, and she just still needs that extra support, but she didn't at any point get into that full-on panic mode that she has done in the past." • "I think just the fact that we are listening to their feelings and understanding where they're coming from makes a difference." • "I have seen more perseverance with tasks and assessments." • "...I've seen a lot less helplessness..." • "I do feel that I've seen a change in the boys in terms of, I felt coming into this, they had been very positive in themselves, but like overly confident in some ways, and I feel like they have kind of turned it down a bit in the class. I think for them, hearing some of the females' perspectives and understanding their feelings in the class, especially when they're calling out that they're done or if they're saying things are easy or they're showing how they got through something quickly, I think they have calmed down a bit and really more so respected the girls going to get a whiteboard or going to get a piece of paper or asking for some assistance." • "And I feel like, for the boys, they're a bit more open to maybe giving them the space to figure it out, or even offering a hand to help them, but not in such a forceful way." • "...we feel like some of the boys who were maybe inadvertently, or not knowingly, causing the girls to have some anxiety because they are so confident in themselves, have actually become more aware of their behaviors, and actually are using coping strategies to deal with stress too." • "...I really think with all this talk about what tools we can use to help us, the entire population is now more willing to use a tool to help them and they're not as embarrassed. It has now just become part of like well this is how we do math."

The data prompted **emotional responses** among teachers and **sudden realizations and insights** relating to student self-efficacy.	5	• "...it was surprising how much they had been thinking about it because you think like Monday morning, it might not be the first thing on their minds, but it did seem to be on their minds." • "...so that was very exciting for me. You know, like I didn't even care at that point if it was right, I was just happy that they had these strategies to work through it, you know, that they felt more confident about it." • "...the other little girl said, 'Using the toolkit makes me think about how I can power through, and it shows that my teacher believes in me because she showed me this toolkit'... and I was like, 'Of course I do, [student name]!'" • "So, that's interesting. Obviously, confidence and self-efficacy really does have an effect on your ability to perform and persevere through challenges."
Teacher-researchers sought to **address the assumptions students held** about who can be successful in mathematics and evaluations of success.	1	• "I feel like it brought more awareness about how others are feeling and shows them that it's okay to feel that way."
Teachers **built upon each other's' ideas** relating to self-efficacy and interventions, introducing connecting ideas, providing possible rationale, or challenging each other's ideas.	9	• "Interesting, so she would probably want some one-on-one time with you to talk this out." • "Right, and they are only in third grade, so they need more of that support and scaffolding." • "I liked how 5th-grade talked about homework. That was something I didn't even think about. I think I focused solely on class time." • "On the toolkits, it seems that as the grades progress, the students are getting more specific with the strategies that they're going to try out to enter back into the task." • "They also seem to be more in tune in the older grades with being able to pull out the toolkit when necessary." • "Do you think their attitudes towards coming to math class have changed at all?"

Appendix U

Sub-Question C: Reflections on Cycle 3

Emerging Theme:	Frequency Count:	In Vivo Quotes / Open Coding
Teacher-researchers **implement interventions and evaluate the success** of these interventions through classroom observations and student interpretation.	36	• "We had a lot of students express that they liked the morning meetings because they like to hear what others have to say and they are able to learn strategies that might work for them too, but we also had several females say that while they like to hear others' ideas, they don't like to express their own feelings, so those students liked the journaling because they could share their own personal feelings." • "The math meetings were by far the most beneficial I think, even for those who did not express anxiety on the questionnaires. It was good for them, and for me, to see what others are thinking. One student even said it was nice to get around with people and talk. The students also found it helpful to get ideas from others to try out. They really moved the topic. They are a group that can get silly with things, but I was really impressed that they were supporting each other and building off each other's ideas and taking it seriously." • "One of our female students expressed that she likes the journaling because it allows her to look back on progress she made." • "As for the morning meetings, they liked hearing that others feel the same way as them, and they could better relate to their peers." • "One girl said that most conversations about stress you have with adults, so it was nice to have these conversations with peers because you can get strategies from people who really understand what you are going through." • "...most reported that they have been using the toolkit." • "One girl explained that she really liked having the teacher coach her through it." • "Another parent who we shared the toolkit with after her daughter was struggling at home also gave positive feedback after the toolkit was shared." • "The mathematician was not as helpful as we thought it would be." • "Most students did not use the Bedtime Math app." • "All the girls found the toolkit to be beneficial because it gave them strategies to use and get back to the problem." • "Only one of the girls liked the journaling. The writing aspect was challenging for them." • "They still need coaching to use their toolkit at times, but for the most part there is less of that initial shutting down."

