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MIDDLE SCHOOL MATH ACHIEVEMENT:
A GROUNDED STUDY OF SELF-EFFICACY DOMAINS

by

Heidi Galassi

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ABSTRACT

Doors to other educational opportunities and future professions are closed when students have a low motivational profile in mathematics starting in elementary school and continue with an unchanged profile into high school (Lazarides et al., 2020). Students must learn how to increase their mathematical self-efficacy in order to increase their opportunities for the future. Increasing self-efficacy promotes other student agency skills that will generate increased engagement and ultimately academic achievement (Fisher et al., 2021). By prioritizing the enhancement of mathematical self-efficacy among students, we can concurrently foster greater levels of motivation and engagement in the subject.

Although self-efficacy is known to be the primary predictor of math achievement, the aspects of building self-efficacy that work best for middle school students is still unknown. This study seeks to address that gap. Through a thorough review of the literature and analysis of existing research, this grounded research study contributes to our understanding of the importance of self-efficacy in education and provides practical implications for improving student outcomes, specifically in the content area of mathematics, utilizing specific strategies in the classroom setting related to Bandura's four domains of self-efficacy.

The research conducted included three phases: The first phase included secondary data from 587 middle school students from a school in Northern California who completed a Self-Efficacy Questionnaire for Children (SEQ-C). Phase 2 included a week-long in-situ problem solving experience with 34 students from four different groups using data from the SEQ-C: (a) students who self-reported low self-efficacy and attend a grade level math class, (b) students who self-reported high self-efficacy and attend a grade level math class, (c) students who self-reported high self-efficacy and attend an enriched level math class, and (d) students who

reported low self-efficacy and attend an enriched level math class. Transcripts derived from student reflections conducted during Phase 2 of the study were analyzed. Subsequently, a select cohort of 11 students, distinguished by their capacity to articulate their chosen self-efficacy domain and its perceived efficacy, were engaged in comprehensive in-depth interviews. These interviews were designed to facilitate an extensive exploration into the underlying rationales that substantiated their chosen self-efficacy domain and its effectiveness.

Findings from the three phases of the research show that self-efficacy is multifaceted and is not limited to a dominant galvanizer and, in fact, individual students were able to verbalize their preferred self-efficacy domain galvanizer and its effectiveness.

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ACKNOWLEDGEMENTS

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CHAPTER 1: INTRODUCTION

Self-efficacy is a crucial factor in the field of education that refers to an individual's belief in their ability to successfully perform a task or achieve a desired outcome. The concept of self-efficacy has been a topic of interest with researchers investigating its role in various aspects of life, including educational achievement (Bandura, 1997; Hiller et al., 2021; Olivier et al., 2019; Usher, Li, et al., 2019). The notion of self-efficacy was first introduced by psychologist Albert Bandura as part of his social cognitive theory, which emphasizes the role of cognitive, behavioral, and environmental factors in human functioning (Bandura, 1977). Additionally, Bandura (1977) parses out the self-efficacy of an individual into four domains: performance outcomes, vicarious experiences, verbal persuasion, and physiological feedback. These domains will be further explicated in Chapter 2.

Background of the Study

Since the introduction of the concept, self-efficacy has been extensively studied in the field of education, with researchers examining its impact on academic achievement, motivation, and perseverance (Birgin et al., 2017; Hackett & Betz, 1989; Pajares & Miller, 1994; Sharma & Nasa, 2014; Usher, Li, et al., 2019). It has been found that people with high levels of self-efficacy are more likely to set challenging goals for themselves, exert greater effort in pursuing those goals, and recover more quickly from setbacks than those with low self-efficacy. Moreover, self-efficacy has been found to be particularly important in elementary, middle, and high school settings, where students are developing their foundational skills and attitudes towards learning (Fisher et al., 2021).

The COVID-19 pandemic has further highlighted the significance of self-efficacy in education, particularly in the context of remote and hybrid learning environments (Heo et al., 2021). During the time of online learning, students with higher levels of self-efficacy were better equipped to adapt to changes in their learning environments and were more likely to engage in self-directed learning (Saefudin et al., 2021). Overall, data has suggested that the pandemic has had a disproportionately negative impact on students who already faced academic and social-emotional challenges (Fisher et al., 2021). Addressing these challenges is important as schools work to support students in the aftermath of the pandemic.

In the comprehensive work of Fisher et al. (2021), seven student agency factors were highlighted and brought to the forefront of teaching and learning. Instead of focusing on learning loss as a deficit, educators have shifted the focus to using student agency factors before, during, and post learning in any content area with all ages of students. Self-efficacy is included as one of the seven agency factors and has been deemed as a crucial part of the discussion around students rebounding post-pandemic.

Moreover, specific types of self-efficacy, such as academic self-efficacy, are deemed to be more predictive of classroom success and academic achievement than general self-efficacy, and the same can be said for content-area-specific and task-specific self-efficacy (Feldman & Kubota, 2015; Liu et al., 2020). For example, mathematical self-efficacy was found to play a vital role in connecting deeper mathematical thinking and mathematics achievement (Li et al., 2020). This becomes exasperated because mathematics is the content area most closely related to negative attitudes and anxiety among students.

Several factors set the groundwork for mathematical achievement, including self-efficacy, motivation and engagement in math lessons, perceived usefulness of math, and gender and the manifestation of math anxiety (Lau et al., 2022; Mazana et al., 2018; Rodriguez et al., 2020). These factors will be further explicated in Chapter 2. Although several factors exist and are connected to mathematical achievement, studies have shown that mathematical self-efficacy is the greatest predictor of mathematics achievement (Ozkal, 2019; Ugwuanyi et al., 2020). Correspondingly, students with greater mathematical self-efficacy beliefs had greater mathematical achievement (El-Adl & Alkharusi, 2020; Yıldız et al., 2019).

Given the growing body of research on the importance of self-efficacy in education, it is crucial for educators to consider ways to foster self-efficacy beliefs in their students. But there is a gap in knowledge regarding the most effective galvanizer of mathematical self-efficacy. This dissertation aims to explore the role of self-efficacy, specifically in mathematics, in educational achievement and to provide evidence-based recommendations for educators on how to promote self-efficacy beliefs in elementary, middle, and high school settings.

Through a thorough review of the literature and analysis of existing research, this dissertation contributes to our understanding of the importance of self-efficacy in education and provides practical implications for improving student outcomes, specifically in the content area of mathematics due to research connecting mathematics achievement with future opportunities and career choices (Domina et al., 2019, p. 295).

Statement of the Problem

The importance of building mathematical self-efficacy in our students is crucial not only for current achievement in math but also for future opportunities and career choices. For example, "Students in high-track classes enjoy a wide range of educational advantages relative to their peers in low-track classes, including access to high-achieving peers, high educator expectations, and rigorous instruction (Domina et al., 2019, p. 295). Therefore, students who are placed in grade-level math classes face significantly greater challenges to success in mathematics than their advanced-level schoolmates. This has negative reverberations later as it creates limited career choices for students who did not have access to enriched mathematical courses.

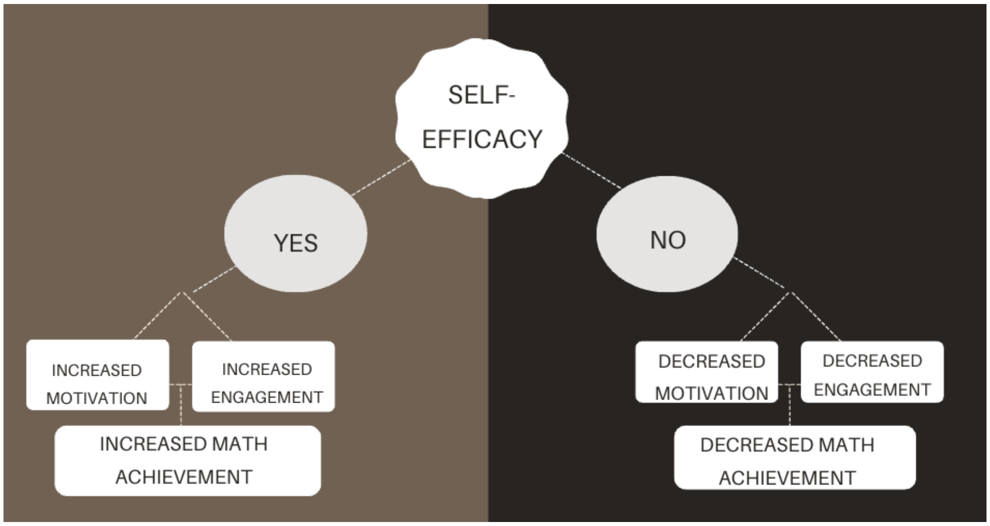
It is widely known that mathematical achievement acts as a gatekeeper to secondary education classes, university acceptances, and career placement (Kokka, 2023; Leyva et al., 2022; C. Wang et al., 2022). For example, whether or not middle school students complete an Algebra I course before attending high school determines their eligibility for enrolling in a Computer Science class (Torbey et al., 2020). Additionally, doors to other educational opportunities and future professions are closed when students have a low motivational profile in mathematics starting in elementary school and continue with an unchanged profile into high school (Lazarides et al., 2020).

Increasing self-efficacy promotes other student agency skills that will generate increased engagement and ultimately academic achievement (Fisher et al., 2021). If we focus on increasing mathematical self-efficacy in our students, it will also increase motivation and engagement. Although we know self-efficacy is the primary predictor of math achievement, we do not know what aspects of building self-efficacy work best. Addressing this gap is the focus of this study.

As shown in Figure 1.1, self-efficacy promotes other soft skills needed to increase math achievement such as perseverance, motivation, and grit (Street et al., 2022). "Domain-specific self-efficacy in mathematics is important because it predicts students' adaptive learning behaviors such as engagement, effort, enjoyment with mathematics through study and career choices" (Street et al., 2022).

Figure 1.1

How Self-Efficacy Impacts Motivation, Engagement, and Achievement in Mathematics



On the contrary, there are some factors that negatively affect mathematical self-efficacy. For example, some school districts use ability tracking (the practice of sorting students into distinct courses according to their ability level) in regards to math courses offered. Data shows that math tracking in the educational setting creates a gated system for low-achieving students in math and further decreases the self-efficacy of low-achieving students (Francis et al., 2020). The negative effects of this type of ability grouping seep into student agency year after year and steadily erodes self-efficacy (Fisher et al., 2021). Since self-efficacy is deeply rooted in math achievement, students must first acknowledge and build self-efficacy in math before they can acquire the mathematical skills needed for success (Birgin et al., 2017; Fomina & Morosanova, 2017; Ozkal, 2019; Pajares & Miller, 1994).

Recently, some progress has been made to increase the self-efficacy of low-achieving students by de-tracking mathematics courses to provide a more equitable education for all and increase the self-efficacy of low-achieving students. The National Council of Teachers in

Mathematics has written a book outlining the steps needed to initiate critical conversations on policies, practices, and issues that impact mathematics education (Bush, 2021.

In addition, a new mathematics framework calling for more equitable education is being worked on by educational advocates, including Brian Lindaman and Jo Boaler. Brian Lindaman is quoted as saying, “We really see equity as the future for better math learning for all students in California” (Fensterwald, 2022). The framework provides for reduced ability tracking while emphasizing more equitable current and future opportunities for all students. Despite significant backlash among the Gifted and Talented Educational (GATE) community, planning for implementation of the new framework continues to move forward (Fortin, 2021).

To establish a more equitable educational environment for all students, it is crucial to incorporate factors within our control that are known to effectively cultivate self-efficacy. Therefore, research endeavors centered around enhancing mathematical self-efficacy can have a substantial impact on elevating students' mathematical achievement, thereby creating broader avenues of opportunity for all individuals involved.

Theoretical Framework

A grounded theory approach to research “is a qualitative research design in which the inquirer generates a general explanation (a theory) of a process, an action, or an interaction shaped by the views of a large number of participants” (Creswell & Poth, 2018, p. 82). Additionally, a key factor of grounded theory research is that the theory is generated or “grounded” in data from participants who have experienced the process (Strauss & Corbin, 1998). This grounded theory study sought to develop a theory based on middle school students’ preference for a dominant self-efficacy galvanizer domain of Bandura’s (1977) four self-efficacy domains. To this end, the researcher chose a grounded theory approach due to the lack of knowledge regarding dominant self-efficacy galvanizers in the educational setting.

Bandura (1997, 1985), who is known as the originator of the theoretical construct of the social cognitive theory which evolved from the idea of social learning theory (SLT), explained three influences that make up his findings, which include behavioral, personal, environmental, and the interaction between them. The concept of self-efficacy developed through Bandura's belief that one's choice making, effort put forth, and perseverance displayed when encountering difficulties can be measured according to specific activities being carried out. For example, "Students who are confident in their academic capabilities monitor their work time more effectively, are more efficient problem solvers, and show more persistence than do equally able peers with low self-efficacy" (Usher & Parajes, 2008, p. 752).

Therefore, if a math student has a lower level of mathematical self-efficacy, then that student is less likely to put forth effort and/or persevere when he or she encounters a difficulty with problem solving. Furthermore, Olivier et al. (2019), who use three theoretical frameworks including self-efficacy theory, found student self-efficacy to be "the turning point between math achievement and emotional engagement," which improves students' feelings of competency and enjoyment for the subject (p. 337). This statement shifts the definition of a positive schooling experience to include emotional engagement in addition to academic knowledge.

Bandura (1977) conducted a plethora of studies and produced numerous theories around self-efficacy, but the social cognitive theory will be the central focus behind the research process. His findings illuminate four domains which create and increase self-efficacy. These include performance outcomes, vicarious experiences, verbal persuasion, and physiological feedback. These domains will be defined and explored in greater detail within the literature review in Chapter 2.

Purpose of the Study

Given the correlation between self-efficacy and math achievement, it is essential to find effective strategies for increasing mathematical self-efficacy in students who attend grade-level math classes. Data shows that detracking ability-based math classes increases self-efficacy, but, in the meantime, increasing the mathematical self-efficacy in our students is the goal. This poses two central questions:

1. In general, what is the most effective way by which math self-efficacy can be increased in middle school students?
2. Specifically, how can we identify which of the four domains of self-efficacy most effectively increases the math self-efficacy for each individual student?

Beyond improving the self-efficacy of low-achieving math students and increasing their representation in enriched-level mathematics courses, if strategies bolstering math self-efficacy are found to be more effective in one domain over another for a particular student, that student can employ the same strategies across different subjects and settings. Furthermore, successfully answering these two central questions could facilitate the development and deployment of a self-efficacy screener across all math students. The screener could inform specific strategies to be implemented in math class for each student according to their predominant self-efficacy domain. These strategies can be used to increase math self-efficacy before and during instruction and can be refreshed from year to year.

This grounded theory study aims to investigate the relationship between self-efficacy domains and student motivation in the mathematics classroom. The findings contribute to educators' understanding of effective self-efficacy strategies that promote intrinsic motivation and enhance students' mathematical abilities. At the time of the study, the approximately 900 students who participated were attending a middle school in Northern California, where students are placed in math classes and separated into ability-based pathways within a multi-tiered system. In this study, “self-efficacy in mathematics” is generally defined as an individual's belief in their own mathematical problem-solving capabilities.

Additionally, the researcher explores the relative effectiveness of the four self-efficacy domains for each of the students in the study. In turn, the researcher seeks to determine if specific strategies centered on each student’s dominant domain can be implemented to improve their math self-efficacy and academic achievement for the purpose of increasing representation in enriched math pathways in a multi-tiered system.

Throughout the course of the research study, necessary questions were considered, such as,

- How do middle school students talk about their learning experiences in grade-level tracked math classes?
- How does math self-efficacy affect motivation in middle school math students?
- How often do middle school students in grade-level math classes feel they are successfully completing specific tasks?
- To what extent and how do middle school students persevere when confronted with challenges in math class?
- Which of the four domains of self-efficacy most galvanizes mathematics self-efficacy in middle school math students?

Research Questions

The following research questions were designed and addressed in this grounded study to determine the impact of self-efficacy on mathematical achievement:

1. Can impromptu, brief interventions conducted immediately prior to or during a math problem-solving session, crafted to enhance the four domains delineated by Bandura, exert a beneficial influence on the levels of mathematical self-efficacy *discernible amongst middle school students*?
2. How do the four domains of self-efficacy influence the mathematical self-efficacy of middle school students in grade-level, ability-based math pathway classes?

Hypothesis

The hypothesis proposed for the purpose of this study is that there is a personal dominant self-efficacy galvanizer for middle school math students that can be harnessed to increase math self-efficacy, capability, class placement, and achievement.

Limitations

This study has the following limitations:

- The researcher was limited to engaging participants for the study from one public institution within a single school district. Therefore, the demographic composition Public School A may not be representative of all middle schools across the United States.
- The researcher did not find studies that specifically identified a dominant domain of self-efficacy among middle school math students either on a group level or within individual students.
- There may be other factors that were not considered when determining if a dominant self-efficacy galvanizer exists. For example, the researcher did not parse out teacher self-efficacy in the current study.
- The sample of participants was not drawn from every state, so results may not generalize to national or international populations.

Delimitations

The delimitations of this study were set based on the researcher's desire to find the dominant self-efficacy galvanizer for middle school students attending ability-based math classes. The researcher is looking to identify how Bandura's four domains of self-efficacy can be used as the basis for developing effective tools for middle school math teachers seeking to improve math self-efficacy among their students. The ultimate goal is to deploy math self-efficacy tools in middle school math classes across the United States and, in doing so, increase the representation of minority students who are underrepresented in enriched math classes. The delimitations for this study are as follows:

- The researcher only interviewed students who attended Public School A who agreed to participate in the study.
- The researcher did not examine other content areas besides mathematics.
- The population of interest included students who reported low self-efficacy in mathematics.
- The researcher focused on academic self-efficacy experiences in math classes only.

Assumptions

The researcher assumes all screening questionnaires used to evaluate and select survey participants were completed truthfully and with full intent to provide the best information to their knowledge. Furthermore, the researcher assumes that all students who then participated in the interview process also provided the most complete and honest information.

Summary

This grounded theory research study is presented in five chapters. Chapter 1 introduced the challenges of tracking mathematics courses into ability-based courses and described the related negative impacts on self-efficacy. It also discussed the underrepresentation of minority students in enriched middle school math courses. The purpose of this study is to identify if middle school students, on a group or individual level, have a dominant self-efficacy galvanizer within Bandura's four domains of self-efficacy for building mathematical self-efficacy most effectively. Research questions and hypothesis were presented, as well as the limitations, delimitations and assumptions for the study.

Chapter 2 is a thorough examination of the four self-efficacy domains presented by Bandura. Chapter 3 details the methods and measurements used to collect quantitative and qualitative data, including the use of surveys and interviews. Chapter 4 presents the analysis of the findings and results of the quantitative and qualitative studies. Chapter 5 discusses the research findings, implications of the results, recommendations for further research, and conclusions.

