8-2022

Mathematics Anxiety: A Mixed Methods Approach to Understanding Secondary Students' Avoidance of Mathematics Impacting Secondary Mathematics Enrollment

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To the Graduate Council:

I am submitting herewith a dissertation written by Indrani Singh entitled "Mathematics Anxiety: A Mixed Methods Approach to Understanding Secondary Students' Avoidance of Mathematics Impacting Secondary Mathematics Enrollment." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

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Mathematics Anxiety: A Mixed Methods Approach to Understanding Secondary Students' Avoidance of Mathematics Impacting Secondary Mathematics Enrollment

A Dissertation Presented for the
Doctor of Philosophy
Degree
The University of Tennessee, Knoxville

Indrani Singh
August 2022

Dedication

The lead protagonist of this journey has multiple roles to play. A mother, a wife, and an educationist in India. She led a perfect life with no insecurities when the long desire to pursue higher studies in the United States daunts "her'. Why would she do that? Who will want to leave their family and move transatlantic alone, establish a new home away from home, and begin a cultural exchange experience through education under the western sky? The protagonist in her early fifties was none other than I. After thirty years, I decided to move back to school in Knoxville as a full-time student motivated by the quest for knowledge and research. However, time and tide wait for none. Graduation is not far away. It's time to bid adieu to the school that trusted me three years back. Therefore, I dedicate this dissertation to my family who lived without me, and each deserves mention.

I have no words to thank my husband, Rajiv, whose unconditional love, trust, and support gave me the courage to embark on a journey less taken. You encouraged me to fulfill my desire to pursue higher studies thousands of miles away from home despite the hardships you would have faced in my absence. My source of motivation was my children, Rishi, Tulika, and Apoorv. You are brilliant and affectionate, and I am crazily in love with you. Your words of encouragement during difficult times, "But, mom, don't give up!" kept me going until the end of the Ph.D. program. My sincere gratitude to my siblings, Dada, Didi, Chorda, Chordi, and their family for the pride they have in me for taking this challenge. I am indebted to Murali, my batchmate and a close friend who guided me from the day I landed in the United States. Finding a comfortable home close to school, clearing my doubts in Statistics, troubleshooting, the list is endless, and only a good friend like you could do. Finally, heartfelt gratitude to my governess, Laxmi, whom I lovingly call "Muniya," for taking care of my home in my absence. Without your cooperation, and unconditional love for me, this journey in the land of opportunities would be a dream.

"Life is about accepting the challenges along the way, choosing to keep moving forward, and savoring the journey."...*Roy T. Bennett. The Light in the Heart*

Acknowledgements

I begin by thanking the Almighty for giving me the strength to complete my Ph.D. program during the pandemic when the entire world was in the grip of a battle for survival. Amidst these hardships, I am grateful to many for helping me complete my dissertation.

My sincere gratitude to my advisor and the dissertation committee Chair, Dr. Frances K. Harper for constant guidance throughout my journey at the University of Tennessee. I am grateful to you for your immense patience, for responding to my endless queries, and for helping me develop my dissertation from words to pages. I have seen difficult days during the pandemic, but your support through these challenging times was unparalleled. In addition, your drive for excellence has led me to learn many new things I would not have known had I not been your colleague and a part of your research projects.

I want to thank Dr. Sherry Bell for trusting me and accepting me as a graduate teaching assistant three years back. Your guidance, valuable feedback, and caring attitude gave me the courage to complete my dissertation as per my plans.

My gratitude to Dr. Lynn Hodge for guiding me through my dissertation and for all the contributions during my journey.

I want to thank Dr. Sondra LoRe Marie for her guidance and feedback which were invaluable.

Thank you once again to my esteemed dissertation committee for your guidance, knowledge, and for being such a fantastic committee and helping me achieve the highest educational degree one can ever dream of attaining. You have provided me with the ultimate tools of success. I shall be grateful to you forever.

Abstract

Empirical research has determined the detrimental effects of mathematics anxiety on students, but little is known about the influence of mathematics anxiety-avoidance behaviors on secondary mathematics enrollment in urban private schools in India, the purpose of the current study. This study followed a concurrent mixed methods approach and triangulation design to investigate the research problem. Participants were grade eleven students (*n*=16) and secondary mathematics teachers (*n*=4) from four private schools in an eastern state in India.

Data were collected quantitatively from students via an online questionnaire (RMARS) to measure their anxiety levels under mathematical situations and tasks. In addition, qualitative data were collected online from individual semi-structured interviews of students and teachers. Finally, an art-based research technique called self-portraits was administered to the students. Based on previous studies, three factors, namely, mathematics examination, mathematics curriculum, and numerical tasks, were adopted to connect the research problem to three research questions.

Key findings emerged from interview response statements after two cycles of coding. The questionnaire's descriptive and statistical analysis using SPSS version 27 revealed that students associated anxiety with mathematics examinations at the secondary level. Results indicated that anxiety was primarily physiological while answering the National Board Examination. Research participants from the qualitative study attributed mathematics anxiety to several sources, such as low self-belief, poor time management skills, large class sizes, and low mathematical concepts. However, interview responses showed disagreements between research participants on instructional practices and strategies. Findings revealed participants' belief in selective studies and private tuition, indicating they were adopted as strategies to alleviate anxiety. Practical ideas for students and recommendations on interventions and instructional practices for school leaders and teachers are provided to mitigate students' anxiety in mathematics, ultimately leading to improved enrollment at the secondary level.

Keywords: mathematics anxiety, avoidance behaviors, secondary enrollment, mixed-methods, mathematics examination

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CHAPTER ONE

INTRODUCTION AND GENERAL INFORMATION

The word 'mathematics' coined in the 6th century BC by the Pythagoreans is derived from the Greek word '*máthēma,'* which in ancient Greek means' what one learns' and in modern Greek means' lesson' (Ribeiro, 2013). Several researchers have established beliefs about learning mathematics. For example, children's perception of mathematics is judgmental and requires rote learning; mathematics problems have only one answer and can be solved using algorithms (Mtetwa & Garofalo, 1989). Similarly, Ernest (2011), in his book '*The Psychology of Learning Mathematics*, reviewed beliefs about mathematics learning, like mathematicians solve problems mentally, and mathematics requires memory. Basic concepts of mathematics like multiplication tables and their application are quickly learned in early grades (Porkess et al., 2011). However, 'Failure and the judgmental nature of mathematics results in anxiety" (Chinn, 2012, p.2).

As a former high school teacher, I am aware of several beliefs around the student community about learning Mathematics, like, 'Mathematics is beyond my comprehension or 'My parents had Humanities in higher education; hence I am not made for mathematics.' One of the most damaging myths propagated in schools and homes is that mathematics is a gift , some are good at it while some are not.(Boaler, 2013a, 2013b). Such myths affect self-belief (Chinn, 2012) and have a damaging effect on mathematics anxious students. Mathematics plays a vital role in all aspects of our lives. It connects us to real-world scenarios, whether cooking, billing for every purchase we make, bank transactions and investments, music, art, or physical education. Resolving daily issues in life would be difficult without mathematical competencies. In the ever-evolving world, mathematical competencies are "insightful readiness to act appropriately in response to all kinds of mathematical challenges" (Niss & Højgaard, 2019, p.12), fundamental to developing 21st-century skills like problem-solving, mathematical thinking, and reasoning.

Mathematics is a complex subject that induces fear among primary and secondary students (Caviola et al., 2017). Fear in mathematics interferes with performance and results in mathematics anxiety (Ashcraft, 2002). However, several measures can be taken to address mathematics anxiety. For example, implementing appropriate instructional techniques and interventions (Venkatesh & Karimi,2010) and innovative pedagogical approaches (Herodotou et al., 2019; Ramirez et al., 2018; Jamieson et al., 2012b) improve student performance and engagement. These measures alleviate heightened physiological arousal to anxiety too (Jamieson et al., 2012b) and reduce mathematics avoidance behaviors of students (Hembree,1990).

Increased attrition and avoidance tendencies in secondary mathematics courses have been a cause of concern in schools. History of poor performance and classroom experiences influence high withdrawal rates (Hourighan & O'Donaghue, 2007). In addition, students' enrollment in advanced mathematics courses depends on the success rate at the secondary level (Mattern & Packman, 2009; Parker, 2004). Difficulty in achieving tasks results in a phobia of mathematics characterized by long-lasting apprehension (Faust, 1992). My personal experiences of mathematics anxiety and similar struggles that my students faced drew me to believe that the consequences of mathematics anxiety grow into mathematics avoidance tendencies and prolonged periods of avoidance behaviors result in attrition. Therefore, keeping this pervasive problem in mind, the current study aimed to understand the nature of mathematics anxiety of secondary students and how avoidance behaviors impact secondary mathematics enrollment.

Research Problem and Context

According to the NCF (2005), mathematics is offered as a compulsory subject at the secondary level. Every child has the right to acquire quality mathematics education. Children's engagement in mathematics helps identify structures and the ability to differentiate between truth and falsity of statements. Broadly, students are unaware of the relevance of mathematics in life and future career prospects (Onion, 2004). Students commonly, but incorrectly, assume that meeting the number of credits for graduating from secondary education provides the stepping-stones to post-secondary enrollment (Venezia et al., 2003). The realization of being under-prepared for classes in higher education, especially science and mathematics, dawns on students only during enrollment (ACT, 2004b).

Students' attitudes affect academic performance (Makondo & Makando, 2020), resulting in low perceived self-efficacy (Bandura, 1997). Mathematics avoidance tendencies could become a 'barrier' in higher education and all disciplines of life (Daker et al., 2021). Students' attitudes affect academic performance (Makondo & Makando, 2020), resulting in low perceived self-efficacy (Bandura, 1997). Mathematics avoidance tendencies could become a 'barrier' in higher education and all disciplines of life (Daker et al., 2021). This avoidance behavior prevents students from developing mathematical proficiency due to reduced levels of mathematics understanding (Ramirez et al., 2018). Furthermore, jobs that require analytical and logical thinking become unachievable when anxious students disregard the relevance of advanced mathematics courses (Mutodi & Ngirande, 2014). Thus, job opportunities will not be plentiful for mathematics-anxious students. Therefore, schools must prepare a nation's students at the secondary level for a better future. (Ramirez et al., 2018, p.148).