Teachers **reflected on their own instructional practices** in relation to the sources of self-efficacy to critically analyze how they intentionally or unintentionally impact student self-efficacy.	12	• "...we would also want to make them more aware of the tools they can use, like the math manipulatives. They are always available, but we need to bring their attention to it more." • "...it's good for me to hear their thoughts. We don't spend enough time talking about their feelings." • "We could do more direct instruction of the coping strategies at the beginning of the year (i.e. leading them through brave breaths)." • "I have also changed, too, by helping the students working independently to know the next step they could take if they finish a task early, instead of checking in with me about what to do next." • "...more recently, I am trying to call on females more and I am changing names in word problems to use more female names. I think I have become more aware." • "Like we are telling them, 'Don't be stressed. It's okay. Keep trying,' but sometimes they do struggle, and they need ways to overcome that beyond just not giving up."
Due to the **emergent** nature of critical inquiry, teacher-researchers are able to **adjust the selected interventions** based on their analyses of the impact of employed interventions.	11	• "Something we could do in the future is to think of it more like a working document throughout the year, and we could keep adding to it as the students find signs that apply to them or strategies that work for them." • "...we need to teach them the language piece as part of the ICA Toolkit, like teaching them to ask for help, sentence frames that are more specific to help them to ask for help, rather than just saying, 'I don't get it.'" • "...we would use the ICA toolkit and make sure it is in a prominent spot from the start of the year." • "I like the idea of the journal, but I would introduce it and then let them use it how they want." • "I would start the toolkit earlier as well and integrate it into the math meetings. It's basically taking what we talked about and putting it up there. Starting it at the start of the year, it becomes more routine for them. They have the expectation at the start of the year that this is what the year is going to entail and it becomes a part of the classroom that they're used to." • "I also like the idea of having a piece of the rollout being in small groups, but I also think it is good for all the students to create it." • "We do plan to come up with a way for students to be able to get journals whenever they want and a place to put them if they want them read by the teachers." • "I would like to do the journaling again, but maybe do it smaller or more concrete in the beginning. It was probably hard for them to think so abstractly."
Teacher-researchers **empowered marginalized female students** by bringing their **voices, lived experiences,** and **interpretations** to the forefront.	7	• "I had students speak out in conversations that I thought would be more quiet, and that surprised me. Students sharing feelings who normally wouldn't have, opened up others to do the same." • "The females, specifically, shared out how it makes them feel rushed and that they are lagging behind." • "Through this process, students have taken risks to share their experiences, both positive and negative." • "We also think that the interventions have empowered a lot of the girls, specifically, to have a stronger voice in the classroom."

Teacher-researchers planned to **create safe spaces** for students that would allow students to **critically reflect** on their experiences in order to **overcome** the **barriers** females face in developing positive math self-efficacy.	3	• "They also like being able to express things that are personal that they might not want to express in a morning meeting" • "One student said it feels better to write it down instead of talking to someone because when she is talking to someone, she doesn't always tell the truth." • "Students showed that they respected each other's thoughts and feelings by listening while others shared on the carpet during our morning meetings."
Teacher-researchers **inquired** about findings in the student responses and posed **critical questions**.	1	• "I am also interested to see how the toolkit would work if we started the year launching it."
Teacher-researchers identified **positive transformation** in their classrooms as a result of the interventions employed.	23	• "The students' abilities to cope have increased overall; it's not fully there, and definitely still needs coaching when they reach that point of being totally stressed out or anxious, but they are more aware, like thinking, "I am feeling this way, and now I need to cope," rather than just shutting down or giving up." • "...When they see something they don't know, they are still sometimes having the self-doubt and saying 'I don't get it,' but it has decreased, and they are better able to work through it." • "There have also been less meltdowns. There used to be so many meltdowns, but I see fewer meltdowns now. Their awareness of being able to express their feelings is heightened, and they are working more slowly and realizing that it is okay to take your time and that if you don't finish, that is okay." • "Yes, they are actually taking action now. At least now, the ones who have the toolkit, are actually doing something about it now rather than just sitting there and letting the stress or anxiety overpower them." • "A lot of students felt they were less nervous or anxious before or during the assessment in comparison to previous assessments. Usually, the hands shoot up immediately, but I received fewer immediate questions during the test." • "In the beginning she was only talking about stress and anxiety, and as she continued, her entries focused more on coping strategies." • "Students expressed that the 'I'm done' conversation helped because people weren't calling this out anymore." • "She said she didn't like math before but it is growing on her now." • "The conversations about announcing when you are done has been a big eye-opener for the kids who were doing that." • "One student has been expressing herself by saying, "I'm frustrated," which is huge for her to identify that." • "Visually, the girls are less stressed and anxious. There is less crying, putting heads down, or avoiding looking at the problem. They are much more often taking action, like getting a whiteboard or drawing it out." • "With the continued coaching, they are starting to move through the process more naturally. In the beginning, it was more of a struggle even to get them to identify how they were feeling." • "There is also less calling out that they're done or rushing to get