CHAPTER 2: REVIEW OF LITERATURE

This chapter presents background and justification for this research study and aims to establish a relationship between Bandura's self-efficacy model's four domains and mathematics achievement in the classroom. The primary objective is to enhance students' learning experiences by identifying particular self-efficacy galvanizers by domain that can effectively enhance mathematical self-efficacy within a group of middle school students or at the individual level. The research suggests that these identified galvanizers hold potential to significantly augment students' mathematical self-efficacy.

Although research regarding links between self-efficacy and mathematics achievement are well studied, research on the topic of effective galvanizers of Bandura’s four domains is limited (Bandura, 1997; Hacket & Betz, 1989; Hiller et al., 2021a; Ozkal, 2019; Recber et al., 2018; Usher & Pajares, 2009; Ugwuanyi et al., 2020; Wang et al., 2022; Zimmerman, 2000). One study involving adults with varying self-efficacy levels using an online statistics lesson reported no dominant self-efficacy galvanizer but rather highlighted the importance of using all four domains of self-efficacy when building self-efficacy in individuals (Huang et al., 2020; Huang & Mayer, 2019).

Several attempts have been made to best measure sources of self-efficacy through student self-reporting or through questionnaires and surveys developed to access data points for each domain (Lent et al., 1996; Matsui et al., 1990; Suldo & Shaffer, 2007). The most popular survey has been the Sources of Mathematics Self-Efficacy Scale (SMES), developed by Lent, Lopez, and Bieschke in 1991, where college students were the focus for participant data (Anderson & Betz, 2001; Britner & Pajares, 2006). Several adaptations of the SMES have been created to include more diverse populations. These cross-sectional studies have provided data at specific points in time, but they have not included specific interventions with pre- and post-intervention data collected.

For example, some researchers asked students to self-report grades or actual assessment scores as a data point for Bandura's "mastery experience" domain, but other researchers have pointed out that "such assessments do not reflect the mastery experiences described by Bandura (1997) as students' *interpretations* of experienced events rather than as their objective performance" (Usher & Pajares, 2009, p. 90).

Usher and Pajares (2009) developed and validated items of a survey used to assess the four domains of Bandura's self-efficacy specifically for middle school students in the arena of mathematics. Survey questions were ordered in four different quadrants, one for each of the four domains of self-efficacy. Each portion of the survey included positively worded questions geared toward assessing the four theorized sources of self-efficacy and the relationships among them. The survey results from the regression analyses supported Bandura's (1997) theory that the domain of mastery experience is the most powerful source of self-efficacy but did not account for which domain was the dominant galvanizer for each participant (Usher & Pajares, 2009). Furthermore, Usher and Pajares (2009) cautioned that other factors may also have been at play, such as gender and ethnicity, when assessing the relationship between Bandura's (1997) four sources and self-efficacy (Klassen, 2004). Therefore, conclusions should not be made without considering participant demographics and the specifics of the research setting.

On the other hand, there is extensive research focused on Bandura's four domains of self-efficacy and how they have been utilized in the classroom to enhance learning. The following review of literature focuses on the vital role self-efficacy plays in fostering academic achievement and, more specifically, the potential for increasing self-efficacy among middle school math students as a means of improving their math capabilities (Bandura, 1997; Fomina & Morosanova, 2017; Lazarides et al., 2020; Li et al., 2020; Liu et al., 2020; Usher & Pajares, 2009; Zimmerman, 2000). Additional topics included in this review include self-efficacy theory and important findings related to self-efficacy's effects on achievement.

Bandura's Theory of Self-Efficacy

According to Bandura (1977), there are four domains that shape an individual's self-efficacy and judgments regarding one's own ability accomplish a task. These include performance outcomes, vicarious experiences, verbal persuasion, and physiological feedback.

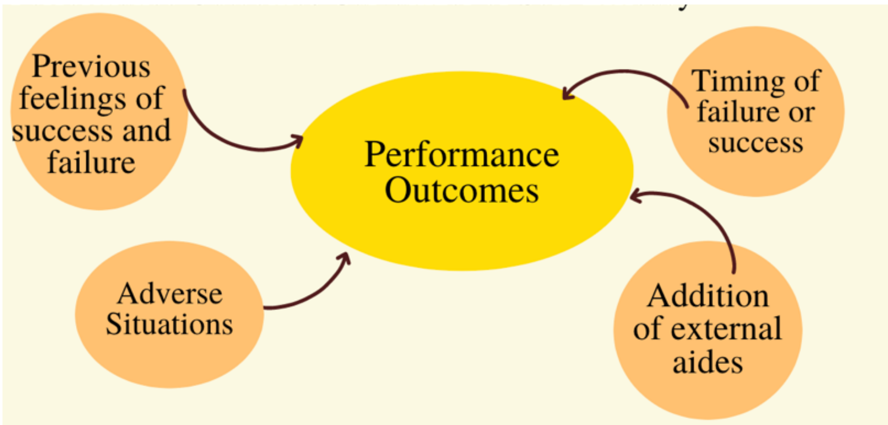
In order to discover if one domain is more effective than another in building self-efficacy, this study investigates the power of each self-efficacy domain and gauges the effectiveness of each domain for each participant in the study. The following sections provide an overview of the different domains, which are frequently referred to throughout the methodological portion of this study.

Performance Outcomes

Performance outcomes (also referred to as "mastery experience") refers to an individual's own direct experience (success or failure) with the task at hand (Bandura, 1997). As shown in Figure 2.1, there are several factors that impact performance outcomes which, in turn, affect self-efficacy. Bandura (1997) theorized that performance outcomes is the most powerful source of self-efficacy. In most instances, previous successes increase self-efficacy, while previous failures decrease self-efficacy and further undermine the very process of building it (Usher & Pajares, 2009). For example, when a student has experienced repeated success in solving a mathematical problem, the student retains a positive feeling before the start of a similar problem and invariably will want to begin solving it. In contrast, if failure is the prominent outcome a student has experienced when solving mathematical problems, a negative feeling will be retained before the task begins and will therefore decrease self-efficacy and dampen motivation.

Figure 2.1

Performance Outcomes Galvanizer of Self-Efficacy



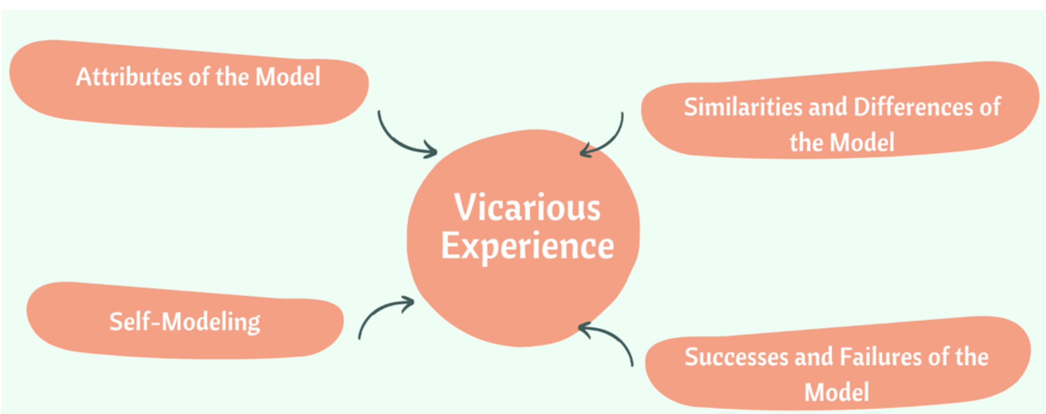
The stability of self-efficacy is ever changing until solidified through multiple experiences in diverse situations over a period of time. This is important to note when trying to build students' self-efficacy through performance outcomes or past experiences because it is how people evaluate their performance, rather than the performance per se, that strengthens or weakens self-efficacy beliefs (Usher, Ford, et al., 2019). Bandura (1997) stated, "performance alone does not provide sufficient information to judge one's level of capability, because many factors that have little to do with ability can affect performance" (p. 81). This is to say that preexisting beliefs of one's own self-efficacy can act as an unconscious or conscious bias before a specific task is ever undertaken and can greatly influence performance—negatively or positively—with no over-arching, real evidence (Usher & Pajares, 2009).

Vicarious Experiences

Vicarious experiences follow the same fundamental logic as performance outcomes; however, the concept centers not on personal experiences but rather, as the name implies, it centers on students observing other individuals performing tasks and making judgements regarding their own abilities depending on the observed performer's successes or failures (Bandura, 1997). It is arduous to form a self-judgment regarding the difficulty of a particular task when the single data point is through observing the individual performing the specific task and sensing or empathizing with them. Because of this, when seeking to assess one's own capabilities based on the observed success or failures of other performers, it is important to make such observations from different perspectives, as shown in Figure 2.2.

Figure 2.2

Vicarious Experiences Galvanizer of Self-Efficacy



It has been generally accepted that students' self-efficacy increases when they watch other students or adults successfully perform a task and decreases if those they are observing are not able to complete the task (Bandura, 1997). But it is more complicated than simply watching others attempt tasks. The students attempting the tasks have great influence on the self-appraisal of performance similarity and, by extension, self-efficacy. According to Bandura (1997), "The instructive contribution of modeling is especially important when perceived inefficacy reflects skill deficits rather than misappraisals of the skills already possessed" (p. 88). In other words, if the student performing the activity mirrors the same characteristics, competence, or skill base as the student observing them, it may increase self-efficacy in the observer. On the other hand, if the performer has or is perceived to have a skill base significantly greater than that of the observer, it may decrease self-efficacy in the observer.

In general, the power of modeling to increase self-efficacy becomes more effective as the attribute similarity between the performer and observer becomes stronger (Rosenthal & Bandura, 1978). The attributes can include age, gender, race, socioeconomic level, or ethnic background (Usher & Pajares, 2009). For example, as a middle school, Latino, male student observes another middle school, Latino, male student solve a mathematical problem successfully, the observer's feeling of perceived self-efficacy increases which, in turn, increases his motivation to start the mathematical problem solving and persevere in completing the task.

If the person assessing their self-efficacy uses self-modeling, the situation becomes even more complicated. Self-modeling is another way to improve self-efficacy (Bandura, 1997). A study conducted by Gonzales and Dowrick (1982), had participants view edited videos of themselves performing a particular skill where only positive results were shown, and failures or struggles were spliced out to create an illusion of skillfulness. When participants viewed the videos, their self-efficacy increased because of *perceived* skillfulness as effectively as *actual* skillfulness. This reiterates the importance of perceived self-efficacy as the precursor to motivation and thus achievement of a skill.

Verbal Persuasion

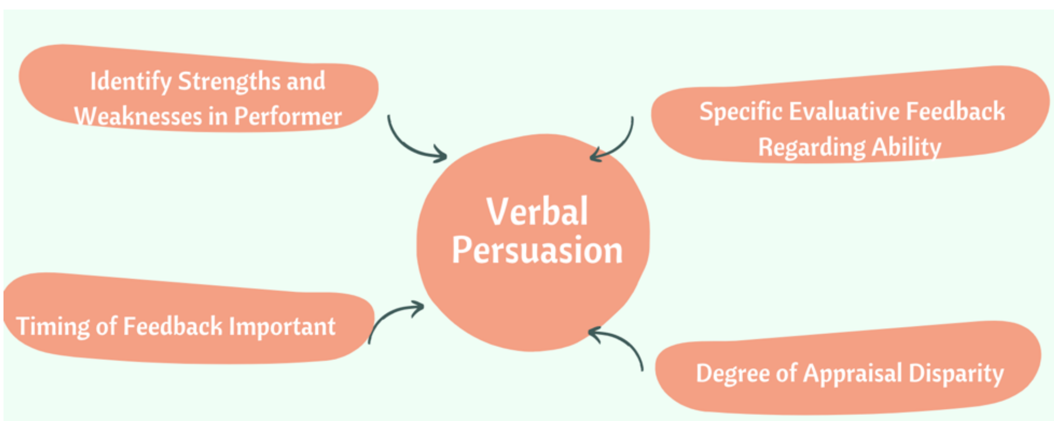
Verbal persuasion (encouragement or discouragement) is described as coaching or evaluative feedback provided to the individual regarding the particular task at hand (Hattie & Timperley, 2007). Verbal cues, feedback, or persuasion can be from another student, parent, or teacher. More importantly, as summarized in Figure 2.3, verbal persuasion can either undermine or improve self-efficacy in students depending on a number of factors including,

- predetermined perceived self-efficacy
- timing (when the feedback is given)
- format and tone (the way in which the feedback is given)
- source (who is delivering the feedback)

Hattie and Timperley (2007) argued that providing task-specific, positive feedback to an individual guides them to see successes along the way that may not have been as apparent or acknowledged in a more general setting and in the absence of task specificity.

Figure 2.3

Verbal Persuasion Galvanizer of Self-Efficacy



Winheller et al. (2013) found that students who have confidence in their ability to control their engagement and learning activities experience greater academic achievement. In light of this, students need specific, positive feedback from teachers regarding their strategies, efforts, and successes. Importantly, students also need feedback reinforcing that they are actively making a positive impact on their own mathematical learning experience (Mandouit & Hattie, 2023). This allows the student to understand how and why they are doing better in their mathematical ability and feel they are making the difference in their own learning, rather than outside forces. In turn, math self-efficacy is increased.

For today's educators, verbal persuasion is not just about positive affirmations, praise, and displays of "you can do it" billboards, it is about being able to diagnose the strengths and weaknesses of a student and creating success experiences, natural and/or artificial, for the student to build upon and increase self-efficacy (Mandouit & Hattie, 2023). As Bandura (1997), passionately and eloquently put it, "mere pronouncements of capacity to shape the course of one's life without providing efficacy-affirming experiences along the way become empty homilies" (p. 106).

Educators benefit from knowing that evaluative feedback has greater effectiveness when it centers on a student's abilities as opposed to focusing on a student's efforts. Schunk and Rice (1986) argued that if the performer (student) is given feedback in regard to their high effort then the performer may believe their successes are due to effort only and their ability is lacking or deficient because of the emphasis on the effort required for success. Emphasizing ability in connection to the progress made toward a goal is the optimal evaluative feedback an evaluator can provide (Bandura, 1997). For example, an evaluator may say, "You have made so much progress over the past two weeks toward your goal. You are 50 percent of the way there. Your ability for this skill is clearly growing!"

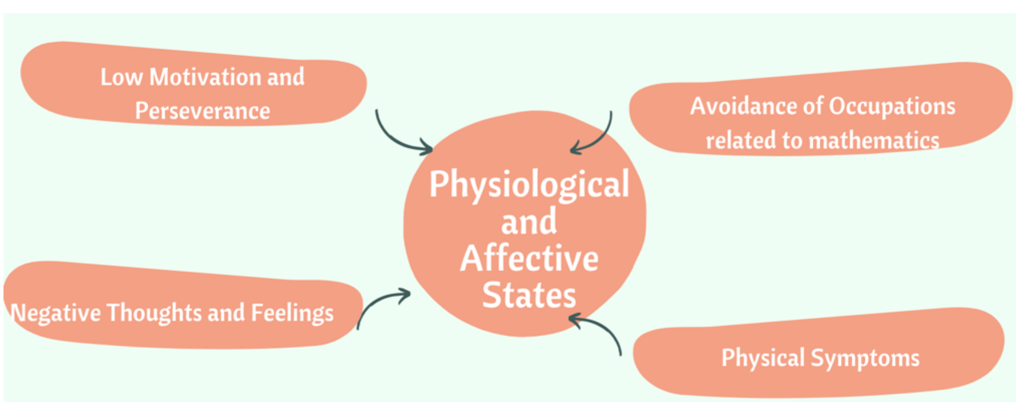
Physiological Feedback

Lastly, physiological feedback pertains to an individual's feelings regarding a task at hand (Bandura, 1997). The feelings can range from anxious to confident and can affect one's judgment of self-efficacy. Hiller et al. (2021) found that an unreasonable fear of mathematics classes hinders students' conceptual learning, thinking positively about mathematics and, in general, feeling calm. Self-efficacy and performance can be highly affected by somatic symptoms created in a situational experience, especially if the experience does not enact a memory from a successful situation in the past (Bandura, 1997). Negative and unconstructive physical symptoms such as hyperventilation, tension, or increased heart rate, may occur when psychological stressors are heightened and, consequently, lower the self-efficacy required to perform the task. This will be explained further later in this chapter.

Consequently, as illustrated in Figure 2.4, low self-esteem, feelings of disappointment, and low motivation occur which, in turn, affects performance and achievement. Prolonged math anxiety may precipitate other causal effects such as physical symptoms and the avoidance of math-related courses and occupations (Brown & Lent, 2006; Lazarides et al., 2020). On the contrary, growth mindset interventions in the classroom have shown to decrease physiological symptoms and positively influence perceived self-efficacy and improve outcomes (Smith & Capuzzi, 2019). Growth mindset interventions consider the concept of fluid intelligence and one's ability to change and grow through continued effort and learning from mistakes (Xu et al., 2022).

Figure 2.4

Physiological and Affective States Galvanizer of Self-Efficacy



Grounded Theory Research

Five different research theories were evaluated to determine which method would be most effective for addressing the research questions. According to Creswell and Poth (2018), grounded theory research includes a systematic approach involving categories, codes, and codings using “systematic procedures guided by the constant comparison of data from the field with emerging categories” (p. 84). The researcher used data from in-situ situations in which participants experienced the same processes and conditions as the research team analyzed and discussed patterns that emerged after each session. Additionally, a grounded theory research study begins with a few predetermined thoughts by the researcher whereby a hypothesis is developed. It is the researcher’s goal to find a relationship between the beginning hypothesis and the experiences of the participants. The exact methodology for this study will be further explicated in Chapter 3.

Self-Efficacy Summary

Each of Bandura’s four domains of self-efficacy significantly shape one’s self-perception of ability and directly links to one’s motivation to begin a task and persevere to complete it. The spectrum of self-efficacy varies person to person, task to task, and goal to goal. The higher the self-efficacy, the more willing an individual is to take on a challenge, set a goal, and expend effort to attain it. Low self-efficacy may temper an individual’s enthusiasm to begin a task and/or diminish their willingness to persevere through a difficult situation.

Even more challenging is the self-appraisal of efficacy, which undergoes many iterations over long periods of time. Several factors contribute to the self-appraisal of self-efficacy of a particular task, such as ability, effort, task difficulty, and luck. These factors are weighted by the performer in a subjective, situational context, which creates difficulties when trying to assess self-efficacy in a particular situation. Little research has been done regarding how people self-assess efficacy, but Bandura (1997) suggested, “there is every reason to believe . . . that efficacy judgments are governed by some common judgmental processes” (p. 114).

Self-Efficacy and Academic Achievement

Self-efficacy refers to an individual’s belief in his or her capacity to execute behaviors necessary to produce specific performance tasks. It is important to note that self-efficacy does not include judgements on one’s personal qualities, such as physical or psychological characteristics, nor does it include how individuals feel about themselves in general. The focus of self-efficacy centers on the confidence in one’s ability to complete a specific task, such as solving a mathematical problem involving fractions. Self-efficacy is measured in terms of how an individual feels regarding their own outcome expectancy measured by mastery criterion and not by the performance of their peers or normative data. Because of this, self-efficacy is typically measured before an individual performs a specific task. This reveals a causal role of motivation and perseverance of the individual, which have long been known to be the precursors of learning in a wide range of settings (Zimmerman, 2000).