Further, research on stereotype threats to women is abundant (Schmader et al. 2008). Constant comparison of mathematics competencies between men and women leads to physiological responses like increased blood pressure and heavy sweating, termed 'skin conductance' (Osborne, 2007). Subtle cultural messages like, 'girls are weaker in computing than boys' trigger self-doubt even in the most deserving girls (Bagès & Martinot, 2011). Woman's belief about success in STEM careers is associated with inherent mathematical skills and intelligence, not hard work and diligence (Kessels ,2015). Such discipline-related ability beliefs, like, success in STEM demands intelligence affect girls' emotions, and discourage them from opting for STEM fields (Ertl et al., 2019).

Exposure to developing mathematical skills that create positive mathematics identities should be encouraged in early grades (Duncan et al., 2007). "A student's timely progress to a four-year degree is reflected in his or her success in mathematics, particularly when one compares the success rates and failure rates of students in mathematics courses." (Parker, 2004, p.29) Therefore, to increase secondary mathematics enrollment irrespective of gender (girls or boys), it is crucial to prevent the development of avoidance tendencies and help build an understanding that mathematics is incredibly important in their lives.

In the following sub-section, I present the research purpose that helped me formulate three research questions. A brief vignette of what motivated me to study secondary students' mathematics anxiety and enrollment helped me in establishing a connection with the research and a need for a thorough investigation of this study.

Research Purpose

The purpose of this mixed-methods study was to examine the nature of secondary students' mathematics anxiety that results in mathematics avoidance tendencies and how it impacts secondary mathematics enrollment, eventually affecting students' life and future career path. The narrow scope of the research on nature of mathematics anxiety leaves many questions unexplored. Therefore, the following research questions aimed at narrowing that scope.

Research Questions

1. Do secondary students have mathematics anxiety, and if so, what is the nature of that anxiety?

2. How do teachers describe the influence of secondary students' mathematics anxiety on avoidance and enrollment in secondary mathematics?
3. What is the relationship between the different dimensions of mathematics anxiety and secondary mathematics enrollment?

Personal Connection

My motivation to focus on secondary students' mathematics anxiety resonates with my personal experiences as a student, mother, and educationist. In my childhood, I aspired to become a doctor. In India, to pursue a career in medicine, STEM courses at the secondary level are necessary. At the elementary level, understanding mathematical patterns and solving problems were uncomplicated and never a challenge. Unfortunately, in grade eight, a classroom experience in mathematics triggered a loss of confidence. Gradually my mathematical skills began declining, and I developed a phobia. Fear resulted in avoidance tendencies and low self-efficacy that prevented me from understanding complex mathematical concepts. As a result, I started concentrating more on other subjects and less on mathematics. Soon, the dispositions and beliefs I developed about my ability to engage and perform effectively in mathematical contexts changed drastically. The aspiration of becoming a doctor in no time became a dream. So, I decided to take a non-STEM course with economics as a compulsory subject at the secondary level. Despite repeated encouragement from my mother, persuading me to opt for mathematics with economics, I decided to drop secondary mathematics as an elective subject. Withdrawing mathematics at the secondary level impacted my admission to the university's economics department.

My mathematics phobia had begun in grade eight. I failed to understand the nature of this phobia, whether physiological or emotional. It was beyond my comprehension whether my fear was triggered by humiliation, aversion, or low self-belief. Ironically, I noticed similar traces of mathematics phobia in my children and the students I taught in two schools. Some examples of students' mathematics avoidance behaviors were skipping mathematics classes and examinations, low participation in mathematics activities and tasks, avoiding eye contact with teachers, and procrastination in completing assignments. As a former high school teacher and K-12 school principal, I also observed the trend of grade eleven students enrolling in STEM and non-STEM courses with mathematics as an elective subject at the beginning of an academic session but eventually dropping mathematics due to low self-belief and poor scores.

These life experiences made me believe that mathematics anxiety is a timeless epidemic affecting children worldwide. Hence, getting to the crux of the problem of secondary students' mathematics anxiety compelled me to explore the nature of the mathematics anxiety of secondary students with the hope of working with schools to alleviate students' mathematics anxiety in future.

Gap in Research

Mathematics-anxious students develop mathematics-averse behaviors. Anxious students develop mathematical incompetency due to negative mathematics attitudes, repeated failures, problems in solving mathematical tasks, high expectations from parents to perform well, uninteresting lessons, and teachers' attitudes toward students (Nicolai Dou & Philippou, 2003). Negative attitudes have implications on students' self-belief about their level of competency (Scarpello, 2007). Incompetency in problem-solving and mathematical thinking can have long-term consequences on career paths (Klinger, 2011).

Mathematics is regarded as "a gatekeeper in India as elsewhere" (Subramanian, 2017, p.132). Though research on mathematics anxiety has been well documented in the West, there is limited research on education in India. Interventions in education were primarily developed for the marginalized section of the society by non-governmental organizations. Recently, a small group of academicians has started engaging in educational issues and mathematics research. For example, the relationship between mathematic anxiety and grade eleven students' achievement in schools affiliated with the central government national educational board in India was examined (Yadav & Singh, 2019). Study findings revealed that attainment in mathematics and mathematics anxiety has an inverse relationship. A high level of mathematics anxiety was observed in students of Government and Government aided schools in India (Zakaria et al., 2012; Khatoon & Mohammed, 2010). Although a significant negative correlation between mathematics anxiety and mathematics achievement was found, little is known about how mathematics anxiety and avoidance behaviors impact secondary students' mathematics enrollment. Moreover, how theories of mathematics anxiety and its nature translate to secondary students’ avoidance of elective mathematics courses, and how it affects enrollment of secondary students in secondary mathematics remains unclear. The current study on secondary students' mathematics anxiety and its impact on enrollment in urban private secondary schools in India will fill this research gap and contribute to the body of literature.

Significance of the Study

A great deal of studies has invested in understanding mathematics anxiety of students and have also cautioned on the impact of mathematics anxiety upon cognition (Crossley et al., 2020), emotional and physiological responses (Bandura, 1977, 1997), academic achievement, and impact on students' future lives (Ramirez et al., 2018). Mathematics anxiety is considered a significant problem among students and a barrier to participation in mathematical tasks (Beilock & Maloney, 2015). Moreover, one cannot deny that mathematical competency is vital for all aspects of human life (Chand et al., 2021). The current study aimed to understand the mathematics anxiety of secondary students. It examined the reasons for withdrawals and avoidance tendencies to explore the impact of students' avoidance behaviors on secondary mathematics enrollment.

The current study findings will augment the existing literature by promoting a better understanding of one factor, mathematics anxiety and avoidance behaviors linked to the gradual decline in enrollment in secondary mathematics and the impact of anxiety in inhibiting secondary students' learning and access to mathematics. In addition, the findings will help develop ways of identifying mathematics-anxious students, designing, and implementing interventions to alleviate anxiety in early grades and increase secondary mathematics enrollment.

I selected several data sources for the current study. The qualitative approach chosen for the study will contribute to the body of knowledge on understanding the nature of mathematics anxiety of secondary students and the reasons for their mathematics avoidance tendencies. The quantitative approach will help school leaders and teachers design instruments to identify and assess anxious mathematics students and measure anxiety levels in different mathematical situations and tasks. Moreover, findings may give ample opportunities to students to build a positive mathematical attitude and understand the relevance of enrolling in secondary mathematics crucial for success in STEM and mathematical learning and their lives in the future. The findings will also open doors for school leaders to develop professional development programs and improve teachers' instructional strategies and practices to address students' anxiety in mathematics.

Definition of Terms

For a better understanding of the current research, I offer definitions of key terms accessed throughout the study.

Mathematics anxiety: " A feeling of tension and anxiety that interferes with the manipulation of numbers and the solving of mathematical problems in a wide variety of life and academic situations" (Richardson & Suinn, 1972, p. 551)

Mathematics avoidance behaviors: Math avoidance behaviors is the consequence of a set of preconceived self- beliefs and attitudes that develop in early mathematical experiences (Tobias, 1978).

Secondary education: According to the new National Educational Policy, 2020 in India, grades nine through twelve falls under secondary education.

Mathematics identity: "Math identity is a form of self-definition, where students see themselves as the type of person who is interested in mathematics and values their success in that topic" (Crossley et al. 2020, p.20).

Self-efficacy : Self-Efficacy is a person's belief in their ability to execute a task and succeed in a particular situation (Bandura, 1977).

Stereotype threat : Stereotype threat refers to the phenomenon whereby girls and women develop fear and negative thoughts about poor performance (here, in mathematics) than their ability on a mathematical task resulting in a negative stereotype that becomes prominent in the performance situation, which can lead to math anxiety (Maloney et al., 2014; Dowker et al., 2016).

Private tutoring : Private tutoring offered by teachers after school hours on payment provides additional academic instruction to children that they study in the mainstream education system (Dang & Rogers 2008).

Math achievement: The ability of a student to imbibe an amount of basic mathematical knowledge to learn in each time and perform a task (Miller & Bichsel, 2004).

Role of the Researcher

In a mixed-methods approach, the researcher connects the qualitative and quantitative data to provide a unified understanding of the research problem and the construct under investigation. (Creswell & Plano Clark, 2007). The principal investigator was the researcher of this study. Therefore, in the current study, I was the sole author. I conducted the study, selected the research site, recruited participants, and determined the research design appropriate for the study. I obtained IRB approval and collected data through IRB-approved online Zoom interviews, online questionnaire, and a self-portrait, an art-based technique. I transcribed and did fine editing of interview response statements, analyzed the results, integrated the findings, and drew conclusions based on the findings .

Delimitations. The delimitations narrow down the scope of the study and allow a researcher to decide the inclusion and exclusion criteria (Simon, 2011). Five delimitations defined the boundaries for the current study. First, the study was limited to grade eleven private secondary schools in urban settings in India. Second, the latest National Education Policy (NEP) 2020 states that grades nine through twelve falls under the secondary level. Moreover, mathematics is offered as an elective subject in grade eleven. Therefore, I recruited grade eleven students for the study to obtain information about avoidance tendencies and declining mathematics enrollment at the secondary level. Third, the study findings were restricted to only twenty participants who volunteered to participate. Fourth, data triangulation was employed for the study's validity, but the information provided by the participants may lack accuracy. Therefore, the study's findings should not be generalized to all mathematics teachers and students at private urban secondary schools in India. Finally, since the subjects were recruited from a specific national educational board, the study findings should not be generalized to other secondary schools in India. India has multiple educational boards that impart education to students from varying demographics (See Appendix A).The findings of the current study may not apply to other educational boards

Organization of the Dissertation.