		through the problems. They are slowing down more and they are clearly putting more thought into reading the directions and thinking about the problem." • "They are now the least helpless and used to be the most helpless.
Teacher-researchers sought to **address the assumptions students held** about who can be successful in mathematics and evaluations of success.	7	• "...they are more aware that they are not the only people feeling stress and anxiety when it comes to math." • "The mathematician also showed that even if it did not land with all of them, they could all be successful if they just keep working at it, and just being female, she challenges that gender stereotype as well." • "We think that students are starting to feel as though there isn't such a thing as a 'math person.'" • "...it was such a revelation for them to hear others say that they feel stressed too. Before this, they felt like they were the only ones having those feelings. So, it was good for them to see they're not the only ones."
Teacher-researchers highlighted the **diverse experiences** of students in their classrooms.	3	• "...there has been more awareness that everyone struggles at some point and everyone does math differently no matter what skill they are on." • "They recognize that some kids need extra support, and no one says anything about it. They definitely recognize that we see things in different ways. The morning meeting discussions have definitely illuminated this." • "...students were shown that people experience stress and anxiety differently and that people may use different strategies to help them solve a problem."
Teacher-researchers identified the need to build a **community** in which **students help each other** to strengthen their math self-efficacy.	9	• "It opened their eyes to seeing that some of the things they do actually causes stress for other classmates. They are more aware that their actions are having an effect on everyone in the room." • "You need to help each other. Some of the conversations touched on that, like asking for helping and working together to help each other complete tasks." • "It seems as though the students accept that other students are feeling stressed and anxious about math, which has in turn promoted respect for one another." • "This helped students see that we are all humans and that we all sometimes struggle with something."