More specifically, academic self-efficacy is defined as one’s belief to achieve a desired level of performance in academic tasks based on the development of cognitive skill and their perceived self-efficacy (Sharma & Nasa, 2014). Further, Muenks et al. (2018) found strong links between term grades and both the perseverance of effort and academic self-efficacy of high school students in a private high school. To further solidify the link between motivation and academic self-efficacy, a study by Usher, Ford, et al. (2019) suggested that students who tend to work through productive struggle using perseverance of effort will not necessarily perform better in school unless they also have increased academic self-efficacy.

In addition, Hammad et al. (2020) found a significant positive effect size of students' self-efficacy beliefs in relation to their persistence and motivation, both of which are critical for student achievement. Adding to these findings, Hattie and Anderman (2019) conducted a "meta-meta study" that collected, compared, and analyzed nearly 50,000 previous studies in education regarding different influences on student achievement. Collective teacher efficacy, teacher credibility, and response to intervention (RtI) all influence student achievement but have different levels of effect. Effect sizes are a simple way to present the statistical significance of these types of influences and their impact in a range of scenarios. Generally, effect sizes in most educational contexts range from –0.5 to +1.75.

According to Cohen (1990), effect sizes of +0.3 or less indicate a small impact or effect, +0.4 to +0.6 indicate a moderate impact or effect, and +0.7 or greater indicate a highly effective impact on student achievement. According to Hattie and Anderman (2019), self-efficacy has an effect size of 0.71 in terms of student learning. The hinge point of effectiveness of all items from a meta-analysis of nearly 1,200 studies has an effect size that is calculated at 0.40. Based on Cohen's scale of effect size, at 0.71, self-efficacy far exceeds the hinge point. This illustrates that self-efficacy is a major influence when it comes to student achievement and the need to engender and increase self-efficacy is crucial in the learning process.

Bandura (1977) also suggested that self-efficacy is directly linked to learning and academic achievement by the motivation level of the learner to succeed and to take risks. Bandura asserted that motivation and risk tolerance depend greatly on self-judgement and expectation of how well an individual will perform the given task. Additionally, students with higher levels of academic self-efficacy are more likely to select more challenging tasks, persevere through them, and develop new and different learning strategies when faced with productive struggle (Honicke & Broadbent, 2016). In a recent study including students in higher education conducted by Ayllón et al. (2019), findings revealed a direct correlation between high levels of self-efficacy and better academic performance in all knowledge areas with self-efficacy playing “a predicting and mediating role in relation to students’ achievement, motivation, and learning” (p. 7). Thus, when self-efficacy is low, the individual has marginal motivation to begin a task and minimal perseverance to attend to it. Conversely, if the individual believes in their ability to succeed and have a preferred outcome, their motivation and perseverance increases as does their overall achievement. The findings of Alhadabi and Karpinski (2019) supported the connection between self-efficacy and grit in research conducted with university-level students.

Furthermore, a case study involving elementary students from Yıldız et al. (2019) found not only a strong link between self-efficacy and academic achievement but also a parallel relationship between self-efficacy beliefs and students’ achievement status, with stronger relations found among low-achieving students than among those making normative academic progress. This suggests that increasing self-efficacy in low-performing students is fundamental to academic progress and growth. Students at risk of not making requisite academic progress are, in all likelihood, those at risk of not attaining sufficient self-efficacy.

Accordingly, student’s academic self-efficacy was found to be directly correlated with student achievement along with the technological self-efficacy of teachers. Namely, 12% of students’ academic achievement is explained by those students’ academic, social, and emotional self-efficacy as well as the technological competence of the teacher (Akturk & Saka Ozturk, 2019). The study connects the self-efficacy of both students and teachers and reveals the role that teacher self-efficacy plays in student achievement. When students believed the teacher could provide technological tools as support, the self-efficacy beliefs of the students also increased.

Self-Efficacy and Mathematical Academic Achievement

Hacket and Betz (1989) put a finer point on the concept of self-efficacy when they defined “mathematical self-efficacy” as, “a situational or problem-specific assessment of an individual’s confidence in her or his ability to successfully perform or accomplish a particular task or problem” (p. 262). Hacket and Betz’s definition aligns closely with Bandura’s (1977) theory of self-efficacy and, importantly, applies it to the realm of mathematics wherein prior experiences, specific situations, and/or problems affect outcomes.

Mathematical self-efficacy is a strong predictor of math achievement (Ozkal, 2019; Ugwuanyi et al., 2020). Furthermore, an increase in self-efficacy in mathematics is associated with improved self-regulation, which in turn leads to higher mathematical achievement. (El-Adl & Alkharusi, 2020; Yıldız et al., 2019).

Another significant factor contributing to math achievement that is closely connected to math self-efficacy is engagement and interest in the math lessons. Studies have found a positive correlation between students’ level of engagement and their math self-efficacy beliefs (Birgin et al., 2017; Fomina & Morosanova, 2017). Accordingly, the greater mathematical self-efficacy a student possesses, the more engaged the student is in math lessons. Moreover, increased math engagement equals increased math achievement.

Beyond the realm of academia, Hackett and Betz (1985) found that mathematical self-efficacy was the most prominent predictor in career-related decisions making for individuals pursuing occupations in the sciences. Considering this fact, educators must note that “cognitions concerning competence may be a far more critical factor than measured abilities in both educational and career decision processes, particularly for women pursuing nontraditional options” (p. 271). In a more recent study, Luo et al. (2021) reported that students’ self-efficacy in science, technology, engineering, and mathematics (STEM) activities, including mathematical problem solving, predicted their STEM career interest. Simply put, the implications of math self-efficacy transcend the classroom into future life choices and should be a valued priority before and during the delivery of curriculum and instruction.

Factors of Mathematical Self-Efficacy

It is important to note that various factors have been connected to both mathematical self-efficacy and mathematics performance, including math self-concept, math anxiety, perceived usefulness of mathematics, gender, and prior experience with mathematics (Honicke & Broadbent, 2016). This section summarizes how each of these factors connect specifically to mathematical self-efficacy.

Math Self-Concept

It is important not to confuse self-efficacy with self-concept. While self-efficacy relates to a specific task and one's self-assessment of their ability to complete it, self-concept includes one's beliefs of their self-worth and perceived general competence. Although these ideas are related and have some crossover, Bandura (1997) argued that they must not be mistaken for each other as they differ in phenomenon. The idea of parsing out the conceptual differences between self-concept and self-efficacy has a long history.

Historically, math self-concept and math self-efficacy have been discussed as significantly different in terms of mathematical output and performance. A recent study by Marsh et al. (2019) focused on the distinction between self-concept and self-efficacy measures. The constructs of self-concept and self-efficacy were found to be essentially indistinguishable with correlations mostly greater than .9 when measured throughout the study. One descriptive element existed during the study which concluded that "self-efficacy is more purely descriptive of expected accomplishments but that self-concept is based on how accomplishments meet standards of worthiness associated with various frames of reference" (p. 31).

This dissertation uses the term "self-efficacy" rather than "self-concept" throughout this study.

Math Anxiety

Negative physiological effects often accompany low perceived self-efficacy, which further decreases motivation as one attempts to mitigate or avoid risk of failure. These phenomena make reducing stress levels and negative thinking an educational imperative as educators seek to increase perceived self-efficacy. This is especially true in cases of math anxiety, wherein students with low mathematics self-efficacy experience unsettled feelings during mathematical operations, fear of failure, and physical stress, all of which conspire to negatively affect their math achievement (Lau et al., 2022).

Lau et al. (2022) cited further findings in the differences between individual and contextual math anxiety. Individual math anxiety exists consistently across the globe, whereas contextual math anxiety among peer groups affects math achievement above and beyond one's own math anxiety. This highlights the importance of classroom culture when studying the connection between math anxiety and math achievement, as it also involves the observations and subjective ideas from peer to peer.

Perceived Usefulness

Students' perceptions about the importance of mathematics in everyday life and in the future influence students' attitudes towards the subject (Adelson & McCoach, 2011). If students connect mathematical problem solving with real life events, they show greater motivation to study, practice, and learn the subject (Syyeda, 2016). Additionally, in a study that involved 17 schools from primary to college students in Tanzania, Mazana et al. (2018) indicated usefulness of math as a key factor among other factors in increasing students' mathematical engagement. The more a student finds math as a useful tool to solve real-life situations, the more a student will engage with said math lesson which, in turn, increases mathematical self-efficacy (Yurt & Sünbül, 2014).

Gender

There is an abundance of data related to gender and math performance. In the interest of brevity, the researcher will cite two studies that distill the pertinent findings. Rodriguez et al. (2020) confirmed previous research that girls in the fifth and sixth grades reported higher levels of math anxiety than boys. Additionally, Rodriguez et al. (2020) reported greater intrinsic motivation for math from boys than from girls. Additionally, Recber et al. (2018) revealed a significant mean difference between boys and girls, favoring males, regarding math self-efficacy scores. Although this difference is significant, Recber also recorded mathematical self-efficacy to be the most significant factor affecting mathematical achievement with a 4.5% variance in achievement scores over gender, which was recorded as the lowest significant factor with a 0.4% variance in achievement scores that could be explained by this unique factor.

This is exemplified by a report indicating that women accounted for 28% of all workers in the Science and Engineering occupations in 2010, marking a gradual increase from 23% in 1993. These statistics highlight both the incremental progress in the representation of women in the field and the significant gender imbalance that persists (NSB 14-01).

Prior Experience

Although prior experience with mathematics is a factor in math performance, Bandura (1997) suggested that students are affected more by their perception of their experience than they are by their actual successes. An individual may have had prior success in solving a specific mathematical problem; however, she or he may have perceived their struggle in completing the task as decreased ability. The stability of self-efficacy is ever changing until solidified through multiple experiences in diverse situations over a period of time. This is important to note when trying to build students' self-efficacy through performance outcomes or past experiences.

Bandura (1997) stated, "performance alone does not provide sufficient information to judge one's level of capability, because many factors that have little to do with ability can affect performance" (p. 81). To illustrate further, an identical specific task may appear different if approached in a dissimilar setting, at a different time of day, and/or if approached in an individual or group setting. Any and all of these factors outside of personal ability may affect the self-efficacy of the performer and thus the end result.

Alternate Findings Between Self-Efficacy and Achievement

Conversely, two studies have provided alternative findings regarding the correlation between self-efficacy and academic achievement not related to the subject of mathematics. Talsma et al. (2019), in a study that involved 207 students in higher education, reported an alternate connection between self-efficacy and self-fulfilled prophecies using data from five self-efficacy questionnaires and five corresponding grades completed and collected over a semester in one subject area. A key finding was the inaccuracy of student-reported self-efficacy beliefs calibrated with their actual capacity to perform. For example, students with higher self-efficacy beliefs were reported to have lower performance scores and the same for the converse. The study recommended further exploration into the calibration of self-efficacy beliefs and authentic performance assessments.

In another study conducted by Rafiola et al. (2020) concerning students' academic achievement, 92 high school students in Padang (Indonesia) were asked to complete a ranking, according to choices provided, regarding factors to improve learning. The results emerged with self-efficacy, learning motivation, and blended learning as the most indicated factors in regard to improving learning. The study reported a significant correlation between academic achievement and learning motivation, blended-learning, and self-efficacy. However, no significant correlation was found when academic achievement and self-efficacy were measured as a stand-alone duo.

In summary, some findings have reported an imbalance between student reported self-efficacy and performance outcomes. For example, students who reported higher self-efficacy scored lower on performance outcomes, while students who reported lower self-efficacy scored higher on performance outcomes. One explanation for this phenomenon is that when students expect low outcomes, they try harder to improve their performance, and when students have higher expectations, their performance declines due to lax preparation (Mooi, 2007). Nevertheless, the performance outcome is still linked to self-efficacy but with contrasting outcomes.

Summary

Research has indicated that self-efficacy, along with the aforementioned factors that affect performance, has stronger direct effects, almost exclusively, on performance than any other factor. The factors of prior experience and gender have affected math performance through their connections to self-efficacy. Pajares and Kranzler (1995) found that mathematical self-efficacy is a greater predictor of math performance than general cognitive ability. Additionally, math self-efficacy plays a greater role in math performance than previous math experience in most circumstances (Pajares & Miller, 1994). This does not overshadow the tendency for previous successes in math to increase self-efficacy. But it does point out the prioritization of self-efficacy, in general.

More recently, Koyuncu and Dönmez (2018) found a correlation between self-efficacy and resistant attitudes and behaviors towards math problem solving and course work completion. Students with more mathematical self-efficacy showed less resistant behavior toward mathematical problem solving, spent more time on assignments, and attained more success in the end. Also, in conjunction with previous studies, the variable of self-efficacy had a greater effect on mathematical success over all other variables included.

Outside academia, Hackett and Betz's (1985) findings about mathematical self-efficacy as the most prominent predictor in career-related decisions for individuals pursuing occupations in the sciences serve as an important reminder to educators that students who are math adverse throughout their educations tend to avoid occupations that may be connected to mathematics in any way.

Foley et al.'s (2017) research suggested that the decreasing interest in Science, Technology, Engineering and Math (STEM) careers may tie more closely to math anxiety than to an actual lack of math and science knowledge among individuals seeking jobs. This infers that decreasing math anxiety should be equal or greater in importance to increasing math and science knowledge. If this was accomplished, it could open occupational doors to pertinent careers for some adults who have the ability to perform the work but lack the self-efficacy to pursue those occupations. Simply put, the implications of math self-efficacy transcend the classroom into future life choices and should be a valued priority before and during the delivery of curriculum and instruction.

The literature referenced in this review make a compelling case for educators placing a much greater emphasis on increasing the self-efficacy of math students prior to and in conjunction with instruction.

To be clear, this study is interested the effects of self-efficacy on middle school math students. Research strongly suggests that self-efficacy is the precursor to learning in mathematics. Further, the researcher asserts that it is imperative for educators to first increase the self-efficacy of students in order to increase motivation, perseverance and, ultimately, academic achievement.

The objective of the researcher is to investigate the potential existence of a dominant galvanizer for math self-efficacy among individual students or groups of students. Additionally, the aim is to explore how this galvanizer can be effectively utilized to enhance motivation at the onset of problem-solving tasks and to foster perseverance during moments of productive struggle. By enabling learners to identify and activate the galvanizer that suits their needs, they can take ownership of their learning experiences and actively create meaningful educational encounters.

Students who need to enact an observed experience as their mathematical self-efficacy galvanizer can create a video of themselves successfully solving a problem and rewatch it before solving a problem. Students who need a vicarious experience as their mathematical self-efficacy galvanizer can watch a video of their preferred performer modeling success before initiating their problem solving. Students who need physiological feedback can employ mindfulness activities before problem solving and use self-talk or deep breathing as a reminder. Students who need verbal persuasion or feedback while problem solving can use a visual to let the teacher know when they need feedback. All of these activities put the onus on the learner and lean away from altering the teaching style to match each student.

CHAPTER 3: METHODOLOGY

To determine if individuals possess a dominant domain that supports the most effective way to increase mathematical self-efficacy, and subsequently increase motivation and achievement, this grounded study used a mixed methods approach.

Research Design and Rationale

Creswell and Poth (2018) defined the purpose of a grounded theory study as the process of discovering or generating a theory for a process or action. Strauss and Corbin (1998) described a grounded theory study as explaining causal situations by determining what factors ultimately cause a phenomenon. For this grounded research theory study, the researcher analyzed the effects of the four galvanizers of self-efficacy: performance outcomes, vicarious experiences, verbal persuasion, and physiological feedback to determine if one or more of the four domains is most effective in increasing self-efficacy among middle school math students. To date, there is scarce research examining a dominant galvanizing self-efficacy domain that significantly contributes to the improvement of mathematical self-efficacy, either at the group level or within individual students (Huang et al., 2020; Huang & Mayer, 2019; Suldo & Shaffer, 2007).

Additionally, it is unknown whether or not individual students engender one of the self-efficacy domains over another when galvanizing mathematical self-efficacy. Therefore, during the research process, the researcher extended the inquiry beyond identifying a potential dominant galvanizer among middle school students or within a group of students and aimed to explore whether middle school participants were able to articulate a preferred dominant galvanizer that they personally find effective for enhancing their own mathematical self-efficacy.

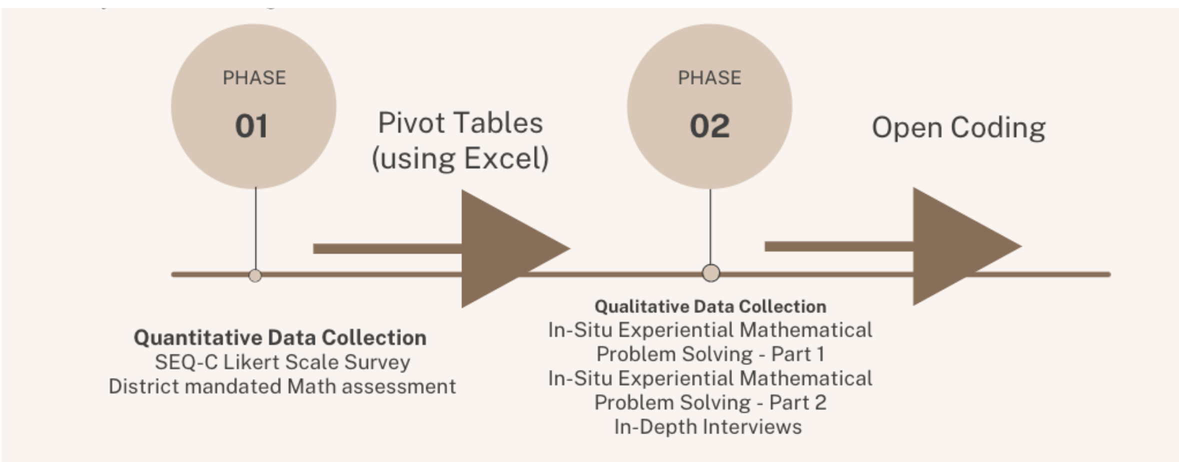
As shown in Figure 3.1, the researcher employed a mixed methods sequential research design that included two phases in order to determine what factors ultimately may cause an individual to prefer one self-efficacy galvanizer domain over another:

- Phase 1: the collection and analysis of quantitative secondary data from the entirety of the sample participants collected during the first two weeks of school
- Phase 2: the collection of qualitative data from a subset of selected participants to be analyzed in depth in order to effectively try and answer the research question (Creswell & Poth, 2018)

The qualitative data is meant to enrich the quantitative findings and help generate new knowledge in the realm of the research question (Creswell & Poth, 2018).