The dissertation is organized into five chapters. Chapter one introduces this study with the research problem, purpose, context, and inadequacy of research. I offer a vignette to establish a connection to the research problem. Next, the rationale and significance of the study lay the foundation for why the phenomena need further investigation. I defined the key terms, and my role as a researcher in the study to establish my integrity and contribution to research. The chapter concludes with delimitations. In chapter two, I provide an in-depth review of the literature search process and the factors responsible for secondary students’ mathematics anxiety and avoidance behaviors. I conclude the chapter with a detailed study on mathematics education in India to help establish why the study needs a thorough investigation with participants in the country of my choice. In chapter three, I provide the theoretical framework and the methodology used in this mixed-methods study. The study findings and analysis are the focus of chapter four. Finally, a discussion on the results, implication of the findings, and recommendations for future research is described in Chapter five.

Chapter Summary.

The chapter began with an introduction to the research study. Then, I described my personal experiences with mathematics anxiety and linked them to the research purpose and research questions. Next, key terms often used in the current research were defined. Finally, the chapter concluded with the delimitations and organization of the dissertation.

CHAPTER TWO

LITERATURE REVIEW

Introduction

Mathematics is commonly conceptualized as a 'tool' to understand the relationship between complex and abstract mathematical concepts that require patience and persistence. The discipline helps solve complex life problems (Saritas & Akdemir, 2009). Ernest argues, 'Today, virtually all human activities and institutions are conceptualized, regulated, and communicated numerically, including sport, popular media, health…' (Ernest, 2002, para. 32). Therefore, the relevance of mathematics is felt across all careers and in our day-to-day life.

Despite the omnipresence of mathematics in our daily lives, high rates of attrition and anxiety persist. Studies have found that low academic scores influence high attrition rates (Hourighan & O'Donoghue, 2007). Undoubtedly, technology enhances children's social, emotional, cognitive, and operational skills (learning to use devices like a keyboard or mouse) Plowman and McPake (2013). Extracting information from different software or technological maneuvering equipment like complex video games draws the attention of students of all age groups. Ironically, career pursuits requiring similar mathematical competence, problem-solving and logical reasoning skills (Chalmers, 2013) for learning science or mathematical concepts do not attract students. If students' interest in STEM and mathematics continues to decline, the shortage of STEM positions from mathematical backgrounds will cross two million by the next decade (Chen & Soldner, 2013). The Economic Times, a leading newspaper in India, reported that STEM-related jobs in India have increased by 44 percent from 2016 through 2019. But the National Science Foundation predicted that a large percentage of jobs in the world would require mathematical and scientific reasoning skills in the next ten years. However, addressing students' anxiety in mathematics and supporting them to navigate stress will help them gain a sense of well-being and openness to learning and appreciating mathematics learning experiences.

I organized this chapter into four sections. The first section is an overview of the literature review search process. In the second section, I review mathematics avoidance behaviors, an outcome of mathematics anxiety. In the third section, I briefly describe the factors that may impact secondary mathematics enrollment, followed by a literature review of mathematics education in India. The discussions in the following section will demonstrate the relevance of the current study.

Overview of Literature Review Search Process

The literature review included scholarly articles and seminal works related to mathematics anxiety, mathematics education in India, and enrollment in secondary mathematics education. I conducted an electronic search of studies to retrieve potentially relevant and diverse studies on students' mathematics anxiety. Computerized research databases ensured that the research material met scholarly standards. Most of the articles I extracted for the study were retrieved from ERIC. All peer-reviewed publications were searched to reflect the most current research using this database. After searching ERIC, Google Scholar, another highly used research tool for articles not contained in the previous ERIC searches, surfaced additional articles. Finally, reference sections of articles that yielded foundational works were considered for the study.

I conducted the searches using keywords that matched the databases' title (TI) and abstract (AB). I resorted to several search terms, namely, TI (*math** OR *mathematics* OR *maths* OR *anxiousness* OR *anxious* OR *anxiety*).The search was limited to adolescents enrolled in urban K-12 schools using the following terms in the title, namely, TI (*secondary* OR *higher* *secondary* OR *urban)* AND TI (*enroll* OR enrollment*). Keywords relevant to educational settings were searched in the abstracts that included AB (*institution* OR *school* OR *education*) AND select a field (*mathematics anxiety*). These keywords assisted the screening process and represented the literature review's emphasis on mathematics anxiety of secondary students in a school setting.

Inclusion Criteria

The abstracts of all articles extracted from the electronic search databases obtained with the keywords described were read. I established the inclusion criteria before conducting the literature review search. To ensure that the study's research questions were addressed in the context of contemporary research, retrieved articles were mostly restricted to research published between 2005 to 2022. The studies extracted from the databases limited the focus to mathematics anxiety of high or secondary school students. There were no restrictions on studies that included meta-analysis, systematic reviews, research design methods, and perception of teachers and students on mathematics anxiety. Apart from India, studies conducted across different nations were also retrieved to examine the geographic distribution of mathematics anxiety within a country's cultural context (Gunderson et al., 2012) and explore research on secondary mathematics enrollment. Several articles published in peer-reviewed journals were included in this review. Literature that is not obtainable through normal publishing channels but published independently, like master's theses, conference papers, and seminal works of scholars who have researched mathematics anxiety, were also included in the literature review.

Mathematics Avoidance Behaviors

Some of the foundational scholars have done extensive research on mathematics anxiety. (For example, Ashcraft, 2002; Richardson et al., 1972; Fennema & Sherman, 1978; Ashcraft &

Moore, 2009). Additionally, reviewing the past seminal works of scholars, I found that the most pervasive and adverse outcome of mathematics anxiety is developing avoidance tendencies (Ashcraft, 2002). Anxious mathematics students develop tendencies of avoiding STEM and taking mathematics-related courses. In the sub-section, to bring an understanding of this study, I provide details of research on effects of mathematics avoidance behaviors.

The Effects of Avoidance Behaviors

One of the critical implications of mathematics anxiety is the development of mathematics avoidance behaviors, which are responsible for underperformance in mathematics (Choe et al., 2019; Ashcraft, 2002). Studies on mathematics anxiety show two consequences affecting students. Firstly, mathematics avoidance. And secondly, poor performance in mathematics (Ashcraft, 2002).

There are two types of avoidance in mathematics (Ashcraft, 2002). First is the 'global avoidance effect,' or 'macro avoidance,' which indicates that high math-anxious students enroll in fewer mathematics courses or opt for courses requiring less mathematical competence. Second, the 'local avoidance effect,' or 'micro avoidance,' which shows that students prioritize speed over accuracy to escape the anxiety of solving mathematics problems, indicating avoidance tendencies. Other avoidance behaviors include skipping classes, low mathematical identity, distractions in mathematics class, and irregularity in submitting homework. Therefore, mathematics-anxious students involved in 'micro avoidance' have greater chances of failing and enrolling in mathematics-related courses. The findings of the current study on secondary mathematics students' avoidance of secondary mathematics enrollment will most likely reflect the influence of 'macro avoidance' on' micro avoidance' and its impact on withdrawal rates.

Similarly, mathematics anxious students of secondary levels have reported consistent high anxiety since middle grades and complained of poor performance and a tendency to withdraw from mathematics or take fewer mathematics courses (Hembree, 1990; Ahmed, 2018; Hart & Ganley, 2019). Several students from different academic backgrounds, past negative classroom experiences, high parental expectations, and a history of low mathematics scores also contribute to avoidance tendencies (Scarpello, 2007). Students with cognitive skills like memory and attention develop mathematics avoidance tendencies despite the high potential to perform (Mattarella-Micke & Beilock, 2010).

A thorough study of the literature for the current research showed that mathematics anxiety and avoidance tendencies of students have been well documented in western countries. However, critical questions related to avoidance tendencies impacting secondary mathematics enrollment in India are still unknown. In the next section, I shall broadly discuss two factors, namely, academic, and sociocultural, in addition to mathematics anxiety, to offer a better and in-depth understanding of the research problem.

Factors Influencing Mathematics Anxiety

Globally, youth have a dim view of the relevance of mathematics competence in life and the slightest intentions to pursue a STEM career. However, students' beliefs about mathematics competence influencing STEM or mathematics career begins in junior high school (Varghese & Malik, 2015). Therefore, mathematics being a key component in STEM, building STEM interests in early grades is imperative. In addition, one of the pre-requisites for enrollment in higher education with mathematics is good mathematics scores at the secondary level. Thus, secondary mathematics scores are gatekeepers for post-secondary education (Douglas & Atwell, 2017).

Although the association between mathematics anxiety and avoidance behavior has empirical evidence, educational research examining the influence of mathematics anxiety and avoidance behaviors on secondary mathematics enrollment is limited. The current study builds on and extends prior research on mathematics courses to address the problem of mathematics anxiety and seeks to understand how mathematics avoidance behavior impacts secondary mathematics enrollment. Therefore, in the following section, I have discussed what prior research has offered about factors influencing mathematics anxiety which may impact secondary mathematics enrollment.

Academic Factors.

This section provides an overview of academic factors. I have organized them under three categories (i) Mathematics performance, (ii) Classroom instructional practices to support learning, and (iii) Mathematics self-efficacy and attitudes towards mathematics.

Mathematics Performance. Mathematics is an interdisciplinary subject that bridges all other sciences like physics, chemistry, engineering, and nonsciences like economics, accountancy, and music. Hence, mathematical skills and competency are critical to academic success (Bryant et al., 2008). Students' mathematics performance gets affected by low interest in mathematics and negative disposition (Maben & Mokgosi, 2021; Khatoon & Mahmood, 2010), and misconceptions about mathematics (Asikhia, 2010). Miller and Bischel (2004) conducted a study to examine the effect of insufficient mathematical content knowledge on confidence and mathematics scores. The study's findings showed that low content knowledge lowers confidence to engage in mathematical activities and tasks. Students' transition from primary to secondary has implications for mathematical learning and scores (Ryan et al., 2021).

Mathematics discussions develop communication and confidence. Moreover, engaging students in mathematics discussions promote understanding of mathematical concepts. (Mercer & Sams, 2006). Similarly, students' participation in classroom mathematics discussions enhances confidence and improves mathematics achievement (Kosko, 2012). Students who actively engage in classroom mathematics discussions have a better and deeper understanding of mathematics and hence can engage in classroom discussions. The confidence of passive learners reflects in their mathematics scores (Kosko, 2012). However, studies supporting this claim do not demonstrate students' interests in secondary mathematics.