Appendix V

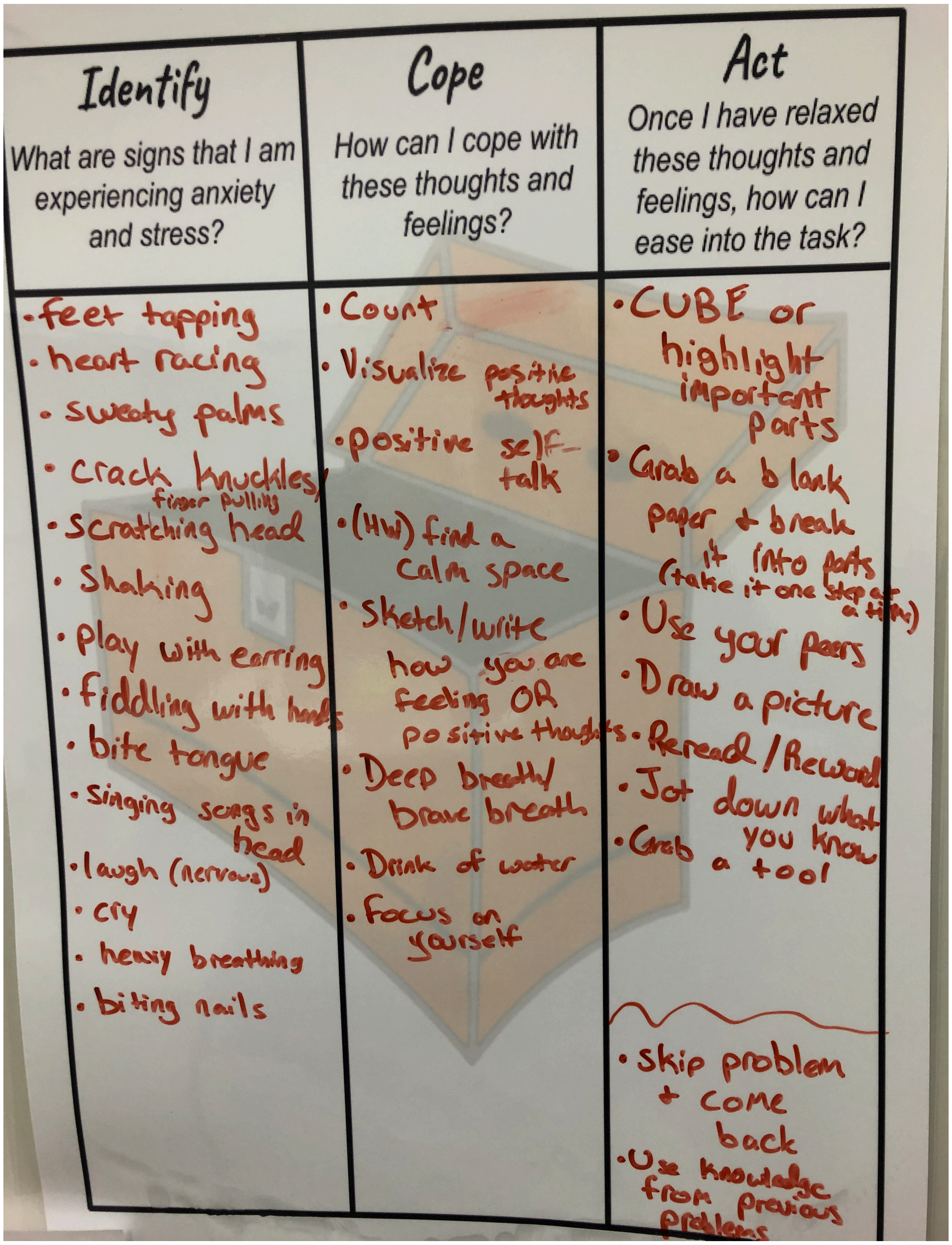
Intervention Resource: ICA Toolkit Poster

ICA Toolkit

Identify	Cope	Act
What are signs that I am experiencing anxiety and stress?	*How can I cope with these thoughts and feelings?*	*Once I have relaxed these thoughts and feelings, how can I ease into the task?*