Figure 3.1

Phases of the Research Design



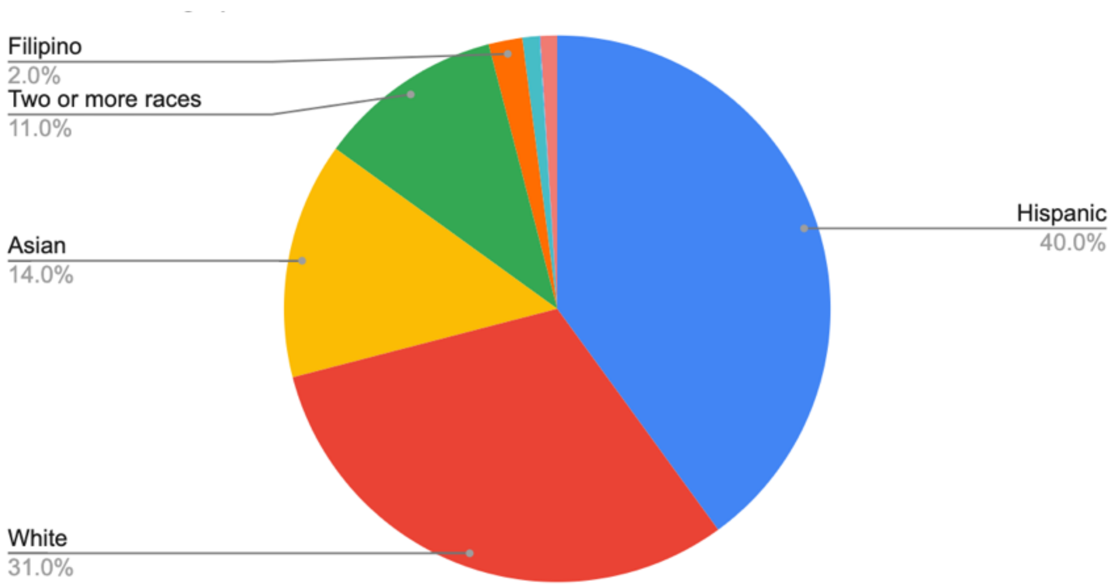
Setting

This research took place in a public middle school in Northern California where, at the time of the study, approximately 900 students attended grades sixth through eighth. For this study, the public school is referred to as Public School A. Public School A is part of a district that uses neighborhood school theory (students attend the public school nearest to their residence due to lack of public transportation), which has created boundaries to delineate enrollment.

As shown in Figure 3.2, the composition of Public School A's student population at the time of the study reflected significant demographic diversity. The socioeconomic status of the student body within Public School A was similarly varied. It is important to note that 34% of students came from a socio-economically disadvantaged family situation.

Figure 3.2

Student Demographics: Public School A



Fifty-seven percent of the student body at Public School A met or exceeded state standards for math according to the state assessment scores at the time of the study. It is also important to note that this specific middle school has two different ability-based math courses for sixth grade and three different ability-based math courses for seventh and eighth grade, as shown in Table 3.1. The different math courses per grade level start with a grade-level-based option and continue with two enriched courses that provide instruction beyond the grade-level standards.

Table 3.1

Public School A: Distribution of Students in Middle School Math Courses

Grade	Total # of Students	Grade Level	Enriched Level 1	Enriched Level 2
Sixth	295	207	88	-
Seventh	282	128	79	75
Eighth	289	97	89	78

Students are enrolled into the different mathematical course levels using a district-level math assessment vetted and provided by iReady (Curriculum Associates, 2023). Student data from this assessment is completed and compiled both at the end of the prior school year and during the first full week of instruction of the current school year. The better of the two data points is used to determine math placement for each student as conveyed to the students and parents using specific score ranges for each course. The iReady Diagnostic is a test designed to help teachers support each student and create a path of personalized instruction for every learner. The adaptive test adjusts its questions to suit each student's needs. Each item a student sees is individualized based on their answer to the previous question.

Table 3.2 shows the iReady diagnostic math scores from May of 2022 for students attending Public School A. There are significant differences among the Hispanic/Latino students, students with disabilities, students who are socio-economically disadvantaged, and students who are English language learners compared to the higher achieving groups of White and Chinese learners, which creates an even more significant achievement gap for the school.

Table 3.2

Math Diagnostic Results - May 2022

Demographic	Tier 1	Tier 2	Tier 3
Asian	91%	7%	2%
Hispanic/Latino	34%	37%	29%
White	82%	13%	5%
Students with Disabilities	30%	27%	43%
Students who are socioeconomically disadvantaged	29%	38%	33%
Students with EL designation	26%	41%	33%
English only students	79%	14%	7%

After completing the iReady Math Diagnostic, students are divided into three achievement tiers:

- **Tier 1** indicates students are achieving mastery on their current grade level or above grade level standards.
- **Tier 2** indicates students are achieving mastery one grade level below their current grade level standards.
- **Tier 3** indicates students are achieving mastery on two or more grade levels below their current grade level standards.

A similar trend as the iReady Math Diagnostic scores from May 2022 is shown in Table 3.3 for typical growth in mathematics achievement overall from August of 2022 to June of 2022. Typical growth is a normative measure used to determine the average annual growth for an average student taking the iReady Math Diagnostic. The normative measure is typically used to understand how well a student is growing compared to average student growth at the same grade and within the same placement level.

Table 3.3

Percentage of Students Meeting Yearly Growth Targets

Demographic	Percentage Met
Asian	71%
Hispanic/Latino	49%
White	67%
Students with disabilities	47%
Students who are socioeconomically disadvantaged	49%
Students with EL designation	51%
English only students	64%

Phase 1: Quantitative Data Collection

Opportunity sampling was used for Phase 1 research because middle school student participants were readily accessible to the researcher, who, at the time of the study, was the second-year principal of Public School A. For participant sampling procedures, the researcher exported and used data from sixth, seventh, and eighth grades. In addition, the researcher used secondary data from school-wide surveys and assessment data completed by all students during the first two weeks of school. Survey results and assessment data were collected using Google Forms, exported into Google Sheets, and analyzed by the researcher.

All student participants completed the Mathematical Self-Efficacy Questionnaire for Children (SEQ-C) (Muris, 2001) using Google Forms (see Appendix C). The original SEQ-C survey was adapted by the researcher add the word "mathematical" to each of the self-efficacy questions to better ensure math-centric responses. The 24-item questionnaire starts with four scholastic and demographic questions regarding student identification number, grade level, mathematics course level, and cultural background. The next 20 questions use a Likert scale related specifically to mathematical self-efficacy. The mathematical self-efficacy questions are grouped into three categories: nine of the items address academic self-efficacy, five items address social self-efficacy, and seven items address emotional self-efficacy.

Suldo and Shaffer (2007) conducted an evaluation of the SEQ-C self-efficacy questionnaire that included 697 American middle and high school students and was later repeated with 318 American high school students. These two evaluations provided support for the use of the SEQ-C survey with American middle and high school students by using correlations that exist between self-efficacy and psychological functioning. The factor analyses in the original validation study among the larger group of middle and high school students reported that all three—academic, social, and emotional—self-efficacy factors were present. The repeated validation study among the smaller group limited to high school students revealed that academic self-efficacy emerged as the strongest of the three factors. Additionally, Suldo and Shaffer recommended omitting Items 3 and 13 due to unacceptable factor loadings. For clarity and context, Items 3 and 13 are listed below:

3. How well do you succeed in cheering yourself up when an unpleasant event has happened?

13. How well can you pay attention during every class?

The researcher accepted these recommendations and used the academic factor items with the omission of Items 3 and 13 when analyzing the students' results from the SEQ-C survey.

After tailoring the SEQ-C survey to make it more focused on mathematics self-efficacy, at the start of the 2020–2021 school year, the researcher employed a pilot group of teachers to evaluate the questionnaire. The pilot group completed the survey and provided actionable feedback including suggested changes to the survey instrument. The pilot teacher group indicated that the questionnaire may be too cumbersome for middle school students and also suggested the addition of a teacher-related aspect that included student responses regarding teacher opinion of student performance.

Based on input from the pilot group, Item 20 was added to the questionnaire to include a teacher aspect in the results, and four original items from the SEQ-C survey were deleted from the survey in order to decrease the number of questions. Among the four original items deleted were three questions among the social self-efficacy factors and one question among the emotional self-efficacy factors. The aforementioned changes are reflected in the final survey used by the researcher (see Appendix C).

The estimated time for completing of the modified SEQ-C survey ranged from ten to fifteen minutes. Completion time did not include an overview of the meaning of mathematical self-efficacy, which was delivered verbally by the teacher before the students began the survey.

At the time of the study, students already completed the SEQ-C survey in August of every school year so the math department can gauge the self-efficacy levels of the students enrolled in their classes. The SEQ-C survey is widely used and available to any individual who is interested in evaluating the self-efficacy of youths and therefore needs no permissions for use in this research. Although alternate self-efficacy surveys exist, the SEQ-C survey is the preferred measure because it was developed for youth, has a simple item format, is domain-specific, and is fairly brief (Minter & Pritzker, 2015).

The year of this study is the second consecutive year the students have completed the survey, data from which is analyzed by the math department, the instructional coach, and an administrator to positively affect mathematical instruction. All sixth-, seventh-, and eighth-grade student responses were exported into Google Sheets to arrive at an aggregate academic self-efficacy score. The aggregate score was calculated by giving all responses to the academic self-efficacy questions a value equal to the value of the Likert response and then summing all. For example, if the student chose "1" in response to a question, a value of one was assigned and used to calculate the total score.

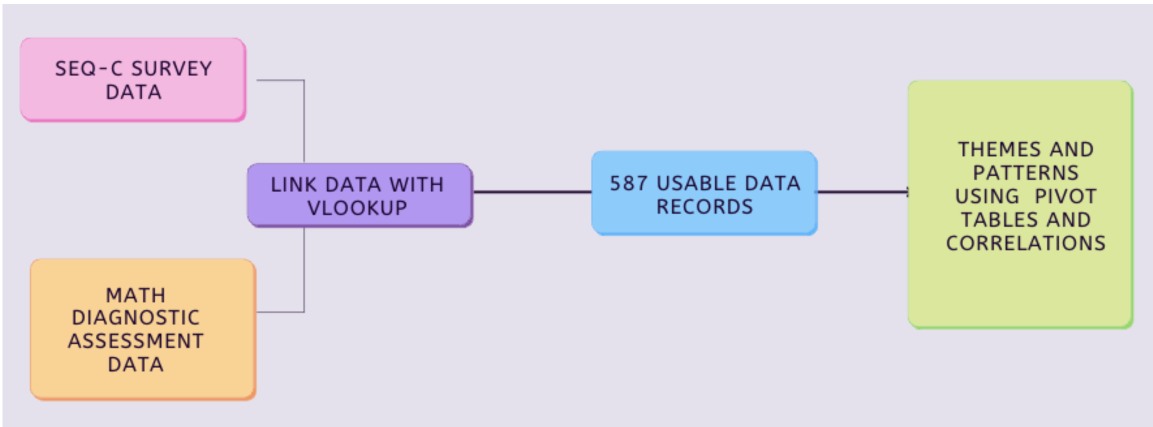
Additional secondary quantitative data was collected from student participants using a district-wide math assessment. This secondary data was culled from a school-wide math assessment that was conducted using a web-based adaptive diagnostic tool provided by Curriculum Associates LLC, which created iReady and is a vetted vendor of Public School A.

All students attending Public School A complete the math assessment during the first full week of school and their scores are used to determine math placement according to data score bands created by the district office. The district assessment provides an appraisal for each student using the following strata: below grade level, at grade level, or above grade level.

As shown in Figure 3.3, the researcher prepared the final step of data to be analyzed for use of participant sampling by linking each of the student's district math assessment score using the student ID number and a VLOOKUP table. After all lines of data were linked, a total of 587 participants were verified, complete, and ready to be analyzed. The researcher used pivot tables and correlation analysis to begin identifying patterns and groups to help answer the researcher's question: Can impromptu, brief interventions conducted immediately prior to or during a math problem-solving session, crafted to enhance the four domains delineated by Bandura, exert a beneficial influence on the levels of mathematical self-efficacy *discernible amongst middle school students*?

Figure 3.3

Preparation for Quantitative Data Analysis



The quantitative secondary data acquired was analyzed using pivot tables and correlation analysis in Microsoft Excel. The researcher started by looking for themes and patterns among specific groups of students. For example, the researcher found that the majority of students who attend the grade level math classes self-report a lower score for self-efficacy while their counterparts who attend the enriched math classes self-report higher scores.

Upon completing the final step of Phase 1 and patterns and/or groups of students were recognized, participants were chosen for the next instrument, the in-situ experiential stations.

Phases 2 and 3: Instrumentation and Qualitative Data Collection

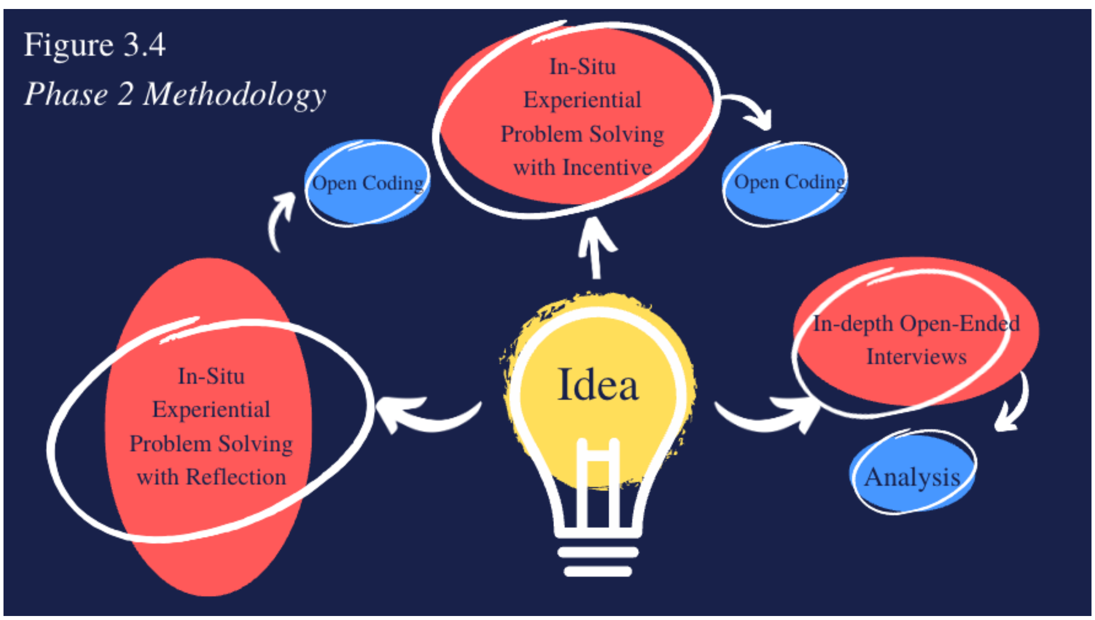
Phase 1 focused on revealing themes and patterns of mathematical self-efficacy and how it correlates to different groups of middle school students in Public School A. Phase 2 focused solely on trying to discover the dominant self-efficacy galvanizer, if any, for each of the students in the subset of participants.

The research team identified a smaller sample of 30–50 student participants using the themes and patterns that emerged from Phase 1 and provided them with a participant assent form. A consent form was sent to the parents or guardians to ensure students had the necessary approvals to participate in the research. The researcher strove to have a minimum of 25 participants in this qualitative phase of the research, which includes an in-situ experience involving mathematical problem solving and an open-ended, in-depth interviews.

During the next stage of qualitative data collection of Phase 2, the complementary data from the in-situ experience and in-depth interviews revealed overlapping and contrasting themes. The researcher followed the triangulation of data technique (Creswell & Poth, 2018). As shown in Figure 3.4, three types of qualitative data was collected: themes from the SEQ-C survey data, mathematical problem solving with an incentive, and open-ended interviews.

Figure 3.4

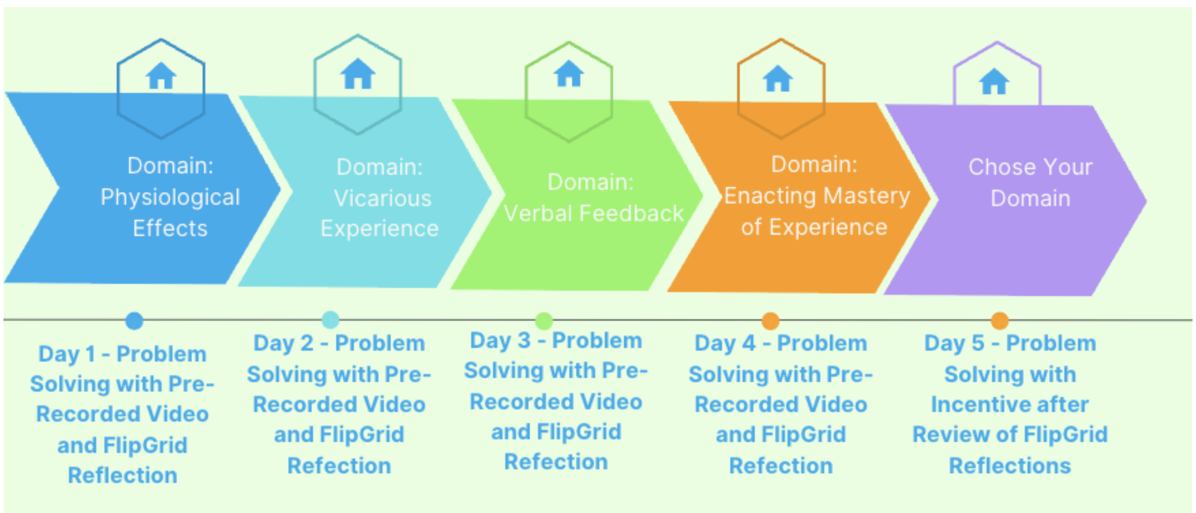
Phase 2 Data Collection Methodology



The first qualitative instrument used included a progression of in-situ experiential mathematical problem-solving sessions, which were held on campus during school hours in Public School A's Multiple Use Room (MUR). Each student participant was required to bring their district-provided Chrome Book and headphones along with a writing instrument. The problem solving followed a five-day progression wherein each of the first four days focused on one of Bandura's self-efficacy domains, as shown in Figure 3.5, as either a video or other form produced by the researcher.

Figure 3.5

Phase 2 In-Situ Experiential Problem Solving Progression



In terms of process, during the first four days of the problem-solving progression, participants were required to either view a prescribed video illustrating one self-efficacy domain and/or follow directions led by the researcher and then proceed with solving a mathematical problem at their proximity level. At any point during their problem solving, participants could re-watch the video, if available. Upon completion of the problem the participants were required to answer a short series of guided questions about their experience and record a reflection to be analyzed later by the researcher. One the fifth day of the problem-solving progression, each student reviewed each of the metacognitive reflections completed at the end of each session before attempting to solve the final math problem.

The researcher created two separate self-efficacy videos for the student participants to watch before solving the math problem during the vicarious experience and physiological response sessions. The researcher provided a scaffolded math problem to the participants before solving the math problem during the performance outcomes session. Lastly, the researcher provided specific, positive feedback to participants as they solved the math problem during the verbal persuasion session.