Poor scores in mathematics are also due to deficits in teaching methods and learning disabilities (Geary, 2011). Moreover, I found that teachers advocating limited and lengthy procedures in solving numerical reduce students' attention power. Therefore, teachers' use of stimulating pedagogies may generate positive mathematical dispositions and help them make meaningful connections with mathematical ideas with pleasure (Enu et al., 2015; Kafata & Mbetwa, 2016). However, the negative impact of an overloaded curriculum in secondary schools on understanding concepts(Ukor & Agbidye, 2015). Similarly, students focusing on multiple topics in a short time results in frustration and lowers self-belief and performance (Perry & Winnie, 2004).

A qualitative study employed semi-structured interviews and surveys of secondary students, teachers, and parents to examine the declining enrolments of capable students in two high-level secondary mathematics courses (Hine, 2016). Students' perspectives and the results of descriptive statistics revealed that two courses in mathematics were not required for university entrances; instead, other relevant courses in mathematics may help secure decent mathematics scores. Hine's study was based on the common belief that high-level mathematics is essential for student enrolment.

Therefore, on reviewing previous literature studies, I found that mathematics performance gets affected due to reasons like negative mathematical disposition; misconceptions about mathematics; a transition from primary to secondary; low interest in mathematics; a deficit in teaching methods, and an inability to cope with mathematics due to an overloaded mathematics curriculum. These constraints may influence students' decision to enroll in secondary mathematics.

Classroom Instructional Practices to Support Learning. Teachers' choice of effective instructional practices can have a long-term impact on student achievement (Munawaroh, 2017). Therefore, schools need to adopt effective learning methods for consistency in improved student learning. Delivering effective instructional practices by mathematics teachers can positively impact students' emotional well-being and stimulate students' interest (Davadas & Lay, 2018). Student engagement and learning depend on teachers' capabilities to achieve desired results even among low motivated and achieving students (Bandura, 1977). However, effective classroom instruction can significantly impact student learning outcomes (Tessema, 2010). For example, adopting a constructivist approach in the classroom promotes classroom discourse and encourages peer mentoring. Moreover, cooperative learning increases students' curiosity to acquire knowledge (Van de Walle et al., 2013). Furthermore, innovative pedagogies enhance teachers' potential to generate interest in mathematics. For example, Liu and Chu (2010) found that game-based learning can improve and sustain students' interest in learning mathematics. In addition, appropriate instructional methods can influence students' mathematical competencies (Hosack, 2006). Therefore, instructional strategies like offering suitable opportunities for students to engage in collaborative learning, engaging in student-centered learning, and increased interaction between teachers and students positively influence mathematics scores.

Therefore, teachers' support in equipping students with mathematical knowledge has multiple benefits, especially in early grades. Namely, support of teachers motivates students (Harackiewicz et al., 2012), improves students' approach to mathematics, and reduces attrition rates (Saritas, 2004). In addition, the literature review suggests that effective teachers with the ability to choose and execute instructional strategies and practices may positively influence students (Harackiewicz et al., 2012), which might impact enrollment in secondary mathematics.

Mathematics Self-Efficacy and Attitudes. Mathematical self-efficacy is derived from 'Self-Efficacy' and linked to mathematics (Kahle, 2008). Self-efficacy in mathematics is a belief in one's ability to execute a mathematical task. For example, believing that 'I can do this math problem' indicates a growth mindset. A growth mindset can be described as a belief individuals have about success that depends on time and effort, and hard work and persistence develop skills and intelligence (Dweck, 2015).

Mathematical self-efficacy can be attributed to both students and teachers. Teachers influence student success in mathematics (Kahle, 2008). Teachers' self-beliefs influence their efficacy and affect teachers in several ways, including the ability to sustain a task when facing challenging situations and resilience when dealing with failures (Bandura, 2012). "Teachers with high mathematics anxiety seem to be specifically affecting girls' mathematics achievement—and doing so by influencing girls' gender-related beliefs about who is good at math" (Beilock et al., 2010, p. 1861). Since children are aware of mathematics achievement stereotypes as early as second grade, the effect influences their academic success even at that age (Sorvo et al., 2017).

Therefore, negative stereotypes and fear of being judged on ability levels can hinder performance and affect students' social-emotional well-being.

A study examined the relationship between academic self-efficacy in mathematics and college enrollment, and the findings revealed that academic self-efficacy in mathematics is negatively correlated with enrollment (Chamber et al., 2016). Similarly, another study indicated how students' attitudes and efficacy affect mathematics performance (Schunk et al.,2014; Negara et al., 2021). Low self-efficacy lowers interest in mathematics and influences mathematics achievement (Zander et al., 2020; Morán-Soto & Benson, 2018). Moreover, career choices are influenced by students' association with people in their day-to-day lives, like teachers (e.g., Amie-Ogan & Friday, 2020), family members (e.g., Li & Qui, 2018), and peers (e.g., Dabney et al., 2012; Nugent et al., 2015). Therefore, individuals' choice of courses and careers is determined by self-efficacy in the subject, interests, and the surrounding environment.

Prior research has found that mathematics self-efficacy significantly correlates with class performance (Alkan & Vesile, 2018; Sevgi & Nur-Caliskan, 2020) and helps mediate the effects of teacher-student relationships on students' mathematical problem-solving ability (Zhou et al., 2020). However, levels of mathematics self-efficacy depend on the grades, especially in high school (Sevgi & Nur-Caliskan, 2020; Alkan & Vesile, 2018). Therefore, students' mathematics self-efficacy is a valid predictor of motivation, learning, and achievement.

Sociocultural Factors

This section provides an overview of sociocultural factors to understand their impact on student enrollment in secondary mathematics. I have organized this section into five categories (i) Gender orientation perspectives towards mathematics learning and achievement, (ii) Parents' educational background and support, (iii) Socioeconomic status, (iv) Cultural features in society, and (v) Role of environment in learning.

Gender Orientation Perspectives Towards Mathematics Learning and Achievement. In educational institutions, mathematics is an integral part of a curriculum. In India, mathematics is compulsory until grade ten, but students can choose to study mathematics at the secondary level. Unfortunately, mathematics is considered a 'masculinized academic domain' (Esmonde & Langer-Osuna, 2013). Recent studies in mathematics education used terms like "mathematical attitude" from a sociocultural point of view (e.g., Darragh, 2016; Stentoft & Valero, 2009) and discussed the "relationship of women with mathematics" (e.g., Radovic et al., 2017, p.435). These studies highlighted superficial complexities involving the underrepresentation of women in mathematics and STEM-related careers (Buchmann et al., 2008). These complexities are further magnified by schools, community and studies on the under-representation of women in mathematics courses and careers, which has a damaging effect on the confidence and self-belief of women in mathematics. A study found that low interest in mathematics significantly correlates with student involvement in STEM-related careers, especially for women and that women's interest in mathematics is less than men's due to a history of poor performance that exerts unnecessary pressure on females, labeling the entire "women' community Amelink (2012). Even if it is a myth, women's stigma develops apprehension. Therefore, stereotype threats disrupt performance, increase attrition, and avoidance tendencies impact enrollment in secondary mathematics.

Students in India decide their choice of subjects in grade eleven. This decision determines their future careers. A study on students' mathematics choices (basic, advanced, or no mathematics) established that gender differences concerning the choices made by the students at the upper secondary school, especially mathematics, strongly influenced admission to higher learning. Furthermore, the study suggested that students who chose advanced mathematics viewed mathematics as an essential subject for future career paths. On the other hand, most males mostly opt for advanced mathematics (Kaleva et al., 2019). Studies that emphasize such predicaments known as stereotype threats strengthen the belief among women that 'Math is difficult.'

A qualitative study employed a self-administered questionnaire to examine the low participation of girls in senior secondary mathematics in the eastern part of India. Senior secondary level in India implies grades eleven and twelve. Findings showed that most participants developed a dislike for mathematics in grade ten. Furthermore, the findings revealed that Algebra scored the least favorite section in mathematics, and instructional practices play an essential role in generating interest in mathematics. In addition, results also showed that mathematics is a male-dominated subject (Gulnaz & Fatima, 2019). Therefore, cultivating mathematical skills that promote positive mathematics identity should be encouraged in early grades.

Parents' Educational Background and Support. Parents or other adults are the first teachers to help children develop learning skills. The involvement of parents in children's academics has a positive influence on the academic achievement of adolescents (Jeynes, 2012). A study showed how schools support students with a smooth transition from home to school by inviting parents for classroom visits (Rodriguez-Brown, 2009). In addition, students' learning numeracy is influenced by parental support (Melhuish et al., 2008). Therefore, parental involvement and support enhance parents' ownership in students' achievement and development.

A study showed a positive correlation between student academic achievement with motivation and encouragement from parents (Chen & Gregory, 2009). However, a meta-analysis demonstrated how parental involvement in mathematics influences students' regular assignments. Findings showed a significant and positive relationship between parental involvement in homework and achievement for elementary and high school students but negative for middle school students (Patall et al., 2008). Therefore, parents are essential stakeholders in knowledge acquisition and guidance to pursue lofty academic goals.

Research has documented fewer dropouts and more school-going students from better-educated parents (UNESCO, 2015; Huisman & Smits, 2009; Ersado, 2005). A mother's level of education is equally critical for girls' educational enrolment in schools (Emerson & Portela-Souza, 2007; Smits & Gündüz-Hogör, 2006). Therefore, daughters of independent and educated working women who are predisposed to information about education have greater possibilities of going to school than daughters of impoverished mothers who lose opportunities to enroll their children in higher education.

Parental support during transition can affect students from primary to secondary education (Newman et al., 2007). For example, parents at home and attending to children safeguard students from developing negative emotions during the transition to the secondary level (Waters et al., 2014). Involvement of parents in various school activities, regular interaction with teachers and students concerning syllabus, and paying attention to regular assignments assigned to students improve student engagement and student achievement (Pong et al., 2005). Overinvolved and overprotective parents (e.g., Luis et al. 2008; Murray et al. 2009) increase student anxiety toward mathematics.