Appendix W

Example of Completed ICA Toolkit Poster



Note. The example ICA Toolkit was completed by the students of Davis/Turner

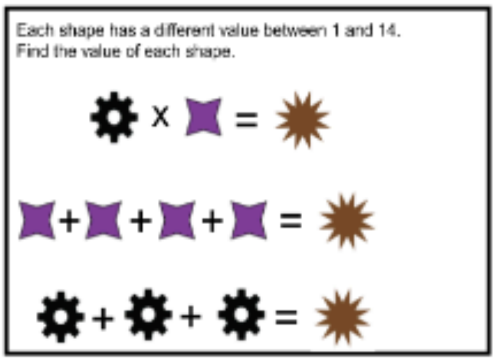
Appendix X

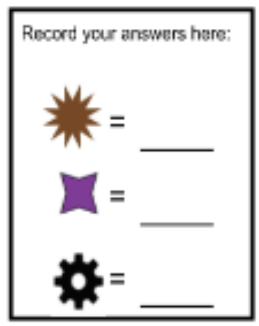
Post-Intervention Questionnaire

Number ______ Grade ______ Teacher ____________ Gender: Female / Male

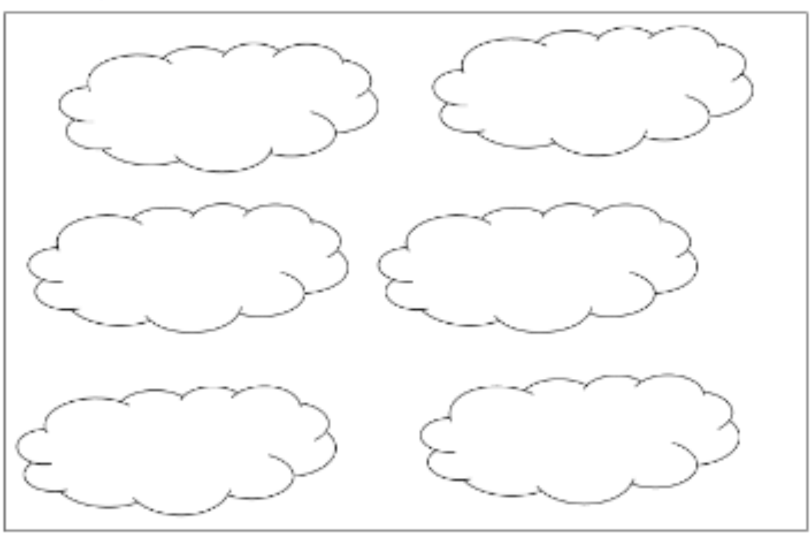
Student Questionnaire

1) Try the math problem below. After seven minutes, you will be asked to continue on through the questionnaire, but it is okay if you did not finish the problem.





2) In the thought bubbles below, write down the thoughts that were going through your mind when you were working on the math problem above. You do not have to use all of the bubbles. You can also create more bubbles if you need them.



3) Draw a picture that shows how you felt when you were working on the math problem on the previous page (you may use stick figures if you would like). Describe the picture below.

4) Think about the thoughts and feelings you just described. Have you been experiencing similar thoughts or feelings in your math class? Explain why you have or have not been experiencing these thoughts or feelings.

5) Over the past few weeks, our class has been working on the strategies listed below in order to help us feel more comfortable in math and to help us overcome any negative thoughts or feelings that we might experience in math.

Strategies we have been working on:

- Morning meetings to talk about our math experiences
- Journaling to write about our math experiences
- ICA Toolkit
- Meeting with a mathematician to learn about her experiences
- Some students also tried strategies at home, like using the BedTime Math app.

Think about the strategies listed above. Have any of these strategies helped you to feel more comfortable in math class or overcome negative thoughts and feelings when you experience them in math?

If so, describe **which strategies** helped you to feel more comfortable or overcome negative thoughts and feelings in math **and why**.

If not, **explain why** these strategies did not help you.

6) **First**, read the description of each job listed below. **Then**, look at the photos of different people. Each photo is labeled with a letter. Write the letter of the photo next to the job that you think the person in the photo has.

Engineer: ________ **Engineer:** Someone who invents, designs, or builds machines, engines, or other works of technology	Author: ________ **Author:** Someone who writes novels, poems, essays, or other types of text
Secretary: ________ **Secretary:** Someone who helps another person with scheduling appointments, making phone calls, and taking notes	Computer Programmer: ________ **Computer Programmer:** Someone who uses coding to create computer software, or the programs that a computer runs on
Mathematician: ________ **Mathematician:** Someone who uses math to solve real-world problems	Architect: ________ **Architect:** Someone who designs buildings
Book Editor: ________ **Book Editor:** Someone who reads a written text and decides if it should be published or someone who proofreads and edits an author's work	Librarian: ________ **Librarian:** Someone who works in a library and helps visitors find information and texts

A	B	C	D
			
E	**F**	**G**	**H**
			

7) Look at how you matched the photos of the people to their professions. Why did you match each person in the way that you did?

Person A - ____

____

Person B - ____

____

Person C - ____

____

Person D - ____

____

Person E - ____

____

Person F - ____

____

Person G - ____

____

Person H - ____

____

8) Is there anything else you would like to share about your math experiences?

____

____

____

____

____

____

____

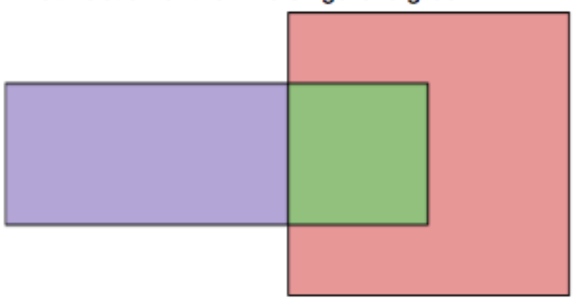
____

Appendix Y

Teacher Mini-Questionnaire

#1

The green square is created by overlapping ⅓ of the purple rectangle with ¼ of the red square. What fraction of the whole figure is green?



#2

You have 24 quarters, one of which is defective and weighs more than the others. You also have a balance scale that will tell you which of two stacks of coins is heavier. It will not provide you with information about their actual weight. What is the fewest number of times you can use the balance to identify the heavy coin?

3) What thoughts and feeling were going through your mind while working on the math problems above? (you may use bullet points in your response)

4) Have you ever had an experience in which your views of your math capabilities have negatively impacted you?