As shown in Table 3.4, each session contained a strategy from a particular self-efficacy domain that had the potential to increase the participant's self-efficacy and provide motivation to solve the problem. For example, the researcher used the physiological feedback self-efficacy domain as the galvanizer on Day 2. Thus, the researcher provided a video that included breathing exercises and positive self-talk exercises for the students to use before and/or during the problem-solving experience.

Table 3.4

Video Content Provided for Mathematical Problem-Solving Experience

Day	Domain	Content
1	Verbal Persuasion	Students will solve math problems at current ability level while receiving specific feedback from the researcher.
2	Physiological Feedback	Students will listen to soft, relaxing music while problem solving.
3	Performance Outcomes	Students will solve a scaffolded math problem before solving other more difficult problems at their level.
4	Vicarious Experiences	Students will watch a video of middle school students solving math problems in a small group situation before solving other more difficult problems at their level.
5	Participant Reflection	Students reflect on the four experiences and choose a domain most effective for them, if possible.

Students were permitted to watch the video content as many times as needed and were not constrained to a time limit. After each daily session, the students recorded a reflection video using FlipGrid, a website that allows for oral responses, instead of written responses. To normalize participant responses, the researcher provided guiding questions for the students to answer regarding the problem-solving session just completed. These steps were completed each day throughout the first four-days of the process. On the fifth day, the students began the session by reviewing their oral responses to each of the four self-efficacy domains before selecting a specific domain video to view prior to attempting to solve the final math problem of the progression.

The goal of the in-situ sessions was to analyze each of the students' preferred self-efficacy domain as they completed mathematical problems. The last problem-solving session concluded with a final reflection regarding the student participant's rationale and motivation for selecting their preferred self-efficacy domain. The researcher used open coding to analyze data from the recorded FlipGrid reflections.

The final instrument used during the qualitative phase of research, Phase 3, was student interviews wherein the researcher conducted one-on-one interviews to delve deeply into each student's mathematical self-efficacy and employment of self-efficacy domains. Interviews were conducted using a semi-structured interview approach in a conference room at Public School A. The interview was recorded using Zoom, which allowed the researcher to view videos multiple times to ensure accuracy throughout the coding process. Zoom also enables written transcripts that facilitated the coding process.

The semi-structured interviews employed open-ended questions related to the four galvanizers of self-efficacy while maintaining a sharp focus on mathematics. The interviews were used to enrich the qualitative data that was extracted from the self-efficacy questionnaire and the qualitative data contained in the FlipGrid videos recorded by the student participants immediately following the problem-solving process. Questions were designed to help determine if the participant carried a particular magnitude for one self-efficacy domain over another domain, or perhaps two domains over the others. In order to best decipher this, the researcher used situational questioning focused on participants' use of different strategies for galvanizing each of the four self-efficacy domains according to Margolis and Mccabe (2006).

The interview questions were geared toward the four different self-efficacy domains after a short summary of the research being conducted was explained. Table 3.5 presents effective strategies for each individual self-efficacy domain to be employed with the goal of increasing motivation. For example, during the interview process, the researcher asked the student participants if they would rather perform a mathematical task similar to one that they had experienced prior success with, or if they would rather view a video of a classmate from their current mathematics class solve a similar mathematical problem that they will be solving after viewing the video. Another situational question was asked in regard to their physiological state. They were asked if they would like to start with a mindfulness activity before working on the problem, or if they would prefer to start working right away. Students were also asked if they would like the researcher to comment on their progress with specific feedback as they worked through the problem-solving.

Table 3.5

Strategies to Galvanize Four Self-Efficacy Domains

Domain	Strategies
Performance Outcomes	Modify the assignment so it is moderately challenging to create success.
	Provide a student example so the student knows the expectations and can replicate them for success.
	Provide a student example so the student knows the expectations and can replicate them for success.
	Teach specific learning strategies to use and when to use them.
	Capitalize on student choice and voice.
	Have students chart their success regularly so they can visually see it.
Vicarious Experience	Have students watch other students who look like them do well on targeted tasks.
	Use students with similar ability as coping models so they can demonstrate strategies.
	Have students record and watch a video of themself succeeding while problem solving.
Verbal Persuasion	Provide specific, positive feedback to students regarding ability.
	Reinforce effort and correct strategy use.
	Give frequent, focused, task-specific feedback.
	Reinforce that success is due to controllable factors, including persistent effort, modifiable ability, and the use of the correct strategies.
	Redirect students to see that failure is due to lack of effort and not due to permanent limitations.
Physiological Feedback	Use body and mind relaxation strategies.
	Teach students positive self-talk.

Domain	Strategies
	Teach students to take breaks when frustrated.

1. **Coding Process**

First, the researcher reviewed the qualitative data gathered from Phase 2 and 3, which required the use of a coding process. To facilitate coding, the researcher uploaded transcripts from the experiential problem-solving FlipGrid videos recorded by the student participants as well as the transcripts from the Zoom interview process to a computer-assisted qualitative data analysis software (CAQDAS) that stored and retrieved the data collected. Furthermore, the researcher used recorded memos to enhance the analytical depth and rigor of the study by reflecting on the study's objectives, methodologies, and participant interactions. This contributed to advancing the research.

The researcher examined the data with a keen focus on discerning underlying patterns and discernible clusters of data that exhibited the potential for coherent categorization, thereby facilitating subsequent in-depth analysis. These emergent data categories were envisaged to manifest through two distinct avenues: (a) the delineations of self-efficacy domains and (b) the articulated student-reported scores derived from the Self-Efficacy Questionnaire for Children (SEQ-C). By exploring these potential categories, the researcher aimed to expound upon the interrelationships within the data and elucidate meaningful insights that could potentially enrich the ensuing analytical discourse and start the quest for enlisting participants in the third phase of the research, which included the in-depth interviews.

As shown in Figure 3.6, inductive coding was the first step in the qualitative analysis process as the researcher looked to categorize and create themes. The researcher had no preconceived notions of what the codes should be but instead endeavored to find naturally occurring themes and patterns. Themes were grouped and developed into codes, which were used to create a narrative regarding the findings.

Figure 3.6

Inductive Coding Process

Researcher's Perspective

At the time of the study, the researcher already had an extensive background in education, having taught middle school mathematics for 15 years, followed by employment as an instructional coach for two different departments of middle school math teachers. The researcher had amassed a breadth and depth of education experiences working in districts that had created several different math pathways using ability-based data and had personally taught the full range of ability-based math courses from remedial, below-grade level credit recovery classes to enriched courses adhering to state standards one or more levels above grade level. Throughout the researcher's teaching tenure, the researcher witnessed decreased motivation due to what she observed to be low or no student math self-efficacy. Further, in her capacity as an instructor, the researcher heard students in grade-level math courses refer to themselves as being "not good at math" or as being "in the dumb class." The literature review shows the importance of self-efficacy as the foundation upon which motivation is built. This study uses that premise for its research and data analysis.

In full disclosure, the researcher identifies as a person with high mathematical self-efficacy with the ability to produce high math scores and, upon much reflection, identifies with the vicarious experience group for increasing self-efficacy.

The researcher believes mathematical self-efficacy is the precursor to motivation and perseverance when students are struggling with learning mathematical concepts. The researcher observed this first hand over the course of her 13-year tenure as a middle school mathematics educator, where self-efficacy was a central topic in mathematics department meetings and ongoing professional development efforts.

Ethical Issues

The researcher received approval from the Institutional Review Board (IRB) committee before proceeding with the research. Potential risks created for student participants in this research study included missed instruction due to the surveys, experiential learning, and interviews conducted on school premises during school hours. Emotional distress may have occurred from performance-related experiences due to mathematical problem-solving induced anxiety. Perceived or actual loss of privacy could be a factor, as students self-reported feelings about self-efficacy. Student names and ID numbers were linked to private achievement information, which potentially could present information risks.

Interviews were held in a private instructional area on school campus during school hours with one other adult present to observe and record videos. All instruction missed was made up by the teacher through the use of targeted tutoring and small group instruction to minimize learning loss. At the time of the study, Public school A employed two licensed counselors for all students.

Students had access to a counselor as needed. Formal consent from students and their parents/guardians was obtained from all participants prior to their participation and commencement of the research.

The subset of students participating in the in-situ learning experiences and recorded interviews had all safety measures explained during the consent process. Videos obtained by the video conferencing tool were uploaded and stored on a password-protected computer. Additionally, student names were kept strictly confidential and separated from the achievement data by using student ID numbers in place of student names.

All participants had the right to not participate in the study with no repercussions. Additionally, participants had the option to disassociate with the research at any point of the data collection. For example, during the in-situ experience sessions, a participant asked to not be included in the research after the second session was completed. Although the researcher excused the participant from the following sessions with no questions asked, the student explained she did not want to miss class because they were learning something new.

Reliability and Validity

Because the research was conducted at the district in which the researcher is the principal, the researcher was careful when conducting interviews and practiced reflexivity by being reflective of her role so as not to influence the sample participants (Maxwell, 2013).

Additionally, the researcher chose to complete the data collection of both phases on her own, but elected to use the research team for the coding process. The inter-coding agreement was the base of the work before the team engaged in coding, creating themes, and analyzing data. The team started by reading passages of the transcripts and then calibrated their findings by discussing definitions, color-coding, and code names.

The researcher circled back with the sample students during the interview portion of the study to confirm findings. As Creswell and Poth (2018) noted, researchers can confirm research validity by “taking data, analyses, interpretations, and conclusions back to the participants so that they can judge the accuracy and credibility of the account” (p. 261).

Summary

This grounded study used a mixed methods approach to explore the four self-efficacy domains and find out if there is a dominant domain in individuals that supports the most effective way to increase mathematical self-efficacy and, in turn, increase motivation and achievement in math. Convenience sampling was used at the school where the researcher was acting principal during the time of the study. Secondary data was utilized for the first phase of the research and analyzed for the purpose of selecting a subset of students for the second phase. The subset of student participants from phase two completed a progression of in-situ experiential mathematical problem solving and used these experiences to answer in-depth, open-ended questions in a one-on-one interview with the researcher. Pivot tables and correlations were used to analyze the quantitative data, and qualitative coding was used to analyze the experiential problem solving and in-depth interviews.

CHAPTER 4: RESULTS

The purpose of this grounded theory research study was to find which one or more of the four domains of self-efficacy most effectively galvanize the mathematical self-efficacy of middle school students in ability-based math pathway classes to inform instructional leaders and mathematical educators in the classroom. The data was collected in three phases with the researcher analyzing for themes and codes after each phase to further inform the next data collection phase. The data is presented in this chapter by each of the three phases.

Phase 1: Quantitative Data Analysis

A convenience sample of data was collected and analyzed using self-reported results from the SEQ-C survey that the current sixth, seventh, and eighth-grade students from the public school in which the researcher resided as the principal. As shown in Table 4.1, there was a total of 611 lines of secondary data collected through Google Forms regarding mathematical self-efficacy, which is completed annually by the students at the beginning of the school year, with a reduction of 24 records due to misreported student ID numbers. The breakdown of the remaining 587 records is parsed by math-ability-level class.

Table 4.1

Number of Students Attending Math Class

Class	Number of Students
6th Grade Enriched	78
6th Grade Highest Enriched	92
7th Grade Enriched	64
7th Grade Highest Enriched	79
8th Grade Enriched	68
8th Grade Highest Enriched	28
7th Grade Level	90
8th Grade Level	88
Total	587

The secondary data was then coded by the researcher to acquire the themes of the results shown in Figure 4.1, which include four different areas.

Figure 4.1

Self-Reported Themes from SEQ-C Survey

Secondary data results included academic scores reported between 9, indicating a low mathematical self-efficacy score, to 45, indicating the highest mathematical self-efficacy score out of a total of 45. Table 4.2 shows that the data revealed a higher reported mathematical self-efficacy by students who attended the enriched ability-based math pathway classes with the converse being true for students who attended grade-level math classes. The range between the scores is as much as 21 percentage points difference for seventh grade and as much as eleven percentage points difference for eighth grade.

Table 4.2

Cumulative Percentage of Students by Class and Math Self-Efficacy Score

	<= 22	<= 23	<= 24	<= 25	<= 26	<= 27	<= 28	<= 29	<= 30	<= 31	<= 32	<= 33	<= 34	<= 35	<= 36	<= 37	<= 38	<= 39	<= 40	<= 41	<= 42	<= 43	<= 44	<= 45
6th Grade Enriched	2%	2%	2%	3%	3%	5%	15%	19%	23%	26%	32%	36%	38%	41%	44%	50%	61%	66%	74%	83%	84%	88%	94%	97%
6th Grade Highest Enriched	0%	1%	1%	1%	1%	5%	8%	11%	12%	13%	18%	25%	29%	36%	48%	55%	62%	70%	73%	80%	84%	89%	92%	95%
7th Grade Enriched	2%	2%	2%	2%	6%	6%	12%	12%	23%	24%	27%	35%	41%	47%	53%	58%	67%	76%	79%	80%	86%	89%	92%	94%
7th Grade Highest Enriched	3%	3%	4%	5%	6%	6%	9%	11%	18%	20%	22%	29%	33%	39%	42%	49%	58%	70%	76%	81%	84%	91%	99%	100%
8th Grade Enriched	0%	0%	1%	1%	7%	7%	10%	12%	13%	18%	25%	29%	35%	38%	51%	54%	63%	71%	79%	87%	88%	90%	93%	97%
8th Grade Highest Enriched	4%	4%	4%	4%	7%	7%	14%	14%	21%	25%	32%	36%	43%	43%	46%	50%	57%	64%	71%	75%	82%	86%	93%	96%
7th Grade Level	7%	8%	8%	11%	12%	17%	26%	29%	32%	39%	39%	45%	49%	56%	63%	68%	70%	74%	76%	80%	87%	89%	92%	96%
8th Grade Level	4%	6%	9%	9%	13%	16%	18%	22%	25%	27%	30%	35%	43%	45%	56%	61%	67%	69%	73%	78%	84%	89%	91%	97%

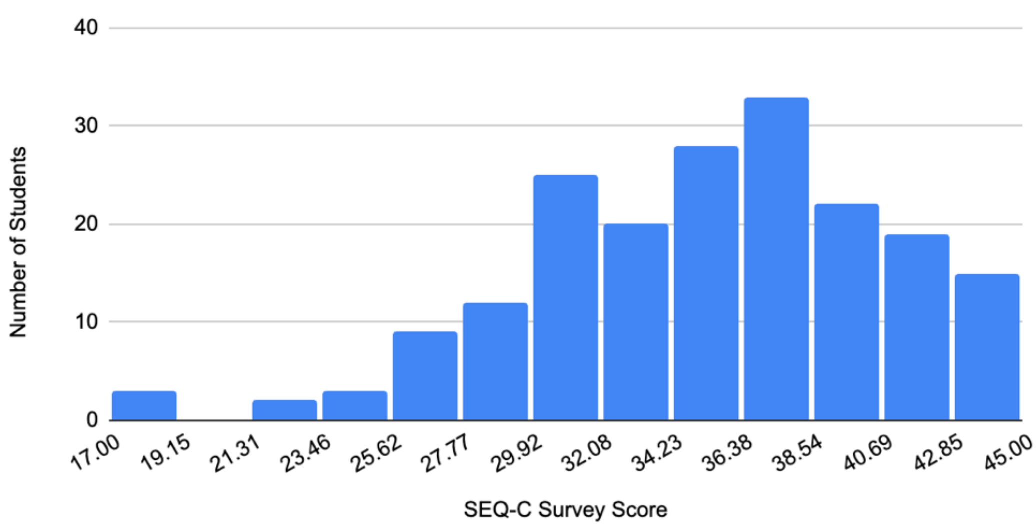
Range between highest enriched and grade level

7th grade	5%	6%	5%	6%	6%	10%	17%	17%	14%	19%	18%	16%	16%	17%	21%	18%	12%	4%	0%	-1%	3%	-2%	-7%	-4%
8th grade	1%	2%	5%	5%	6%	9%	4%	8%	3%	2%	-2%	-1%	0%	2%	10%	11%	10%	4%	2%	3%	2%	3%	-2%	0%

The majority of the students who attended the grade-level math class self-reported low mathematical self-efficacy at a higher rate than the students who attended enriched math classes, although outliers were found showing that some students in the grade-level math class self-reported high mathematical self-efficacy. As shown in Figure 4.3, the two other data themes consisted of students who attended the enriched-level math classes who self-reported high mathematical self-efficacy with outliers found showing that some students in the enriched-level math class self-reported low mathematical self-efficacy.

Figure 4.2

Self-Reported Self-Efficacy of Students Enrolled in Enriched Math Classes



Phase 2: Qualitative Data Collection

Utilizing the four distinct thematic groups as a foundational framework, the researcher undertook a process of deliberate selection to constitute a more refined cohort of participants. This concerted selection aimed to pave the way for an in-depth exploration of the theoretical concept pertaining to dominant self-efficacy domains as catalysts for the augmentation of mathematical self-efficacy. As an outcome of this process, each participant within the four thematic groups was extended an informed consent form, which included comprehensive details pertaining to the research scope and subsequent procedural steps.

The researcher successfully procured a total of 34 duly signed consent forms, underscoring the assent provided by both the parental guardians and the participating students. This demonstrated willingness on the part of both parents/guardians and student participants to actively engage in the research, thus underscoring their commitment to its objectives.

As shown in Table 4.3, the smaller group consisted of students from all four categories in order to get a better understanding of their mathematical self-efficacy and whether there was a dominant galvanizer that was most effective for them that may have been implemented during mathematical instruction that contributed to their self-efficacy score reported.

Table 4.3

Four Themed Groups

	Low Reported Self-Efficacy	High Reported Self-Efficacy
Grade Level Class	6	12 (outliers)
Enriched Grade Level Classes	4 (outliers)	12

Table 4.4 presents a deeper, more detailed look at the results of the data that were collected, including class attendance and self-reported SEQ-C score.

Table 4.4

Count of Self-Reported SEQ-C

Class	19	20	21	22	23	25	26	28	30	33	34	35	37	38	40	41	42	43	44	45	Total
6th Grade Enriched								1													1
7th Grade Enriched	1																				1
7th Grade Highest Enriched					1	1				1	1		1	1			1				7
8th Grade		1	1	1	1		1	2				2			2	4			2	1	18
8th Grade Enriched									1	1											2
8th Grade Highest Enriched																2		1	2		5
Grand Total	1	1	1	1	2	1	1	3	1	2	1	2	1	1	2	6	1	1	4	1	34

In-Situ Experiences

To answer the research question, "Can impromptu, brief interventions conducted immediately prior to or during a math problem-solving session, crafted to enhance the four domains delineated by Bandura, exert a beneficial influence on the levels of mathematical self-efficacy *discernible amongst middle school students*?", five separate in-situ experiences were set up for the 34 students, and each session was completed with a self-reflection around the effectiveness of the unique mathematical self-efficacy galvanizer used for the specific session. Video clips were utilized during the vicarious experience domain and the physiological response domain (see Appendix D).