Socioeconomic Status (SES). Large strands of literature focus on the effects of SES on better opportunities in a child's education. For example, families with higher parental SES positively impact students attending school and the quality of education (Zhao & Hong, 2012). Moreover, income inequality is a pressing problem in developing countries like India (Thorat, 2016). Although the education sector in India has seen rapid progress in addressing the diverse challenges, unfortunately, enrollment numbers dropped sharply in secondary schools (Duraiswamy, 2001). The increased and widened inequalities have received little attention.

Socioeconomic backgrounds determine opportunities for students from low-income groups that shape their life into promising futures. Mathematics scores and a sound mathematics foundation are a gateway for all entrance tests for higher learning. The craving to qualify for these examinations is so intense that secondary students enroll in institutes that run privately and charge exorbitant tuition fees (Bose, 2015). Students even join private coaching institutes charging hefty tuition fees for securing high scores at the National Board examinations held at the end of grade twelve. This arrangement conveniently excludes students from low-income groups raising the issue of social justice. Therefore, the significant class difference in the Indian society results in uneven distribution of cultural capital in India as far as educational attainment is concerned (Bose & Kantha, 2019). Cultural capital can be best described as the necessary skills, and knowledge students require to leverage their social status.

The growing social concern highlighted in the studies includes widening inequalities and higher education among different socioeconomic groups (Sinha, 2018). Children largely confined to economically well-off families are often enrolled in schools (Huisman & Smits, 2009; Mingat, 2007), specifically private. However, increased income inequality has reduced access to secondary education for students from disadvantaged backgrounds in India due to high costs of higher education, ignorance of the benefits of higher learning, lower preferences for education, and inadequate parental guidance (Tilak, 2007).

The study conducted by Duncan and team (2007) showed a causal relationship between social class, educational attainment, and college completion. In addition, the concept of private education offered to the community on humanitarian grounds seems to be diminishing (Tilak, 2006; Varghese, 2015). Participation and secondary enrollment are not high despite increased demands for secondary education in India (Kingdon, 2007). Thus, a sound and progressive educational policy would help reduce significant challenges in secondary enrollment and substantially improve educational opportunities for children in education.

Culture Features in Society. In India, historical and sociological reasons are predictors of educational inequities and differences in learning (Bose & Kantha, 2014). The social hierarchy based on social class, caste, and socio-cultural factors determines students' accessibility to education in India (Bose & Kantha, 2014; Thorat & Neuman, 2012). The system of patriarchy and caste are two significant cultural features in India. In the patriarchal system, power is in the hands of men. Men have always shown their supremacy over women due to the patriarchal system in India (Trivedi & Tiwari, 2016). The dropout rates and enrolment in higher education imply that getting girls to enroll in schools is the first hurdle; once surmounted, girls are more likely than boys to stay on for primary education but pose a challenge again at the secondary and higher level of education (Nair, 2010, p.101). The government of India is addressing the dominance of girl education, yet there are states with low girl literacy rates, as reported by India Bureau (2021).

Furthermore, caste in India is one of the oldest institutions in society. "Caste is a form of social stratification that places every Hindu and, in fact, every Indian irrespective of one's religious affiliation into one of the several endogamous castes" (Subramanian, 2017, p. 131). Ironically, 'caste-based exclusion' (p. 132) is prevalent in India. Based on *'jati'* (Hindu word for caste), discrimination and social exclusion of students from the stigmatized disadvantaged social groups in India is an ongoing battle despite legal safeguards and universal education promised by the Indian Constitution (Thorat & Aryama, 2005). Primarily non-governmental organizations have engaged in interventions for the underrepresented groups in the society (Subramanian, 2017). It is worth noting and agreeable to Subramanian's' claims about limited research on education in India. In recent years, the awakening of educational needs of a diverse group of students is being researched, especially in mathematics education. Engagement of '*Dalits'* (Hindu word for lower castes or the untouchables) in Mathematics Education research is almost negligible, "even though mathematics remains a gatekeeper in India" (Subramanian, 2017, p.132). However, most studies highlight caste oppression in rural or slum areas in India.

Community-based education promotes learning. But there is limited research on community-based education drawing upon everyday lives in India (Bose & Kantha, 2014). The authors asserted that culturally relevant pedagogy in mathematics cultivates a positive mathematical attitude of students from the lower social hierarchy. Research in this field could improve students' self-belief, increase their confidence in their mathematical ability, and remove the age-old misconception of mathematics as a complex subject. By developing a superior disposition toward mathematics (Okurot, 2005), we can contribute to a discussion on how we can better represent students from diverse backgrounds and support mathematics-related choices.

There are plenty of studies related to education issues in India, but educational research is limited. In education and caste in India, low school enrolment, completion rates, dropouts, and failure rates are typical in the marginalized section of the society (Chauhan, 2008). Despite government intervention in providing educational opportunities, different educational experiences magnifying the differences in socioeconomic conditions in India are also reported (Banaji, 2005).

A study examined students' general and mathematics performance in twenty-one secondary schools in the eastern part of India. Results revealed wide variations in the academic environment among the schools and mathematics performances. Improvement in mathematics performance in secondary schools was an immediate requirement, but the findings also revealed that from a social perspective, performance was getting affected (Das et al., 2014). Educational opportunities open doors to employment opportunities and reduce social crises. Therefore, mathematical knowledge relevance of secondary school mathematics in life can make students competent to handle social problems and lead a better life in the future.

Role of Environment in Mathematical Learning. An effective learning environment motivates and enhances student achievement (Mart, 2011). Therefore, teachers' role in a mathematics classroom is of paramount importance. For example, the mathematics classroom can be a source of trauma for students, especially when the subject is offered rigidly and without yielding results. (Tobias,1990). The teachers' responsibility is to motivate and create a learning environment. The classroom environment significantly boosts student achievement (Zhou et al., 2020). Teachers play an integral role in influencing children by building positive attitudes toward mathematics.

Cropp (2017) noted that peer mentoring intervention positively influenced mathematics competence. Peer mentors collaborating with students in understanding mathematics concepts create a collaborative and conducive classroom learning environment (Waters et al. 2014). On the contrary, Aldrin and Dio (2019) argued that peers might negatively impact mathematics competence. The negative influence of peers in mathematics classes influences students' learning ability. Therefore, the school environment is an essential predictor of measuring the well-being of students as it encompasses the teaching and learning process that influences student achievement and development (Amedeo et al., 2008; Aldridge & McChesney,2018)

Riaz and Asad (2018) examined the effect of student perception of an effective classroom environment on student achievement in secondary mathematics. The study's findings revealed that student engagement and students' ability to judge the relevance of mathematics in life promote mathematical identity. The results also showed how classroom engagement for students with low scores in mathematics improves student learning outcomes. Sharan (2006) suggested that since mathematics deals with abstract elements, teaching and learning require an attitude and analytical thinking of students and teachers' content knowledge.

I discussed how the two factors might contribute to secondary mathematics enrollment in the previous section based on several studies. The first factor was academics. Research has shown the impact of mathematics scores, suitable classroom instructional practices adopted by teachers to support learning, and mathematical self-efficacy of teachers and students influences teaching and learning and shapes attitudes and self-beliefs of students. The prevalence of caste in the Indian society, parental background, socio-economic status, and learning environment encompassed sociocultural factors.

The impact of academic and sociocultural factors on students cannot exist independently. Each element is dependent on the other. However, factors impacting mathematics course enrollment in secondary education may differ for every individual. The following section will discuss how mathematics anxiety as a construct may be a more promising factor in secondary mathematics enrollment.

Mathematics Anxiety Influencing Students

Foundational scholars like Hembree, Faust, and Tobias have invested enormous research on mathematics anxiety. Tobias (1978) linked mathematics anxiety and student achievement through effective classroom teaching and learning. Similarly, Faust (1992) found that mathematics learning is sometimes associated with the phobia that interferes with mathematics performance. Stoehr and Carter (2011, 2012) demonstrated how emotional responses like humiliation, discomfort, and depression during mathematical learning affected self-belief.

Ma and Xu (2004) demonstrated how mathematics anxiety increases with students' transition from junior to secondary school. Furthermore, when girls develop mathematics anxiety in early high school, they tend to sustain it at the secondary level. Hembree (1990) observed that levels of mathematics anxiety are minimal in elementary grades. However, researchers reported negligible gender differences in elementary and middle school (Lindberg et al. 2010).

Studies on stereotype threats showed how suitable interventions alleviate mathematics anxiety and nullify stereotype threats (Schmader et al., 2008; Thoman et al., 2008). In 1995, the term 'stereotype threat' was coined by the two scholars Steele and Aronson, and their study showed that when the black students were informed that their race was correlated with performance, their performance was lower than their white peers. Still, their scores were at par with the white students when not focused. These stereotype threats can retard growth and negatively affects racial or ethnic groups.

Similarly, Wahid et al. (2014) examined the correlation between mathematics anxiety and students' attitude toward mathematics performance. The findings of the study revealed that mathematics performance correlates with mathematics anxiety. The results also showed that a history of low scores in mathematics reduces confidence and motivation to achieve results in mathematics anxiety.

The studies discussed above demonstrate that mathematics anxiety may influence students' secondary mathematics enrollment. However, although several factors leading to mathematics anxiety have been addressed in research, mathematics anxiety as a factor influencing secondary mathematics enrollment in India has not been explored. Therefore, the following section will describe the three dimensions of mathematics anxiety adapted from the study of Alexander and Martray (1989) as factors for measuring the levels of mathematics anxiety in students.

Dimensions of Mathematics Anxiety

Alexander and Martray (1989) redesigned the seminal 98-item mathematics anxiety scale of Richardson and Suinn to examine the levels of stress generated and integrated 25-items under factors related to mathematics examination (ME), solving numerical tasks (NT), and mathematics courses or curriculum (MC). Anxieties resulting in specific physiological and emotional responses affect students' mathematical learning experiences. In the following sub-section, I will discuss individual dimensions of mathematics anxiety (See Figure 1). The linkages of the three dimensions of mathematics anxiety to data collection methods will be discussed in Chapter three.

Mathematics Examination. According to Zwettler et al. (2018), examination anxiety relates to an individual's experience linked to assessing performance and understanding concepts. Anxiety symptoms during or before a school examination fluctuate according to situations and differ from person to person. Ping et al. (2008) conducted a study to examine the symptoms of test anxiety and how the pattern of symptoms fluctuates during a clinical examination.

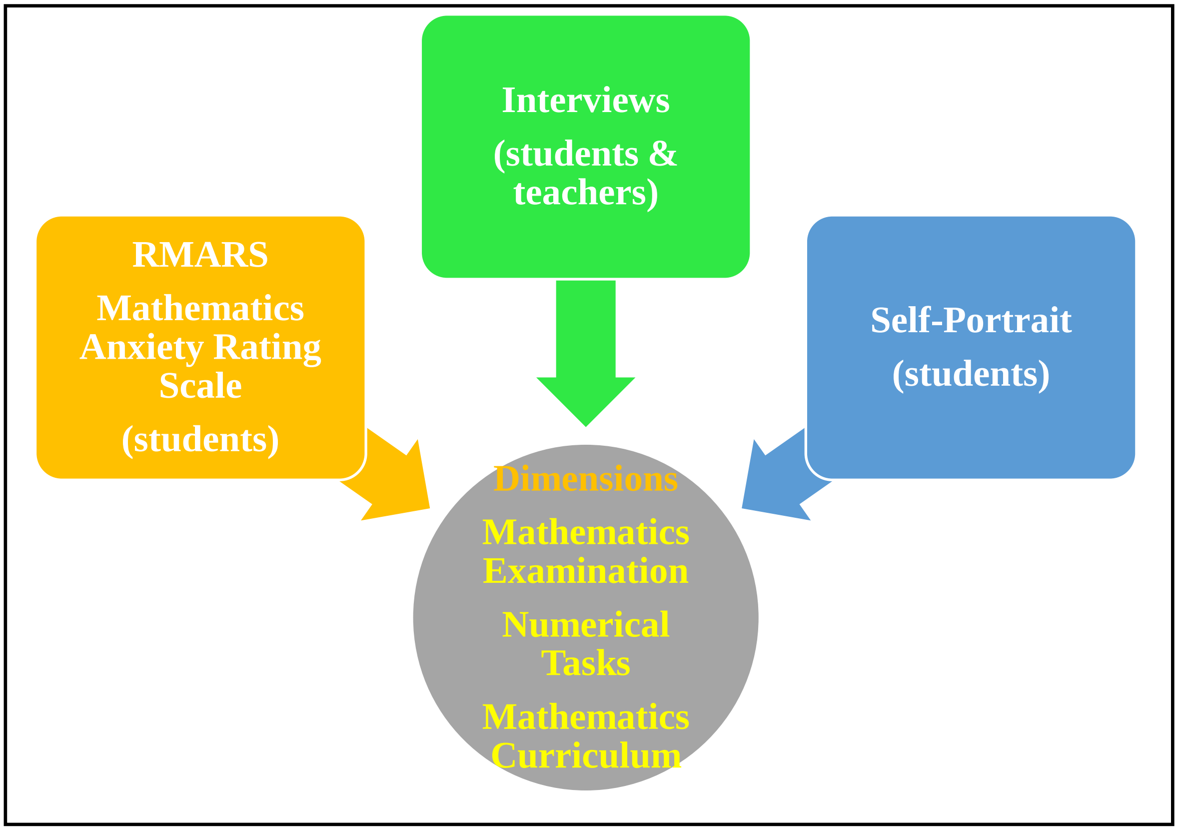

Figure 1

Dimensions of Mathematics Anxiety and Data Collection Methods

Findings showed that alternate hot and cold flushes accompanied by trembling were consistent throughout the examination. Some of the physiological symptoms observed during different stages in an examination were high pulse rate, redness of the face, hot or cold flushes, trembling, and bladder disturbances. Still, racing of the heart scored the highest among the many symptoms. The emotional responses to the examination were feeling tensed, petrified, and reduced levels of concentration and comprehension. The study also showed that feeling 'tensed' scored the highest among all emotional responses. The researchers found that students feeling 'tensed' was associated with a history of poor performance due to lack of knowledge and pressure of time.

Beilock and Maloney (2015) showed that mathematics test anxiety has a debilitating effect on students' mathematical learning abilities influencing an individual's perception. The researchers found some typical 'unhealthy' mathematics myths that are long-established. For example, Ashcraft (2002) stated that mathematics is innately complex. Another common myth about mathematics is "Being good at mathematics is considered relatively unimportant, or even optional"(Ashcraft, 2002, p. 181). Guimarães et al. (2021) claimed that mathematics test anxiety disrupts the cognitive system, impacts student learning, and lowers self-belief toward mathematics. Gough (1954), who coined the term '*mathemaphobia*,' examined why students performed poorly in mathematics tests despite proficiency in mathematics. Behavioral factors played an integral role in disarraying mathematical skills and developing low self-efficacy affecting mathematics performance (Bandura,1977).

Numerical Tasks. A study examined the impact of arithmetical problems on performance and has also shown that a negative attitude toward mathematics hinders students' numerical abilities affecting mathematics performance (Beilock & Maloney, 2015). Ashcraft & Faust (1994) examined the relationship between mathematics anxiety and numeral cognition with four groups of participants' levels of mathematics anxiety. The tasks were two simple single-digit additions and multiplications numerical, two complex sets of two-digit additions, and mixed arithmetic operations. Findings suggested that the students with high mathematics anxiety were in a hurry to complete tasks. The four anxiety groups showed no significant differences in performance in simple arithmetic operations but had difficulty solving complex calculations. These findings demonstrated the anxiety-complexity effect, suggesting a debilitating effect on performance when the tasks attempted were difficult for students with high anxiety levels. In addition, the authors pointed out that these findings projected two types of avoidance. First, the 'global avoidance effect' indicated that high math-anxious students enroll in mathematics courses or opt for courses requiring less mathematical competence. Second, the 'local avoidance effect' indicated that students prioritized speed over accuracy to escape the anxiety of solving mathematics problems.

Furthermore, Hembree (1990) found that students who do not derive pleasure in mathematics problem-solving due to anxiety displayed negative attitudes toward mathematics and avoided mathematics-related situations and numerical tasks. The failure to solve numerical tasks indicates mathematics avoidance tendencies. In addition, high mathematics anxious students develop negative attitudes that result in reduced mathematics achievement (Ashcraft & Krause, 2007). A study conducted by Ashcraft and Kirk (2001) on the relationship between mathematics anxiety, performance, and working memory showed that individuals with higher levels of math anxiety have a reduced working memory capacity when tested with either a computation-based or language-based span task (p.227). Working memory is the “small amount of information that can be held in mind and used in the execution of cognitive tasks, in contrast with long-term memory, the vast amount of information saved in one’s life" (Namaziandost et al., 2018, p.4). Researchers claimed that classroom teaching demands accuracy and speed and focuses less on emotional and cognitive support, leading to mathematics aversion behaviors (Turner et al., 2002), further contributing to mathematics anxiety. Bandura (1977) explained that teachers' self-efficacy might also disrupt students' learning and ability to accomplish a given task. Conversely, teachers with high self-efficacy stimulate students' motivation and improve students' self-belief and problem-solving ability, and vice versa.

Mathematics Curriculum. Blazer believed that implementing age-specific interventions and textbooks, study techniques related to students' learning styles, and mathematics methods courses that support visual, auditory, and kinesthetic learners are necessary to promote understanding of mathematical concepts. Students resort to rote learning when they fail to understand mathematical concepts (2011). Failure to understand mathematical concepts and procedures reduces students' interest and mathematical ability.

Ramirez and a team found that teacher anxiety has a compounding effect on students' stress levels. Anxious teachers are less responsive and fail to motivate students to participate in classroom discussions or design lesson plans according to the curriculum to suit the socio-cultural background of students (2018). On the other hand, students make meaningful mathematical connections when curriculum and teaching revolve around the learners' interests (Howes et al., 2013). The authors further focused on the need to incorporate classes that encourage mathematics activity, student engagement in problem-solving, modeling, and projects that would generate interest in them.

Majoni (2017) found that 'curriculum overload,' also termed 'curriculum crowded,' implied an excessive amount of content taught and learned within a limited time available for instruction. Another study showed that studying fewer topics at great depths helps understand concepts better (Schwartz et al., 2009). It improves student academic scores and enhances student satisfaction alleviating students' anxiety (Laird et al., 2008). Challenges of the 21st century are indicators to remind the policymakers and curriculum developers that understanding mathematical concepts are a keystone to learning as opposed to rote learning (OECD, 2014)

Though there is limited research in India on the impact of an overloaded curriculum on learning, Wolmarans' study in the West found that students struggled with mathematics at the secondary level due to the vast knowledge gap (2010). The knowledge gap is the lack of gradual transition from high school to institutions of higher learning (Moyo, 2013). In other words, the curriculum at high school does not provide sufficient support to student learning at the secondary level. This knowledge gap results in high dropouts, attrition, or avoidance of mathematics (Moyo, 2013). Hence, one factor affecting student enrollment in STEM or non-STEM courses with mathematics is low mathematical understanding and abilities (Reddy et al., 2014). The authors further pointed out that secondary mathematics competence involves "problem-solving, analytic and abstract thinking [which] is the order of the day" (p. 167).

In the next section, I present a discussion on mathematics education in India and the challenges faced by students in mathematics learning. This section will help understand what the current study aimed to investigate and why it is crucial.

Mathematics in Indian Secondary Education

An Introduction to Education in India

A dramatic change in the economic policy in the 1980s and 1990s brought a sea change in the education sector, providing entry of international agencies into education and opening space for globalized education. According to Nambissan (1996), India has two education layers. One is for the elite who join private schools, and the other is a public school for the marginalized, making the Indian society socially and economically hierarchical. Khan (2019) reported that in 1994, ninety percent of elementary school students were enrolled in purely government schools (sixty-seven percent) and government-aided schools (twenty-one percent). Only approximately nine percent of children were enrolled in private unaided schools.

Students from elite backgrounds and higher social classes have the advantage of being exposed to a dominant social culture, necessary skills, and mathematical knowledge that gets transmitted through generations to them. Therefore, such students have an advantage that helps them build their future with a limited number of challenges in educational attainment. On the contrary, students from marginalized and historically underrepresented groups are "legitimated by their educational failure" (Haralambos & Heald, 2013, p. 259).

System of Examination in India

In the current educational system in India, especially in the private schools' annual examinations are held at the end of each academic year that determines students' possibilities of getting promoted to the next grade. Apart from several mid-term tests and continuous class assessments that lead to a host of emotional setbacks, students are conscious of the scores they obtain at the national level board examination held at the end of the tenth and twelfth grades. These scores determine students' enrollment in reputed institutions for higher education.