The results of each session showed that there was no one unique galvanizer that was most effective for the 34 students or a certain group of students. For example, all students enrolled in the enriched-level eighth-grade math class did not report an overwhelming inclination to a specific math self-efficacy galvanizer, such as needing verbal persuasion while solving the mathematical problems. All students were able to verbalize the effectiveness of each galvanizer of self-efficacy, and some students were able to verbalize which of the four galvanizers was most effective for them.

Performance Outcomes

Table 4.5 presents a compilation of responses to the performance outcome galvanizer that was deemed positive and effective by the students. While the number of data points is limited, it is noteworthy that the comments predominantly emphasized the favorable influence of engaging in a math problem-solving activity at the commencement of a session. This practice not only enhances self-efficacy but also engenders a sense of comfort and ease, thereby promoting increased self-assurance and preparedness to confront subsequent math problems. The experience of achieving success in solving the initial problem resulted in a pronounced surge of confidence, thereby exerting a beneficial impact on individuals' mindset and subsequent performance. Through repeated instances of success and improvement, students' math self-efficacy was reinforced, leading to a cycle of enhanced skill development and increased self-efficacy.

Table 4.5

FlipGrid Responses - Performance Outcomes (Positive Reactions)

Class	Outlier	Comment
Grade Level	No	"After solving the math problem at the beginning of the session, I felt more confident. I really need problems like that because it was easy and just made me feel comfortable."
Grade Level	No	"So, like, it just gave me confidence for doing, like, the math problem and, yeah, like, I just feel more confident."
Grade Level	Yes	"After solving the math problem at the beginning of the session, I felt more confident to solve more math problems."
Grade Level	Yes	"The math problem in the beginning felt easy and I felt confident, so I didn't do anything wrong in my solving already."
Grade Level	Yes	"My favorite strategy is doing the math problem ahead of time because it helps get you in the right mindset."
Enriched Grade Level	No	"It really gave me a confidence booster of the soul because I answered it in five seconds and, you know, just I appreciate the confidence booster, you know."
Highest Enriched Grade Level	No	"The problem at the beginning was pretty easy and it gave me the confidence that helped me succeed later on."
Highest Enriched Grade Level	No	"It helped me just get some confidence and get out of my own head."
Highest Enriched Grade Level	No	"It like, it kind of warmed up my brain a bit and I felt like I started to get ready to do the math."
Highest Enriched Grade Level	Yes	"I also feel that my math self-efficacy is mostly increased when I am experiencing a successful math-solving session because when I get more right, I feel I get better and better. And I get more confident because I'm getting them right."

Alternatively, Table 4.6 provides responses from participants who did not find the performance outcome galvanizer effective to increase mathematical self-efficacy. In fact, participants expressed that solving an easy math problem had little to no impact on their emotional state or confidence. They attributed this lack of change to the simplicity of the problem, as it did not challenge their abilities or require significant mental effort. In contrast, they speculated that a more challenging problem would have elicited a greater sense of accomplishment and boosted confidence, as it would have required them to engage their cognitive abilities and employ a variety of problem-solving tools. The expectation of a more complex problem also contributed to confusion when the initial problem turned out to be straightforward.

Table 4.6

FlipGrid Responses - Performance Outcomes (Negative/Neutral Reactions)

Class	Outlier	Comment
Enriched Grade Level	No	"I felt no change in emotion after doing the math problem because the math problem was really easy."
Enriched Grade Level	Yes	"Solving the math problem made no difference in how confident I felt before I started solving the math problem."
Highest Enriched Grade Level	No	"I think if it were a more challenging problem, I would have felt more accomplished when I completed it, and I would have felt more accomplished in my skills because I had to work my brains and use a variety of tools. So I felt more ready to tackle other things."
Highest Enriched Grade Level	No	"So solving my math problem made no difference to help my confidence."
Highest Enriched Grade Level	No	"The math problem at the beginning was quite easy, and I feel like it did not impact my performance and the other questions. I think it sort of confused me because I thought it would be more difficult, and I was looking for, like, what made it more complicated."

1. Vicarious Experiences

Table 4.7 provides an overview of the responses obtained from the vicarious experience galvanizer. The responses indicate positive perceptions and effectiveness as reported by the students. It is important to note that the data points are limited in number. The comments primarily emphasized the favorable impact of observing other students, particularly peers of similar age, successfully solving math problems. The act of witnessing these achievements was seen as fostering confidence and acting as a motivational factor, encouraging individuals to invest greater effort in their own problem-solving endeavors.

Table 4.7

FlipGrid Responses - Vicarious Experience (Positive Reactions)

Class	Outlier	Comment
Grade Level	No	"Watching other kids my age solve math problems successfully makes me feel like I could do the math problem just like them. Even if they're struggling, but they still get the right answer, I could relate to that. Yeah."
Grade Level	No	"I feel that my math self-efficacy is mostly increased by watching other kids succeed in math problems and having a successful math because it motivates me to try better. Let's try to get a better score than other students."
Grade Level	No	"So watching the video I feel more confident that I can solve similar math problems because I feel like if you work in a, like, group it's like you can all help each other to, like, solve a problem. I feel like you get more motivated to learn with other people around you."
Grade Level	Yes	"Watching other kids my age solve math problems because if I can't solve a math problem that mostly means I just forgot how to solve it. So watching other kids can make me refresh my memory and solve it."
Grade Level	Yes	"After watching the video, I feel more confident that I can solve similar math problems because, I mean, then I understand how the kids solved in the different ways they did it and you might get it wrong, but you might at the end get it right."
Grade Level	Yes	"Watching other people solve problems and how other people do it may be helpful, but I don't know if it's among other kids. I don't know if they do it correctly, but it would be better to watch an adult."
Enriched Grade Level	No	"Alright, so after watching the video, I feel more confident that I can solve similar math problems because I noticed the students really didn't really get it at first. But after they put together the different perspectives and they, like, kind of pieced the problem together like a puzzle because they all understood one portion. So once they all put it together, it was like it was perfect. So I think that if I could do that in groups, I would succeed as well."

Class	Outlier	Comment
Highest Enriched Grade Level	No	"And so I think if I was put in that situation I would do pretty well too. Because if I was in a group and we all understood a little portion, we could find the most efficient way to solve a problem. It would increase confidence because we're all working together, and then if we cannot get the answer correct, we can all offer what little we have to get a great solution."
Highest Enriched Grade Level	No	"After watching the following video, I feel more confident that I can solve similar math problems because I realized that when these students worked together it became a lot easier even though they didn't understand it at first. And I think that working in groups on certain problems, you can hear different perspectives on problems that you can think of, so it makes it easier to, like, just figure out, like, the answer."
Highest Enriched Grade Level	No	"I don't think any of the other strategies really help other than maybe solving a math problem before that's difficult or that's on the same level so I can get used to it and so I can learn the strategies, and then also seeing a teacher solve the problem and show what strategies they use first is helpful."

Additionally, observing peers encountering challenges and eventually arriving at correct solutions created a relatable experience that contributed to the enhancement of self-efficacy. Participants expressed that the videos depicting middle school-aged students engaged in group settings, collaborating on math problems with their peers, established a supportive and motivational environment.

Within this context, the collective problem-solving efforts and the incorporation of diverse perspectives appear to contribute to a more comprehensive understanding of the given problems. Collaboration not only facilitated the identification of efficient strategies but also provided opportunities to learn from the approaches employed by others. Additionally, participants recognized the significance of observing teachers as they demonstrate problem-solving strategies and provide guidance throughout the process.

On the contrary, Table 4.8 provides responses from the students who did not find the vicarious experience galvanizer effective to increase mathematical self-efficacy. The comments highlight the varying effects of watching other middle-school-aged students problem-solving in a math class. While some participants expressed confidence in their own problem-solving abilities and felt that watching the videos was unnecessary, others felt that the videos had minimal impact on their confidence level or comfort with similar problems.

Table 4.8

FlipGrid Responses - Vicarious Experience (Negative/Neutral Reactions)

Class	Outlier	Comment
Enriched Grade Level	Yes	“I feel I don't need to watch the videos before solving the problems because I can already solve the problems normally really fast.”
Highest Enriched Grade Level	No	“Yeah, after watching the video, I had the same level of confidence I had before, and I can easily solve a similar problem so it really didn't do that much to me. It was cool video but I didn't get any boost of comfort.”
Highest Enriched Grade Level	No	“Watching the other people solve math problems did not help me. Um, I think seeing a teacher solve the math problem first might help because I could see what strategies they used. Watching the video of students doing it did not help me. But I do see how it could help people because they could see the strategies they used.”

Participants acknowledged that watching a teacher demonstrate problem-solving strategies might be more helpful as it provides insights into effective approaches. The participants recognized that although the videos may not have personally benefited them, they acknowledged the potential value for others, as observing the strategies used by students in the videos could be beneficial.

Verbal Persuasion

Table 4.9 presents the complete set of responses obtained from the verbal persuasion galvanizer. All responses indicate positive perceptions and effectiveness according to the students. It is worth noting that the comments primarily highlight the importance of receiving feedback during the process of solving math problems and its positive impact on self-efficacy and confidence. Participants expressed a preference for feedback as it allowed them to evaluate their performance and ascertain whether they were progressing in the correct direction. Constructive feedback was seen as providing guidance, assisting individuals in identifying errors, and promoting improvement, thus contributing to an enhanced understanding of the problem-solving process.

Table 4.9

FlipGrid Responses - Verbal Persuasion (Positive Reactions)

Class	Outlier	Comment
Grade Level	Yes	"Actually, I do like getting feedback when, uh, I'm doing a math problem because it actually helps me know if I'm doing good or bad."
Grade Level	Yes	"I like feedback while I'm solving problems because, um, sometimes I don't understand how to solve it, so I like it when they help me solving problems. I feel confident I can solve the problems easier when they give feedback because then it makes me understand how to do it."
Grade Level	Yes	"For me, I sometimes like getting feedback, but sometimes the feedback is just more like insulting than, like, actually productive. Sometimes when I get feedback I know what to do, and so I can build off of that to get the right answer. So yeah, feedback is good."
Grade Level	Yes	"I like getting feedback from the teacher because it helps me to learn from my mistakes and what I did wrong."
Enriched Grade Level	No	"Like, I like getting feedback because it kind of, I don't know, it helps me learn more, you know, I feel better as a person because they start to, like, describe it. They really walk through it, make sure you have a good understanding."
Enriched Grade Level	No	"I think that feedback from the teacher while I'm solving a problem, most increased my self-efficacy in that because, like, I'd like getting feedback because then I can work on it."
Enriched Grade Level	Yes	"I feel that my math self-efficacy is most increased by listening to feedback from the teacher while I'm solving because it helps me know if the way I'm solving is most efficient and fastest or is slow and inefficient. This is because I'm in the middle of a problem and I've been stuck on it for like 15 minutes. Let's just say just move on and come back and check on it and then you can move on and actually finish."

Class	Outlier	Comment
Highest Enriched Grade Level	No	“I feel more confident to solve the problems when I get feedback because I like people telling me what I do wrong so then I can improve off of that and, like, I know what I need to improve on because, like, when I mess up and they tell you can do this you can do that it, like, helps me because I know what I'm doing wrong and, like, it just it helps me get a better understanding of what I can improve on.”
Highest Enriched Grade Level	No	“I guess feedback helps sometimes when I'm having trouble with stuff, but when it's easy, it kind of just gets annoying. So it kind of depends on the situation, but most of the time I'll ask for feedback.”
Highest Enriched Grade Level	No	“I feel more confident to solve problems when I get feedback because, you know, typically it's, like, positive feedback, but the only time I ever get nervous about, like, solving problems, like, with negative feedback because I'm, like, worried that, like, I was doing all of them wrong, and then I’m worried I’m gonna mess up the rest of them. But when I get, like, positive, like, feedback, I feel confident I can solve problems easier because they're, like, ‘you're doing a good job.’ So then I think I know what I'm doing. Sometimes I don't like getting feedback. Sometimes I feel like you could either, like, lower or, like, make my energy, like, higher, but a lot of times I feel like it would, like, lower my self-confidence. But sometimes, you know, it's good, so I don't mess up all of them badly. So I both like getting feedback, but I also feel like it can also be bad.”
Highest Enriched Grade Level	No	“So I feel like generally if I'm doing a difficult problem and then someone comes to give me a feedback, then it helps because I have that assurance that I am doing it correctly, or if I'm doing it wrong that I have been corrected before I get too far.”
Highest Enriched Grade Level	No	“I feel confident that I can solve the problems correctly when I get feedback, because when I get feedback, I get tips. I don't like getting feedback and solving the problem because I can get maybe a bit pressure and all that, so it might screw up more, and I might just wanna solve it on my own. And I like getting feedback on solving problems because sometimes it's always good to have tips.”
Highest Enriched Grade Level	No	“I think feedback is the most helpful. I don't think any of the other strategies really help other than maybe solving a math problem before that's difficult or that's on the same level so I can get used to it and so I can learn the strategies, and then also seeing a teacher solve the problem and show what strategies they use first is helpful.”
Highest Enriched Grade Level	Yes	“I feel that my math self-efficacy is mostly increased when I'm getting feedback from the teacher because they know more than me, and they're usually giving me some advice that I haven't heard of, and it's usually very helpful.”

The feedback provided by teachers was highly valued due to their expertise and ability to offer valuable advice and strategies. Some participants expressed appreciation for feedback across all situations, while others emphasized its greater benefits during challenging problems to ensure accuracy before investing excessive time. Nevertheless, feedback was also recognized as a potential source of pressure or a factor that may lower self-efficacy if perceived negatively.

Table 4.10 provides responses from the students who did not find the verbal persuasion galvanizer effective to increase mathematical self-efficacy. The comments revolve around negative perceptions and anxiety associated with receiving feedback during problem solving. Participants expressed a preference for uninterrupted focus when working on problems, feeling that feedback can slow them down and distract from their thought process. They indicated that feedback during problem-solving can make them feel like they have done something wrong and hinder their progress. The interruption caused by feedback can lead to forgetfulness and confusion regarding their initial train of thought. Additionally, participants expressed nervousness about meeting expectations and feeling pressured when receiving feedback, as they worried about the judgments or standards set by others.

Table 4.10

FlipGrid Responses - Verbal Persuasion (Negative/Neutral Reactions)

Class	Outlier	Comment
Grade Level	No	"I don't like getting feedback on solving problems because I feel like it kind of, like, slows me down. When I'm solving problems, I prefer to, like, do it until, like, until I'm good and, like, I'm done. And then, like, when I'm done with my work, like, they can give me the feedback, not while I'm doing it, because then I feel like I did something wrong, and I don't want to keep going."
Enriched Grade Level	No	"I guess you could say I don't like feedback on some problems because, like, it's often distracting, and I would like to keep solving the problem, so mostly I find feedback most distracting."
Highest Enriched Grade Level	No	"I feel nervous when I get feedback because I'm like on a train of thought, and it kind of messes me up when someone tries to talk to me, and it makes me forget what I was thinking before. But I also get nervous because I feel like I have to meet the expectations for everybody."

Physiological Feedback

Table 4.11 presents the responses obtained from the physiological feedback galvanizer, with all responses indicating positive perceptions and effectiveness according to the students. The comments primarily highlight the positive influence of music and relaxation techniques on math performance. Participants expressed that listening to music while solving problems aids their focus and concentration by diverting attention from overthinking. Music was described as a calming and enjoyable element that mitigated the perception of math as boring and created a more relaxed environment. The combination of relaxing music and positive self-talk was identified as an effective approach to increasing math self-efficacy. The calming effects of music and relaxation techniques were attributed to improved concentration, reduced nervousness, and enhanced problem-solving abilities. Participants noted that these techniques instilled a sense of calmness, focus, and smoother cognitive functioning, ultimately rendering math problems more manageable.

Table 4.11

FlipGrid Responses - Physiological Feedback (Positive Reactions)

Class	Outlier	Comment
Grade Level	No	"The music made me progress into math better."
Grade Level	No	"When I was listening to music while I was problem solving it helped me because I'm not thinking too much about the problem and I'm not over thinking it."
Grade Level	No	"I feel confident I can solve problems easier after I watched the video because I feel like it makes, like, you calm down, and I work better with music than other people just telling me I'm doing great, and I prefer, like, it better because I feel like it does help, like, especially if you're, like, just nervous about it because, like, it just, like, helps, like, solve problems more easier."
Grade Level	Yes	"The music helped me concentrate a lot. It made me focus on doing the math problems. And I don't know, it just helped me concentrate a lot, and I was able to do them, like, a lot faster and more focused."
Grade Level	Yes	"I think listening to music makes me feel more confident about math because it helps me focus and it makes it more fun, I guess. It makes math seem less boring because you're actually listening to something. And I don't know, it just helps me focus a lot better."
Grade Level	Yes	"I feel that my math self-efficacy is mostly increased by listening to relaxing music or using positive self talk because it calms me down and I feel more confident in doing my math."
Grade Level	Yes	"I felt like what would help me the most is listening to relaxing music and using positive self talk when solving math problems because it really gets you more relaxed and helps you focus more."
Grade Level	Yes	"I feel more confident in the math because the calming music was relaxing, and it took my mind off the noise that was in the background. I don't really feel nervous doing the math problem because, well, it was kind of easy and it made me concentrate a bit more. I feel calm. I feel confident after listening to the little video about the relaxation because it felt calming. I did watch the video before solving the problems. And I watched the video one time, and it was really helpful."
Enriched Grade Level	No	"I felt more confident when I watched the video because it put my mind into, like, a calming state so that I could answer the problems with more ease, and it was just all around a better experience."
Highest Enriched Grade Level	No	"I played the video two times, and I think it did help because it kind of made me more focused and like calmer so I could focus. Also, when I was watching it, it kind of gave me a break for a few seconds so that I could focus again and stuff."

Class	Outlier	Comment
Highest Enriched Grade Level	No	"Yeah, I feel like out of all the days we did, the one that helped my math self-efficacy increase the most was definitely the relaxing music or using positive self talk because, like, just being able to relax and listen to, like, good music, it helps you, like, calm down and not overthink things. It makes the problems easier to attack and your mind just works smoother, and you remember things easier. So it definitely helped me do math problems. So I definitely thought that it was the best."

Table 4.12 provides responses from the students who did not find the physiological feedback galvanizer effective to increase mathematical self-efficacy. These students expressed a preference for a quiet environment while engaging in math-related activities. Participants indicated that the video or music provided did not have a significant impact on their math performance. They mentioned that they usually listen to other music during math, implying that their personal choice of music is more effective for them. Some participants stated that the music or video was distracting while solving the problems, and they felt they work best when it is quiet and free from distractions.

Table 4.12

FlipGrid Responses - Physiological Feedback (Negative/Neutral Reactions)

Class	Outlier	Comment
Grade Level	Yes	"Uh, I don't really think the video did anything. I don't really like math. I watched the video one time, but it didn't really do anything because I usually just listen to other music during math."
Highest Enriched Grade Level	No	"I felt confident that I could solve the problems presented even without music. The music was kind of tuned out in my head, so it didn't make much of a difference, at least from what I saw. I didn't feel more confident."
Highest Enriched Grade Level	No	"I feel like the music was distracting when doing the problems. It's kind of hard to tell because the problems were easy. But I think I work best when it's quiet."
Highest Enriched Grade Level	No	"When there's, like, music playing, it's distracting for me. And I think I do better when it's quiet and there's no distractions around me."

Students were able to verbalize their most effective galvanizer for math self-efficacy after completing the four in-situ sessions using each of the galvanizers. On the fifth day of in-situ sessions, 16 out of 34 students claimed one or more than one most effective domain that galvanized their math self-efficacy after the four problem solving sessions. Table 4.13 includes comments from the 16 students and reveals diversified choices with the following breakdown: (a) four students chose vicarious experience, (b) four chose performance outcomes, (c) six chose physiological response, and (d) five chose verbal persuasion as their dominant domain galvanizer.

Table 4.13

FlipGrid Responses - Most Effective Galvanizer

Class	Outlier	Comment
Grade Level	No	"I feel that my math self-efficacy is mostly increased by watching other kids succeed in math problems and having a successful math session because it motivates me to try better and, you know, try to get a better score than other students."
Grade Level	Yes	"I feel that my math self-efficacy is mostly increasing by watching other kids my age solve math problems because if I can't solve a math problem that mostly means I just forgot how to solve it. So watching other kids can make me refresh my memory and solve it."
Grade Level	Yes	"I felt like what would help me the most is listening to relaxing music and using positive self talk and solving math problems because it really gets you more relaxed and helps you focus more."
Grade Level	Yes	"I feel that my math self-efficacy is mostly increased by listening to relaxing music or using positive self talk because when it calms me down and I feel more confident in doing my math. And also from feedback from the teacher because it helps me to learn from my mistakes and what I did wrong."
Grade Level	Yes	"I feel that my math self-efficacy is mostly increased by watching other kids my age solve math problems and feedback from the teacher while I'm solving because it just gives me more motivation, and it really helps more emotionally to, like, let me know that I could do it."
Grade Level	Yes	"I feel like my math self-efficacy is increased both by listening to relaxing music and by using positive self talk because it just really does help me, like, get better."
Grade Level	Yes	"My favorite strategy is the doing the math problem ahead of time because it helps get you in the right mindset."
Enriched Grade Level	No	"Alright, so I think that feedback from the teacher while I'm solving a problem most increased my math self-efficacy in that because, like, I'd like getting feedback because then I can work on it right. So I could work on it, and it just makes me an overall better person."
Enriched Grade Level	Yes	"I feel that my math self-efficacy is most increased by listening to feedback from the teacher while I'm solving because it helps me know if the way I'm solving is most efficient and fastest or is slow and inefficient. This is because I'm in the middle of a problem and I've been stuck on it for like 15 minutes."

Highest Enriched Grade Level	No	“I think the one that helped me the most was listening to relaxing music or using positive self talk because it like, I don't know, it kind of just made me more relaxed, and it kind of could clear my brain a bit so that I could focus more on the problems. I don't think the feedback really helped me because it kind of just made me lose my train of thought and, like, I don't know, it didn't really help me that much. The experiencing a successful math problem didn't really help me that much because it kind of didn't really relate to what I was doing, and it didn't really give me that much confidence because I knew I could solve that for a while. Then watching other kids like myself solve successfully didn't really help me either because it was kind of not, like, teaching me anything or anything like that, and it was just me observing and that didn't really help anything. I think the listening to relaxing music helped me but, like, it didn't help me that much. For me, the one that helped me the most I feel was just doing them on my own and listening to the relaxing music.”
Highest Enriched Grade Level	No	“So either one or four probably. It depends if it's a problem I'm really stuck on or if I'm just like I'm like ‘Okay, I got this.’ But I see why, like, all these people could, like, think of each one as helpful. I think my self-confidence for math is already pretty good, though, because, like, I'm in 7.2 and I know that I can do math. I don't really know if it really helped that much, though, because I already kind of knew I had confidence.”
Highest Enriched Grade Level	No	“I felt like my math self-efficacy was mostly increased by listening to relaxing music because it helped me calm my brain, and it soothes my feelings so I felt like I could focus on my work more.”
Highest Enriched Grade Level	No	“Yeah, I feel like out of all the days we did, the one that helped my math self-efficacy increase the most was definitely day two, Tuesday. I think listening to the relaxing music or using positive self talk helped me because like just being able to relax and listen to like good music, it helps you, like, calm down and not overthink things. It makes the problems easier to attack and your mind just works smoother and you remember things easier. So it definitely helped me do math problems. So I definitely thought that it was the best.”
Highest Enriched Grade Level	No	“None of the methods really helped me. The math was pretty simple and so I didn't really need confidence, but encouragement from the teacher was really nice.”
HIghest Enriched Grade Level	Yes	“I feel that my now self-efficacy is mostly increased when I'm getting feedback from the teacher because they're, like, they know more than me and they're usually giving me some advice that I haven't heard of, and it's usually very helpful.”
Highest Enriched Grade Level	Yes	“I also feel that my math self-efficacy is mostly increased when I am experiencing a successful math solving session because when I get more right I feel I get better and better. And I get more confident because I'm getting them right.”

It is also important to note that all students who responded with performance outcome as their dominant self-efficacy galvanizer attended the enriched grade-level math classes. Additionally, only students who attended the grade-level math classes stated the vicarious experience domain as their dominant galvanizer.

Phase 3: Follow-up Interviews

Upon a comprehensive analysis of the transcribed reflections from the 34 participating students, discernible indications emerged, suggesting the presence of an overarching dominant catalyst that engenders mathematical self-efficacy among the individual participants. This propensity is evident in the distinct reflections rendered by each student, which collectively allude to the existence of a prevailing influential factor in fostering their mathematical self-efficacy.

Each student within the cohort demonstrated the capacity to engage in a reflective discourse concerning their respective in-situ problem-solving experiences and the corresponding efficacy of each session. Within this analytical context, it is noteworthy that certain students exhibited the capability to identify one or more specific self-efficacy domain galvanizer(s) that resonated with their cognitive disposition.

In light of the preliminary analysis and the intent to delve more profoundly into the underlying mechanisms governing the discernment of a preeminent self-efficacy galvanizer intervention, the researcher exercised discretion in directing attention toward a subset of 11 students. This subgroup, characterized by their heightened articulation of a conspicuous self-efficacy galvanizer intervention, served as a focal point for subsequent investigation. Notably, this selection criterion was guided by the students' adeptness in not only articulating the presence of a dominant galvanizer intervention but also expounding upon the rationale underpinning its efficacy in the context of their mathematical self-efficacy enhancement.

To understand the intricate dynamics at play, the researcher conducted one-on-one interviews with the 11 chosen participants. The dialogues during these interviews were meticulously recorded, with the intent of facilitating analysis, coding, and subsequent probing into the process underpinning the identification and validation of a dominant self-efficacy galvanizer intervention. This interpretive inquiry sought to unmask the intricate cognitive and perceptual nuances that shaped participating students' discernment of these catalytic factors and their cognitive functioning, thereby contributing to an enriched understanding of the motivational dynamics within the realm of mathematical self-efficacy. Table 4.14 provides the demographics of the smaller sample of students.

Table 4.14

Four Themed Groups - One-on-One Interviews

	Low Reported Self-Efficacy	High Reported Self-Efficacy
Grade Level Class	1	6 (outliers)
Enriched Grade Level Classes	2 (outliers)	2

The one-on-one interviews provided further insight regarding mathematical self-efficacy in all four domains of self-efficacy. Each of the 11 students were asked 12 general questions regarding mathematical self-efficacy. Table 4.15 includes questions with a sampling of answers coded by the researcher.

Table 4.15

One-on-One Interview Questions and Comments

Interview Question	Participant Comment	Attending Math Class
How confident do you feel when it comes to solving math problems?	"If it's at the beginning of class, I need to turn my math brain on, at end of class then okay because we did it with examples all period."	Highest Enriched Math Class
What do you think are your strengths and weaknesses in math?	"I think my strength is feeling confident in general solving problems and I'm not scared to ask for help. My weakness is sometimes when I'm bored, I can't focus. But when I get on a roll then I'm on it and I'm focused."	Grade-Level Math Class
Have you ever felt like you couldn't do well in math? If so, why?	"This year because I moved up a level and missed some things. I would be confused but then I would see other kids not knowing it either so I felt better about it."	Highest Enriched Math Class
Have you ever struggled with a math concept? How did you overcome that challenge?	"I actually talked to one of my classmates this year to get help because my teacher needs to help a lot of students. We would do the problems together but sometimes I would try to do it on my own and then ask her questions. I would rather work with a partner instead of on my own."	Highest Enriched Math Class
Do you think that the amount of effort you put into studying math affects your performance?	"When I feel like I'm not good at math, I practice it over and over again. For example, for multiplying and dividing fractions, I did them all summer with my mom because I didn't know how to do it. Now I don't have any trouble."	Enriched Grade-Level Class
Have you ever received positive feedback from a teacher or peer that has boosted your confidence in math?	"This year my teacher makes me feel confident and gives me direction and I understand it really quickly. I've never felt like it was okay to get it wrong, but now I'm more okay with it."	Highest Enriched Grade-Level Class

Interview Question	Participant Comment	Attending Math Class
How do you typically prepare for math tests?	"My teacher this year told me to go through my notes and do the same problems over and over again to see if I get the same answers. I never did this before and it really helped me."	Highest Enriched Level Math Class
Have you ever worked with a tutor or sought extra help in math? If so, how did that experience go?	"I always felt like I wasn't good at math; I was never in the .1 or .2 classes, I had tutoring in elementary school, but it didn't really help."	Grade-Level Math Class
How do you feel about group work in math?	"If I work with someone in math, I want to pick my partner. I like working with someone in math if they are good at math too. I'm competitive so I want to do better than the person next to me or the one I'm working with."	Grade-Level Math Class
	"When I work with other people, I may get distracted if they are doing it a different way and then I wonder if I'm doing it right."	Highest Enriched Grade-Level Math
How do you feel when you solve a math problem correctly?	"When I solve a math problem correctly, it boosts my confidence and I want to do more."	Grade-Level Math Class
	"If I solve a math problem correct, I feel great. But if I don't, I don't get anxious. I just think about it and then come back to it. Either way, it's okay."	Enriched Level Math Class
What is your earliest memory of a success in math?	"When I was in kindergarten, I remember knowing how to add without using the blocks the other kids were using. My dad practiced adding with me even before that."	Highest Enriched Grade-Level Math
What is your earliest memory of a failure in math?	"Biggest failure was in elementary school in fourth grade because my teacher gave me no feedback, no help, and, sometimes, I would hand in something and it didn't even get a grade."	Grade-Level Math Class

Performance Outcomes

Performance outcome was stated to be important for three out of 11 students because they needed to have practiced the problems enough to be consistently correct before feeling they could proceed on their own and feel confident. Unanimously, students stated that if they have already experienced a concept or similar problems, they feel self-efficacious to begin solving problems regarding the same concept or more of the same problems. Furthermore, all 11 students stated that encountering a new concept or problem-solving session would decrease their self-efficacy.

Vicarious Experiences

The domain of vicarious experiences ranged between a certain ambiguity or indifference regarding other students performing well on similar tasks to students being competitive in nature and wanting to outperform other students. All students mentioned that modeling from a teacher, including explicit instruction and explanation, to be necessary before performing a mathematical task. In fact, one student explicitly stated they would not even proceed with a new problem concept without feeling anxious and would ask for support.

All students who accelerated a level of math over the summer stated that at the beginning of the year they felt some decreased mathematical self-efficacy due to other students in the class verbalizing their knowledge of concepts which they did not quite understand at that point. Two students stated that they felt as if they were “bad at math” because “other students knew things they did not know how to do.”

Verbal Persuasion

Feedback was a factor for all students who participated in the one-on-one interviews and was perceived to be a self-efficacy booster. The feedback did not need to be from a specific type of individual. In fact, feedback was appreciated from a peer who was collaborative, a peer who was struggling and receiving support, or a teacher. Students just needed to hear that they were performing well for either the purpose of positive reinforcement or for guidance if they were solving incorrectly or proceeding down the wrong conceptual path and needed redirection.

Physiological Response

Although feelings of being anxious were mentioned, the use of strategies to inhibit self-doubt or anxiety were not mentioned except from one student. The student mentioned using music or positive self-talk when encountering new concepts or math problems. All other students used either a vicarious experience or feedback from the teacher to overcome feelings of being anxious.

Primary Research Question

The primary research questions was developed to determine whether or not brief interventions conducted immediately prior to or during a math problem-soling session, crafted to enhance the four domains delineated by Bandura, exert a positive influence on the mathematical self-efficacy of middle school students. Although the data suggests there may not be one overarching self-efficacy galvanizer for a group of students, it does suggest that students may be able to verbalize which of the four galvanizers of self-efficacy is most effective for them, which answers the secondary research question: how do the four domains of self-efficacy influence the mathematical self-efficacy of middle school students in grade-level, ability-based math pathway classes?

Also, it is important to note that these four domains are interconnected and can influence each other. For example, a positive mastery experience can enhance self-efficacy, which in turn can influence one's physiological and affective states. Similarly, social persuasion can influence vicarious experiences and vice versa.

CHAPTER 5: DISCUSSION

In today's rapidly evolving educational landscape, the responsibilities of educators extend far beyond imparting knowledge and facilitating learning. Educators play a pivotal role in shaping the academic journey of their students by fostering engagement and motivation. One vital aspect of this role is the cultivation of students' self-efficacy—their belief in their own abilities to succeed and overcome challenges. By empowering students with a strong sense of self-belief, educators can inspire them to become active participants in their own learning process, unlocking their full potential and propelling them toward academic success.

The idea of increasing self-efficacy in order to increase motivation and thus engagement is not a new idea (Alhadabi & Karpinski, 2019; Ayllón et al., 2019; Honicke & Broadbent, 2016; Ozkal, 2019; Ugwuanyi et al., 2020; Usher, Li, et al., 2019; Yıldız et al., 2019). This study suggests that there may be strategies educators can employ in the classroom to (a) encourage students to apply metacognition to discover which self-efficacy galvanizer(s) most effectively increase their self-efficacy, and (b) help students employ strategies to increase self-efficacy according to the situation and, in turn, increase motivation and engagement.

In contradiction to the regression analysis instituted after a survey created by Usher and Pajares (2009), which indicated the performance outcome domain as the most powerful source of self-efficacy, this study suggests there may not be one overarching self-efficacy galvanizer for each student. Furthermore, this study also suggests that each of the four galvanizers of self-efficacy can be sought, and strategies can be employed during class instruction in conjunction to the core curriculum.

Based on the findings, educators and policymakers can work to enhance students' mathematical self-efficacy by providing positive learning experiences, encouraging peer support and mentoring, offering constructive feedback and praise, and addressing any emotional or stress-related barriers that hinder students' confidence in math.

In accordance with Usher and Pajares (2009), it is important to note that self-efficacy is a complex and dynamic construct, and individual differences, such as gender and ethnicity, can also play a role in how these domains influence a student's mathematical self-efficacy. Therefore, tailored interventions and support might be needed to address the specific needs of each student.

Summary of the Study

Chapter 1 discusses the importance of increasing self-efficacy in students in order to increase engagement and motivation and consequently academic achievement. Chapter 2 reviews the growing body of research related to self-efficacy and highlights the needs of addressing self-efficacy to increase academic achievement. The review of literature does not include an overwhelming base of literature that supports a dominant domain of self-efficacy to most effectively utilize. Furthermore, the available literature is inconclusive and requires further research. Chapter 3 outlines the research methods and phases of data collection and coding used to formalize theories and attempt to answer the research questions. Chapter 4 presents the results of the data collected, including demographic profiles and the qualitative analyses for each of the research questions. This chapter explores the findings of the grounded theory research study, focusing on identifying the domains of self-efficacy that most effectively galvanize the mathematical self-efficacy of middle school students in ability-based math pathway classes and proposes suggestions for further research.

Primary Research Question

In agreement with Usher, Ford, et al. (2019), this study suggests that math self-efficacy can be enhanced through various methods and is ever changing through multiple experiences in diverse situations over an extended period. Participants noted the following strategies: watching other kids succeed in math problems, receiving feedback from the teacher while solving problems, listening to relaxing music or using positive self-talk, and experiencing successful math-solving sessions. These approaches contributed to increased motivation, confidence, focus, and a calmer state of mind, allowing individuals to tackle math problems with greater ease. While different participants had their preferred methods during the study, a combination of these strategies can lead to improved math self-efficacy. The theme emphasizes the importance of utilizing a diverse range of approaches to enhance confidence and performance in mathematics.

Although few studies have been conducted in order to research a dominant self-efficacy galvanizer using Bandura's four domains, the researcher's findings coincide with other studies that show multiple domains are effective in a variety of situations and with a variety of participants. This includes the study involving adults and an online statistics lesson, which reported no dominant self-efficacy galvanizer but highlighted the importance of using all four domains of self-efficacy when building self-efficacy in individuals (Huang et al., 2020; Huang & Mayer, 2019).

The domain effects from performance outcomes, vicarious experiences, verbal persuasion, and physiological responses all contributed to increasing or decreasing the self-efficacy of the participating students in a mathematical class setting. Although determining a dominant galvanizer for each student or specific group of students was inconclusive, some students were able to verbalize a dominant galvanizer that was most effective for them in a specific situation. This idea was confirmed by the following student comment when that student was asked about their confidence in solving math problems: "It depends on the problem I am working on and who is teaching the class." This comment concurs with Bandura's (1997) theory that self-efficacy is fluid, and performance alone does not provide sufficient information.

Bandura's Self-Efficacy Domains

The role of students' metacognition cannot be underplayed when increasing self-efficacy. Although the theory of large numbers was not reached, several participants in this study were able to verbalize how they felt about each of the in-situ experiences and which one or more of the four domains were most effective in increasing their mathematical self-efficacy. One student proclaimed,

> I feel my math self-efficacy is mostly increased by watching other kids succeed in math problems and having a successful math session because it motivates me to try better and, you know, try to get a better score than other students.

This comment suggests the vicarious experiences domain may be a dominant galvanizer for the participant. Another student expressed an affinity for the verbal persuasion domain as a galvanizer by stating,

> I feel that my math self-efficacy is most increased by listening to feedback from the teacher while I'm solving because it helps me know if the way I'm solving is most efficient and fastest or is slow and inefficient. This is because I'm in the middle of a problem and I've been stuck on it for like 15 minutes.

Performance Outcomes

Bandura (1997) theorized that the performance outcome domain may be the strongest predictor of self-efficacy, which was true for some participants but did not have enough of an overwhelming response to declare it as the dominant domain. One student stated during a one-on-one interview,

> I think my self-efficacy in math is already pretty good, though, because, like, I'm in 7.2,

> and I know that I can do math. I don't really know if it really helped that much, though, because I already kind of knew I had math self-efficacy.