Moreover, the pressure of preparing for multiple examinations for higher learning institutions' enrollment affects students' mental health. (Raina,1983). The stress in preparation for examinations contributes to school dropouts (Ramanujam, 2012). Mishra (2011) reported that graduates selecting mathematics-related careers have been declining in India, despite the theoretical importance of mathematical skills in real-world applications. High mathematics anxious students are likely to avoid mathematics-related tasks (Ashcraft, 2002). Therefore, improving an individual's mathematical competence at the secondary levels for opening career options and the quality of life is necessary.

Education in India is diverse. There are primarily six boards imparting quality education to a diverse population (Joshee, 2003). The six boards across India (See Appendix A) broadly clarify each offering a different curriculum and assessment system. Rampal (2003) and Ramanujam (2012) refer to mathematics as India's 'killer' subject since students have mathematics anxiety. Mathematics is an interdisciplinary subject essential for STEM courses in secondary education, and strong computational and mathematical skills are indicators for progressing economies like India (National Research Council, 2013). Mathematics is mandatory in the private schools participating in the current research until year ten. National boards have specific requirements for taking secondary STEM and non-STEM courses. For example, English is compulsory, and four to six subject choices. These subject choices include humanities, sciences, mathematics, vernacular languages, and arts. Students selecting STEM can drop mathematics if a student desires to go for medicine. Unfortunately, students avoiding or dropping mathematics do not introspect the interdisciplinary nature of sciences and mathematics. For example, a physicist would use calculus to teach motion, and a mathematician would use physics for certain concepts like quantum and general relativity.

Similarly, the non-STEM (Commerce) stream offers accountancy, commerce, and economics as compulsory subjects. Ironically mathematics is elective. Despite economics falling in the social sciences category, advanced mathematics and statistics form its core for understanding the discipline. Similarly, accountancy and Commerce without mathematics create a knowledge gap. Hence, a sound knowledge of mathematical skills is essential even in the non-STEM Commerce stream. Unfortunately, mathematics-anxious students drop mathematics despite the importance of non-STEM subjects and careers. Withdrawing secondary mathematics and avoiding mathematics limits the choice of subjects or courses in higher education and career options for secondary students.

Additionally, the national boards in India demand the registration of grade eleven students with subject choices for the national level examination held at the end of grade twelve. As an ex-principal of a private K-12 school in an urban setting, I have observed students enroll in secondary mathematics in grade eleven at the beginning of the academic session but decline during registration. Therefore, it is crucial to understand the nature of anxiety and the reasons for withdrawal from mathematics, and low enrollment in secondary mathematics.

Research on Mathematics Education in India

Khan (2015) debated the inclusion of mathematics and science in the curriculum within the formal schooling system, but their importance has never been questioned. Khan (2015) pointed out that most students find mathematics difficult. Teaching mathematics is even more difficult than any other subject taught in school. Khan further argued that students in India have strong feelings about mathematics. Failure in mathematics is a significant reason for school attrition. These aspects of mathematics compel researchers to examine the problem, but curriculum developers find it challenging to address the issue. This statement reflects the importance of my study and its contribution to the mathematics education literature.

Bose (2015) found that drawing mathematical knowledge from everyday life experiences is not offered in 'formal' education schools. Mathematical knowledge acquisition from traditional schools depends on the students' socioeconomic status. It is also assumed that social hierarchy concerning the caste system and class based on economic situation influences mathematics achievement (Kantha, 2009; Weiner et al., 2006).

Bose (2015) conducted another study on aligning students' knowledge of mathematics, study habits, and identity with school learning. Students selected for this study were middle graders (between ten and twelve years of age) largely from a primarily diverse low socioeconomic background. Bose examined the participants' numeracy knowledge, focusing on arithmetical operations and solution strategies of textbook-type word problems (2015). Bose also observed that everyday experiences that include cultural diversity and work practices shape students' mathematical knowledge (2015). Findings of the study revealed that the integration of community fund of knowledge and school mathematics signifies that learning from both domains has a relevance that is yet to be explored. Moreover, the analysis and impact of a hybridized aspect of society and culture on mathematics learning needs attention and must be studied systematically.

Challenges of Mathematics Learning for Indian Students

With more than one billion population, India has leaders investing time in pedagogical practices to improve educational equity and social justice. Yet, ironically, this country's community of mathematics education researchers is diminutive (Subramaniam, 2019). The vision of mathematics education introduced by the National Curriculum Framework 2005 (NCF) conceptualized constructivist pedagogy that resonates with "joyful learning" and "activity-based learning." Yet Rampal (2003) acknowledged that India is not free from challenges.

There are different views about the reforms that need to be brought about in the middle and secondary mathematics curricula. Critical mathematical concepts are taught at the secondary level (grades eleven and twelve). Although essential mathematical skills and mathematical competence are required to understand concepts, the emphasis is more on training students for an entrance examination. Further, too many building blocks in the mathematics curriculum make understanding concepts challenging for students (Dutta , 2016). For example, understanding set theory is essential for solving a numerical probability. If students miss out on learning chapters between set theory and probability, a distinct gap in learning arises.

Moreover, excessive emphasis on content and not process creates discord in developing a linkage between each chapter and grades. For example, the broad knowledge gap between grade ten and eleven mathematics curriculum becomes a cause of struggle for students and reasons for failure in Mathematics, resulting in anxiety. This stress influences students to withdraw after enrolling in secondary mathematics. Dutta further explained that the lack of illustrations, colors, and graphics in textbooks fails to draw students' attention. Rote learning and the inability to connect mathematical ideas to real-life situations leads to students' anxiety. Innovative curricular experiments and reforms are not enough to eradicate failure, anxiety, and exclusion from schools. Still, these reforms can provide opportunities to bring about positive changes in mathematics education (Subramaniam, 2019).

Research on Challenges of Mathematics learning in India. There may a longer list of challenges of mathematics learning in India but for the current study, I address a few of them that will help to understand the growing need of research in this field. Saloni (2018) found that high school students in India focus on competitive examinations for specialization in professional colleges or institutions of higher learning. The Hindustan Times New Delhi[1](2016), a leading newspaper in India, reported that lakhs of students who enroll in entrance examination coaching centers at grade eleven are under tremendous pressure from parents, society, and peers to compete in the competitive examinations. Students who can withstand pressure move ahead, but

[1] Hindustan Times is an Indian English-language daily newspaper introduced and founded in 1924 by Sunder Singh Lyallpuri, founder-father of the Akali movement and the Shiromani Akali Dal in Punjab Province. It played an integral role in the Indian independence movement as a nationalist and was a pro-Congress daily.

math-anxious students who avoid secondary mathematics are unsuccessful in the competitive examinations leading to anxiety and frustration.

Subramanian (2017) reported how the education minister of Maharashtra in India expressed his disappointment over students' giving excess importance to two levels of mathematics and neglecting other subjects. In 2008, students opted for 'general mathematics' for the grade ten board examination, which was comparatively more manageable than the two-level mathematics. However, this change saw a lot of criticism from the NCF 2005. On the contrary, the Central Board of Secondary Education, controlled by the Central Government of India, announced the implementation of two levels of grade ten mathematics examinations. This implementation resulted in mathematics reducing into a discipline that needs to be managed. Setting more straightforward examination questions, generous internal marking, and rote learning techniques were some of the ways mathematics is 'managed.'

Dewan (2016) discussed the role of language and culture in teaching mathematics and examined the relationship of mathematics with language and culture from a sociocultural perspective. Students' mathematical ability can be improved by using their existing knowledge based on their social and cultural backgrounds combined with problem-solving skills. The author suggested that students learn to decode problems, identify knowledge required to interpret problems, disintegrate, and identify strategies to solve problems. By offering a platform to share ideas and techniques to solve problems identified by students and linking mathematics to real-life experiences learned in the community, will promote students’ appreciation of mathematics and its relevance to life (Dewan, 2016). Therefore, it is evident from the available literature that mathematics anxiety affects students, but its impact on avoidance tendencies resulting in decreased enrollment in India is not clear. Hence needs systematic exploration

Conclusion

Developing students' positive mathematical and scientific attitude is a powerful bridge between learning and cultural contexts (Sfard & Prusak, 2005). After seventy-four years of independence and freedom from colonial rule, the National Education Policy (NEP), which replaced the NEP of 1986, was reapproved in 2020, intending to transform India's education system by 2040. As far as foundational literacy and numeracy are concerned, the NEP 2020 states that the country's education system will get the highest priority to achieve universal foundational literacy and numeracy in primary school by 2025. The guidelines of this Policy will have relevance provided the most basic learning requirement (i.e., reading, writing, and arithmetic at the foundational level) is first achieved.[2]

Chapter Summary

The chapter provided an overview of the literature review process and a study on mathematics avoidance behaviors. The next segment provided details on factors that may impact secondary mathematics enrollment apart from exploring mathematics anxiety as a factor affecting secondary mathematics enrollment. In the successive segment, I discussed the three dimensions of mathematics anxiety that will eventually help me understand secondary students' anxiety levels under different mathematical situations and tasks through various data sources. Finally, an overview of mathematics education, examinations, and challenges in mathematics learning for students in India connects the research problem and explains why this study needs to be investigated. This discussion will further fill the gap in the educational research on students' anxiety impacting secondary mathematics enrollment.

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[2] "Cabinet Approves National Education Policy 2020, paving the way for transformational reforms in school and higher education systems in the country". *pib.gov.in. Retrieved 8 August 2021.*

In the next chapter, I explore the methodology for the study. The chapter begins with the research purpose and questions, the theoretical framework, research methods, design, and data analysis procedures. Finally, the chapter concludes with details on potential ethical challenges and threats to the validity of my study.

CHAPTER THREE

METHODOLOGY

Introduction

In this study, I investigated secondary students' mathematics anxiety. Namely, I sought to garner the perception of secondary mathematics teachers and students' perception of mathematics anxiety and to explore the relationship between mathematics anxiety and student avoidance behaviors and secondary mathematics enrollment. For this purpose, I employed concurrent mixed methods triangulation design to meaningfully connect the research problems and questions with the assumptions of Bandura's self-efficacy theory and the three sources of self-efficacy that influenced and informed my work.

This chapter is organized into five sections. The first section begins with the research purpose and research questions. In the second section, I present the theoretical framework chosen for the proposed study. The following section deals with the research design and rationale for selecting the design. Next, I provide details of the research site and recruitment procedures of the two sets of participants, preceded by a preliminary pilot study. In the fifth section, I describe the data collection and analysis procedures followed by details on potential ethical challenges and threats to the validity of my research and concludes with chapter summary.