In another one-on-one interview, a participant said, “When I skipped a level of math over the summer, I thought I couldn’t do math anymore because the other kids knew more than I did.” This comment suggests the vicarious experience domain decreased their mathematical self-efficacy. Additionally, another student commented,

> My teacher checks in with me and gives me compliments on my work when I’m doing it correctly. If I’m wrong, he tells me to check it, and I may see something that is wrong, and then I fix it and it’s fine.

This suggests the domain of verbal persuasion came into play when increasing this student’s self-efficacy in math.

This is not to discount the value of performance outcomes in increasing or decreasing mathematical self-efficacy, but it is noteworthy that performance outcomes was not overwhelmingly the dominant elixir stated by the participants, which contrasts with findings and theories from other studies (Bandura, 1997; Usher & Pajares, 2009). Overall, the theme highlights the importance of early wins in building confidence and fostering a positive mindset for successful math problem-solving sessions.

Vicarious Experience

The findings pertaining to vicarious experiences yielded a range of outcomes. Several students reported negligible awareness of their peers, whereas others exhibited a competitive disposition, demonstrating keen observation of fellow students' problem-solving sessions. Moreover, the variability in students' responses to vicarious experiences suggests the presence of additional factors influencing their level of self-efficacy. Participants had perceived differences in their classroom experiences, including being immersed in their own cognitive processes, focusing solely on their individual performance without paying significant attention to their peers or actively comparing themselves to others and closely monitoring not only the completion of problem-solving tasks but also the speed at which their classmates accomplished them.

These divergent reactions highlight the intricate interplay between the four domains of self-efficacy galvanizers and other factors of social dynamics and, again, are concurrent with findings from other studies (Huang et al., 2020; Huang & Mayer, 2019). Further investigation is warranted to explore the underlying mechanisms and contextual factors contributing to these diverse responses. Overall, the theme highlights the benefits of observing and collaborating with peers in math problem solving, which appears to increase self-efficacy, foster motivation, and facilitate the acquisition of effective strategies.

Verbal Persuasion

In accordance with other studies regarding feedback for reinforcing self-efficacy, teachers play a crucial role in the building of self-efficacy of their students as verified by several participants during the in-situ experience reflections and the one-on-one interviews (Akturk & Saka Ozturk, 2019; Mandouit & Hattie, 2023). Overwhelmingly, teachers giving feedback to increase mathematical self-efficacy was mentioned by all 34 students during the one-on-one interviews. The participant comments ranged from teachers circulating the classroom and giving tips and redirection while students were problem solving to teachers rendering verbal praise. One student revealed, “my teacher calls me a scholar and tells me that I’m doing a good job, and then I feel good about what I did.”

Some students mentioned that other peers asking them for help or commenting on their ability boosted self-efficacy. One student beamed after commenting, “When I’m done with my work, I help other kids in class, and it makes me feel more confident because I can help others. After I help them, they tell me how helpful I am and that I'm smart." But comments from peers were not as influential as teacher comments. In general, the theme underscores the significance of feedback in math problem solving, its role in enhancing self-efficacy, providing helpful tips, and guiding individuals towards better understanding and improvement.

Physiological Feedback

Although research has pointed to anxiety as a major inhibitor to mathematical performance and academic achievement, it was surprising that students did not state physiological response strategies as the most effective domain to build self-efficacy in math (Brown & Lent, 2006; Hiller et al., 2021b; Lau et al., 2022; Lazarides et al., 2020). On the other hand, in agreement with Xu et al. (2022), participants stated overcoming their fears of math-related tasks by using growth mindset, relaxing music, and other methods to reduce anxiety, such as positive self-talk or thinking of a pleasing memory. Often, listening to music is prohibited in the classroom and pausing for a memory break may be seen as work avoidance. Therefore, the strategies to reduce negative physiological responses may not be the first line of defense to combat decreased self-efficacy.

Limitations and Delimitations

There were just under 900 students who attended Public School A at the time of the study; however, 611 students completed the SEQ-C survey at the beginning of the year due to lack of teacher follow through, lack of time, and absences. Similarly, 24 students provided student ID numbers which were unverifiable and therefore not utilized during the quantitative analysis portion of the study. For the quantitative analysis, 587 students were utilized.

For the qualitative analysis, all students were provided with a consent form; however, 34 students ultimately opted to participate in the study. Some students who reported the lowest mathematical self-efficacy scores did not choose to participate in the study. In turn, valuable information could have been missed in regard to increasing self-efficacy in the mathematical setting. Also, the current sample size utilized for the qualitative analysis may not be sufficient to provide comprehensive and generalizable insights and may have increased the margin of error.

Recommendations for Further Research

Given the outcomes of the research completed, in addition to the limitations described in Chapter 1, there are some areas of the study that warrant further investigation. Future research should include a more in-depth study of each of Bandura's four domains as self-efficacy galvanizers. Participant in-situ experiences were successful in starting to identify a dominant domain or domains for each student to increase their self-efficacy. But a much more extensive set of data are needed to research this further.

The researcher suggests involving more participants from all four themes: students attending grade-level math classes with low self-efficacy, students attending grade-level math classes with high self-efficacy, students attending enriched math classes with low self-efficacy, and students attending enriched math classes with high self-efficacy. In addition, the four domain-enriched in-situ experiences should be calibrated to allow for more time for observation and note taking by the researcher. Students were able to self-report their feelings regarding each experience per domain, but researcher observations may add to the research data by using overall body language, such as hesitations in problem solving, facial expressions, or vocal expressions.

As for the individual in-situ experiences, the starter problems used for the performance outcome session could be differentiated more for the students. The researcher used problems from a computer-based program that provided individual sets of problems to students based on their adaptive assessment. Some students noted that their problems used for the performance outcomes experience were too easy. This could be because the adaptive assessment did not produce problems based on the individual participant's ability level.

The researcher used week-long experiential sessions including one problem-solving session and reflection per domain. Perhaps the research could be enriched by using multiple iterations of each problem-solving session per domain to gain more data and an understanding of a potential dominant galvanizer emerging throughout the process.

Finally, classroom observations could be utilized as a follow-up between the in-situ experiences and one-on-one interviews. The researcher could attend math classes and observe student behavior in real time in a natural setting instead of during forced problem-solving sessions using one galvanizer at a time.

Implications for Practice

After conducting research on the four domains of self-efficacy and their effects on academic achievement in the middle school math classroom, several implications emerge that can inform instructional practices and support student learning. Firstly, fostering self-efficacy beliefs in students can significantly impact their academic performance. Educators should design learning environments that provide opportunities for students to experience success, receive constructive feedback, and engage in collaborative problem-solving activities.

Additionally, addressing students' self-efficacy in different math domains, such as problem-solving, conceptual understanding, mathematical communication, and mathematical reasoning, can lead to more holistic development of mathematical abilities. Teachers can implement strategies to explicitly teach self-regulation skills, such as goal-setting and self-reflection, to enhance students' self-efficacy and improve their overall achievement in mathematics.

Furthermore, by recognizing the role of social and emotional factors in self-efficacy, educators can create a supportive classroom climate that encourages peer collaboration, celebrates effort and progress, and nurtures a growth mindset. By integrating solutions based on these implications into middle school math classrooms, educators can empower students, enhance their self-efficacy beliefs, and ultimately foster improved academic achievement.

A classroom environment that incorporates the research findings on self-efficacy from this study would have several key elements present to create an optimal learning environment. Various instructional strategies encompassing all four domains would be implemented to enhance mathematical self-efficacy. First, the classroom would be designed to promote student engagement and active participation. The physical space would be arranged to facilitate collaboration and small group discussions, encouraging students to share their ideas and learn from one another to improve self-efficacy through vicarious experiences.

Next, differentiated warm-ups would be utilized at the beginning of class to increase self-efficacy through the performance outcome domain. Headphones would be available for students to play relaxing sounds or music during problem solving when needed to reduce the negative effects of the physiological response domain. Students would use feedback cards to indicate whether or not they would like to receive feedback at any point throughout the problem-solving process.

The utilization of feedback cards can be instrumental in supporting students who experience distractions from feedback during problem-solving tasks, potentially preserving their cognitive flow and maintaining focus on their train of thought. Teachers would also provide scaffolding and support as needed, while also encouraging students to take risks, make mistakes, and persist in problem-solving in order to foster self-efficacy through the verbal persuasion domain.

Assessment practices would align with fostering self-efficacy. Instead of focusing solely on grades and final outcomes, formative assessments would be emphasized to provide ongoing feedback and opportunities for students to reflect on their progress. Students would be encouraged to set personal goals and track their growth, recognizing that effort and improvement are essential components of the learning process.

Professional development for educators would be crucial to support the implementation of these strategies. It would involve ongoing training and workshops focused on the research findings related to self-efficacy and academic achievement. Teachers would learn about effective instructional strategies, assessment techniques, and classroom management approaches that foster self-efficacy beliefs in students. They would also explore strategies for creating a positive classroom climate, promoting student motivation, and addressing individual differences in self-efficacy.

Overall, the classroom environment and professional development would be designed to empower both students and teachers. By integrating research-based practices that nurture self-efficacy beliefs, the classroom would foster a positive, supportive, and engaging learning environment, ultimately enhancing students' academic achievement in mathematics.

Conclusions

It is inspiring to know that the results of the research verified the importance of bringing social-emotional learning into the classroom. Self-efficacy is an indicator of both engagement and motivation and needs to be further focused upon in order to ignite these soft skills in our students who have low mathematical self-efficacy. But first, as educators, we need to assess the self-efficacy of every student. Next, we need to build upon the current soft skills of metacognition with our students in order to find the most effective galvanizer to increase the self-efficacy. We know that self-efficacy may ebb and flow and if students knows which galvanizer is most effective for them and how to utilize strategies for each, those students will be able to consistently increase self-efficacy in different settings. Educators are encouraged to leverage the resources and strategies derived from this study and implement them within the classroom setting to enhance not only students' self-efficacy but also their motivation and engagement levels.

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Chapter 2 APPENDIX A

Citi Certificate

CITI PROGRAM

Completion Date 04-Mar-2022
Expiration Date 03-Mar-2025
Record ID 47633892

This is to certify that:

Heidi Galassi

Has completed the following CITI Program course:

Not valid for renewal of certification through CME.

Social & Behavioral Research - Basic/Refresher
(Curriculum Group)
Social & Behavioral Research
(Course Learner Group)
1 - Basic Course
(Stage)

Under requirements set by:

Concordia University Irvine

CITI
Collaborative Institutional Training Initiative

Verify at www.citiprogram.org/verify/?wfc76d4be-150b-4a1f-a0fa-8fd2ab176b6e-47633892

Chapter 3 APPENDIX B

CONCORDIA UNIVERSITY IRVINE

INSTITUTIONAL REVIEW BOARD (IRB) DECISION FORM

Review Date March 20, 2023
Reviewer ID# **151036**
Category ☒ Expedited Review 45 CFR 46.110
☐ Full Board Review 45 CFR 46

IRB Application #	**16776**
Title of Project	Mathematics And Self-Efficacy: A Grounded Study Focusing On The 4 Domains Of Self-Efficacy And Mathematical Achievement
Principal Investigator Name (PI)	**Heidi Galassi**
PI Email (use CUI email, if applicable)	**Heidi.Galassi@eagles.cui.edu**

DECISION
☐☒ **Approved**

Effective duration of the IRB Approval: 06/02/2023

For Expedited and Full Board Approved, Please Note:
a. *The IRB's approval is only for the project protocol named above. Any changes are subject to review and approval by the IRB.*
b. *Any adverse events must be reported to the IRB.*
c. *An annual report or report upon completion is required for each project. If the project is to continue beyond the twelve month period, a request for continuation of approval should be made in writing. Any deviations from the approved protocol should be noted.*

Chapter 4 APPENDIX C

SEQ-C Survey

Student Math Self-Efficacy Survey

Self-efficacy is how you feel about your ability to complete specific task. If you have high self-efficacy, you feel you can complete the task successfully. If you have low self-efficacy, you feel you are not able to complete the task successfully. Please answer all questions below so we can better help you in math class.

hgalassi@mvwsd.org Switch account

Not shared

* Indicates required question

What is your student ID number? (It should start with 600)

Your answer

What is your name? (first and last) *

Your answer

How would you describe your ethnicity? *

- ○ Asian
- ○ Black/African-American (Non-Hispanic)
- ○ Hispanic/Latino
- ○ Native American
- ○ Pacific Islander
- ○ White/Caucasian (Non-Hispanic)
- ○ Other: ____________________

What grade are you in? *

- ○ 6th
- ○ 7th
- ○ 8th

Who is your math teacher? *

- ○ Bansal
- ○ Tran
- ○ Lau
- ○ Mulkey
- ○ Lee
- ○ Flint
- ○ Ditty

What math class do you attend?

- 6.1
- 6.2
- 7th grade math
- 7.1
- 7.2
- 8th grade math
- 8.1
- 8.2

How well can you get your math teachers to help you when you get stuck on schoolwork? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you express your opinions when other classmates disagree with you in math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well do you succeed in cheering yourself up when an unpleasant event has happened regarding math? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you study math when there are other interesting things to do? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well do you succeed in becoming calm again when you are very anxious in math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you become friends with other children in math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you study for a math test? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you have a chat with an unfamiliar person in your math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you prevent yourself from becoming nervous in math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well do you succeed in finishing all your math homework every day? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you work in harmony with your classmates in math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you control your feelings in math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you pay attention during every math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you tell other classmates that they are doing something you don't like in math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well can you give yourself a pep-talk when you feel low in math class or about math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well do you succeed at understanding the subject of math in school? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well do you succeed in satisfying your teacher with your math schoolwork? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well do you succeed in satisfying your parent(s) with your math schoolwork? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well do you succeed in suppressing unpleasant thoughts? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well do you succeed in passing a math test? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

How well do you succeed in not worrying about things that might happen in math class? *

	1	2	3	4	5	
Not at all	○	○	○	○	○	Very well

Submit

Clear form

Chapter 5 APPENDIX D

Links to In-Situ Experience Videos

Physiological Response Video – Relaxing Music

Vicarious Experience Video

Chapter 6 APPENDIX E

Consent Form

Appendix H

APPENDIX H: PARENTAL INFORMED CONSENT

Dear Parent(s) or Guardian(s),

I will be conducting a study in order to determine the most effective way to increase math self-efficacy in the content area of mathematics. This is a part of my final research project for my doctoral degree at Concordia University Irvine, CA.

Math self-efficacy refers to your belief in your own ability to do math. It's how confident you feel when you are faced with a math problem or math-related task. If you have high math self-efficacy, you believe you can do math well, even if it's difficult. If you have low math self-efficacy, you may doubt your ability to do math, even if you have the skills and knowledge to solve the problem.

Having high math self-efficacy can help you approach math problems with a positive attitude, which can lead to better performance and enjoyment of math. Conversely, having low math self-efficacy can lead to anxiety and avoidance of math tasks.

It's important to remember that math self-efficacy is not the same as being good at math. Even if you struggle with math at first, you can still develop high math self-efficacy by practicing and building your skills.

There are four different ways in which you can increase your math self-efficacy:

1. Mastery experiences: This means the experiences you have when you successfully complete a math problem or task. When you solve a difficult problem, you feel good about your ability to do math, which builds your math self-efficacy.
2. Social persuasion: This means the feedback and encouragement you receive from others, such as teachers, parents, and peers. When people tell you that you are good at math and encourage you to keep trying, it can boost your math self-efficacy.
3. Vicarious experiences: This means the experiences you have when you see others, such as classmates or teachers, succeed at math. When you see someone else do well in math, it can help you believe that you can do well too.
4. Emotional and physiological states: This means how you feel and react when faced with a math task. If you feel anxious or overwhelmed, it can lower your math self-efficacy. If you feel calm and confident, it can raise your math self-efficacy.

I am writing to ask permission to use the data I collect from your child during two different phases in this process. The first step in the study is to try and determine if your child would prefer using one way over another to increase their self-efficacy regarding their own math problem-solving ability. This will consist of five different 15 minute sessions when your child will engage in the following during school hours:

1) Start by watching a short one minute video

APÉNDICE H

APÉNDICE H: CONSENTIMIENTO INFORMADO DE LOS PADRES

Estimados padres o tutores,

Realizaré un estudio para determinar la forma más efectiva de aumentar la autoeficacia en matemáticas en el área de contenido de matemáticas. Esta es una parte de mi proyecto de investigación final para mi doctorado en la Universidad de Concordia en Irvine, CA.

La autoeficacia matemática se refiere a su creencia en su propia capacidad para hacer matemáticas. Es la confianza que sientes cuando te enfrentas a un problema matemático o una tarea relacionada con las matemáticas. Si tiene una alta autoeficacia en matemáticas, cree que puede hacer bien las matemáticas, incluso si es difícil. Si tiene poca autoeficacia matemática, puede dudar de su capacidad para hacer matemáticas, incluso si tiene las habilidades y el conocimiento para resolver el problema.

Tener una alta autoeficacia matemática puede ayudarlo a abordar los problemas matemáticos con una actitud positiva, lo que puede conducir a un mejor desempeño y disfrute de las matemáticas. Por el contrario, tener una autoeficacia matemática baja puede provocar ansiedad y evitar las tareas matemáticas. Es importante recordar que la autoeficacia matemática no es lo mismo que ser bueno en matemáticas. Incluso si tiene dificultades con las matemáticas al principio, aún puede desarrollar una alta autoeficacia matemática practicando y desarrollando sus habilidades.

Hay cuatro maneras diferentes en las que puede aumentar su autoeficacia matemática:

1) Experiencias de dominio: esto significa las experiencias que tiene cuando completa con éxito un problema o tarea de matemáticas. Cuando resuelves un problema difícil, te sientes bien con tu habilidad para hacer matemáticas, lo que aumenta tu autoeficacia matemática.
2) Persuasión social: esto significa la retroalimentación y el aliento que recibe de otros, como maestros, padres y compañeros. Cuando las personas le dicen que es bueno en matemáticas y lo animan a seguir intentándolo, puede aumentar su autoeficacia matemática.
3) Experiencias vicarias: esto significa las experiencias que tienes cuando ves que otros, como compañeros de clase o maestros, tienen éxito en matemáticas. Cuando ves que a alguien le va bien en matemáticas, puede ayudarte a creer que tú también puedes hacerlo bien.
4) Estados emocionales y fisiológicos: Esto significa cómo te sientes y reaccionas cuando te enfrentas a una tarea de matemáticas. Si se siente ansioso o abrumado, puede disminuir su autoeficacia matemática. Si se siente tranquilo y confiado, puede aumentar su autoeficacia matemática.

Le escribo para pedir permiso para usar los datos que recopile de su hijo durante dos fases diferentes de este proceso. El primer paso en el estudio es tratar de determinar si su hijo preferiría usar una forma u otra para aumentar su autoeficacia con respecto a su propia capacidad de resolución de problemas