Research Purpose

The purpose of the concurrent mixed-methods triangulation study was to examine the nature of secondary students' mathematics anxiety that results in mathematics avoidance tendencies and how it impacts secondary mathematics enrollment that eventually affects students' future career paths and life. The research questions addressed are:

Research Questions

1. Do secondary students have mathematics anxiety, and if so, what is the nature of that anxiety?
2. How do teachers describe the influence of secondary students' mathematics anxiety on avoidance and enrollment in secondary mathematics?
3. What is the relationship between the different dimensions of mathematics anxiety and secondary mathematics enrollment?

Theoretical Framework

A theory can be defined as "a systematic set of interrelated statements intended to explain some aspect of social life"(Rubin & Babbie, 2017, p. 615). A range of theories from education, music, sports, psychology, and neuroscience have been used in studies researching mathematics teaching and students' mathematics anxiety (Lessani et al., 2017; Santha, 2017)."

Philosophically, mixed methods predominately utilize pragmatism (Johnson & Onwuegbuzie, 2004; Teddlie & Tashakkori, 2009). According to Teddlie and Tashakkori (2009), "Pragmatism rejects the either/or choices associated with the paradigm wars, advocates for the use of mixed research methods, and acknowledges that the values of the researcher play a large role in the interpretation of results" (p. 8). In the current study, I employed a pragmatic approach in a mixed methods design with Self-Efficacy Theory. An important tenet of pragmatism and pragmatic inquiry focuses on the view that desire is necessary to produce actionable knowledge in research (Corbin & Strauss, 2008; Feilzer, 2009). "The principle of actionable knowledge as a starting point for research, researchers can develop research agendas anchored in respondent experiences and, hence, ensure the research is of practical relevance" (quoted by Kelly & Cordeiro, 2020, p. 3). Morgan (2014a) explained that pragmatists emphasize 'the nature of experience' (p. 27). Similarly, Creswell and Clark (2003) explained that pragmatists focus on acting on problems in the 'real world.' The viewpoints of Creswell and Morgan enhanced my understanding of pragmatists who engage with multiple experiences of research participants about a phenomenon through a process of inquiry. Furthermore, the current study explored students' real-world problems in mathematics lessons. The process of a pragmatist inquiry allowed me to examine the phenomena embedded in the respondents' experiences through four data collection methods.

Questions that have always intrigued me were why some students have a keen sense of mathematical learning and the ability to handle challenges while others are incurious and unreceptive? Conversely, why do some students have a high level of mathematical competence and confidence in their abilities while others seem demoralized? I begin here by describing the theoretical framework work guiding this study. Self-Efficacy Theory provided an insight into the theoretical underpinnings necessary to address the research questions and problems. In the following sub-section, I will begin with a background of the theoretical framework, explaining the applicability of Bandura's theory of Self-Efficacy and how the three sources of Self-Efficacy theory influence an individual's self-efficacy in real-world mathematical learning experiences in a pragmatic way.

Self-Efficacy Theory – Theoretical Framework

Research on mathematics anxiety started with two theories (Eysenck & Calvo, 1992): Processing Efficiency Theory and Attention Control Theory. Processing Efficiency Theory assumes that worry reduces attention and working memory's capacity to process performance (Eysenck & Calvo, 1992). Second, the attentional control theory takes the debilitating effect of anxiety which manifests in impaired attention control leading to poor performance in any given task that requires the involvement of the working memory system.

'Self-efficacy' was originally conceptualized by Albert Bandura (Bandura, 1977). Today, the American Psychological Association (2018) defines self-efficacy as,

> "An individual's belief in [their] capacity to execute behaviors necessary to produce specific performance attainments. Self-efficacy reflects confidence in [exerting] control over one's motivation, behavior, and social environment. These cognitive self-evaluations influence all manner of human experience, including the goals for which people strive, the amount of energy expended toward goal achievement, and [the] likelihood of attaining [particular] levels of behavioral performance. Unlike traditional psychological constructs, self-efficacy beliefs are hypothesized to vary depending on the domain of functioning and circumstances surrounding the occurrence of behavior." (Para.1)

Self-Efficacy Theory

The Self-Efficacy Theory of Albert Bandura initially developed from The Social Learning Theory that gradually progressed to form the Social Cognitive Theory. The Social Cognitive Theory of Albert Bandura emphasizes on the dynamic interaction between personal, environmental, and behavioral factors that constantly influence the behavior and motivation of an individual. The self-efficacy of an individual influences the difficulty level of goal accomplishment. The theory postulates that an individual's performance accomplishment is influenced by the level of goal setting (Bandura & Wood, 1989; Wood & Bandura, 1989). Self-efficacy theory primarily focuses on the belief of an individual to complete a goal successfully. To attain a goal, the Social Cognitive Theory focuses on four processes which are interrelated and influence motivation. The four processes of goal realization include self-observation, self-evaluation, self-reaction, and self-efficacy (Redmond 2010). The current study employed the theory of self-efficacy, which is a subset of Bandura's Social Cognitive Theory, as a theoretical framework. Bandura introduced the term self-efficacy in his book titled "Self-Efficacy: Toward a Unifying Theory of Behavioral Change" in 1977. Historically, researchers from different fields have extensively examined the factors leading to mathematics avoidance tendencies due to mathematics anxiety. This problem has been prevalent for several years (Ashcraft, 2002). The concept of self-efficacy has been used by scholars in various fields like psychology, medicine, sports (Pajares, 200). Since a decade, self-efficacy as a theoretical framework has been used to address issues in education like achievement, anxiety, and motivation (Pintrich & Schunk, 2002).

"Self-efficacy theory provides explicit guidelines on how to enable people to exercise some influence over how they live their lives" (Bandura, 1997, p.10). Humans have immense potential to exercise personal control over any act they perform to bring about a significant outcome. The greater the influence over their lives, the more they can mold their lives according to their liking, develop self-belief and enhance confidence. Efficacy belief or perceived self-efficacy is the key to all human actions and is an essential human life component (Bandura, 1986). Bandura further stated, "Perceived self-efficacy refers to beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (1997, p.3). In other words, individuals' beliefs about their capabilities to perform at a designated level in a prospective situation influence them and affect their lives.

Self-efficacy theory focuses on the belief that individuals engage in activities in which they are confident about their competency and effectiveness in performing a specific task (Pajares & Miller, 1994). Bandura's (1997) self-efficacy is a concept that branches out of the psychological perspective of humans, where self-belief determines whether an individual can

"[..] successfully execute the behavior required to produce the outcomes" (Bandura, 1977, p. 193). Students' beliefs in self-efficacy are an essential factor for accomplishing any task (Bandura,1992a) and form a significant basis of action (Bandura,1997). Different people may exhibit similar skills in each situation when guided by self-efficacy beliefs. For example, high self-efficacy does not necessarily imply success, but highly efficacious students may have the capability to perform in mathematical tasks more than low self-efficacy students (Nandeshwar & Jayasimha, 2010). Bandura pointed out that highly efficacious individuals attribute their success to competence and failure to low effort or surrounding circumstances, whereas individuals who regards themselves as inefficacious attribute their failures to inability to perform due low confidence (1977). A sense of self-doubt can overpower even a highly competent child (Bandura & Jourden, 1991; Wood & Bandura, 1989). On the contrary, a student with high resilience and a sense of efficacy can produce extraordinary results in mathematics under challenging situations.

Students exhibit different levels of self-efficacy that help them acquire skills they desire to learn in a mathematical task (Schunk & Zimmerman, 2007). Furthermore, signs of increased self-efficacy and motivation indicate progress and a sense of accomplishment. Thus, an individual's self-efficacy plays an integral role in deciding on a task, executing it, and overcoming obstacles they encounter while accomplishing it (Bandura, 1977). In other words, highly efficacious students can achieve, hence are more successful in a prospective task [here, mathematics]. Furthermore, analytical, and problem-solving skills are essential for completing a task effectively. Therefore, developing problem-solving skills require strong efficacy to be able to accomplish a task at any situation, face failures, and challenges that can impact personal and social life (Bandura, 1995). An individual with a strong sense of efficacy has the potential to be focused on a given task that otherwise may impact adversely.

"Efficacy beliefs affect thought patterns" (Bandura, 1997, p.118). Thoughts are vital elements that influence behavior, attitudes, and emotions. Cognitive effects guide an individual towards proficiency in each task (Bandura, 1986). Highly productive individuals have an optimistic perspective and consider situations as opportunities for growth and learning (Bandura , 1977). On the contrary, inefficacious individuals may develop a negative attitude towards any tasks related to learning and personal development. In addition, such students assess learning opportunities as risky since they are skeptical about their abilities to perform because they suffer from self-doubt (Bandura, 1997) and most likely find the surrounding environment a threat (Bandura, 1986). Ahmed et al.'s (2012) study demonstrated a reciprocal relationship between mathematics self-concept and self-efficacy. Researchers defined mathematics self-concept as students' perceived self-belief of their ability to perform well in mathematics-related tasks (e.g., Jacobs et al., 2002, Wigfield & Eccles, 2000). Math self-concept improves with self-confidence and a positive internal dialogue, such as, ‘I am confident, I can do this.’

Bandura's self-cognitive theory posits that self-efficacy influences anxiety levels. Bandura (1997) defined anxiety as "a state of anticipatory apprehension over possible deleterious happenings" (p. 137). Inefficacious individuals perceive themselves incapable of effectively handling tasks and meeting desired goals (1988, 1997). In other words, the inability to perform mathematical tasks and history of poor performance negatively impact students' efficacy. The outcome of such experiences with mathematics results in anxiety. Rozgonjuk et al.'s (2020) study demonstrated a negative correlation between mathematics anxiety and self-efficacy. The study compared the importance and effectiveness of adopting a surface learning approach for alleviating mathematics anxiety with other social sciences. Findings showed that the surface learning approach developed for teaching students with low mathematics self-efficacy was negatively correlated, providing evidence that students need a greater focus on students' accomplishments of goals.

Based on Bandura's (1977) Self-Efficacy theory, Hackett, and Betz (1981) described how the concept of self-efficacy expectations can be related to student career related behaviors that align with mathematics avoidance behaviors. Furthermore, low self-efficacy expectations may adversely affect an individual's behavior, and avoidance tendencies in approaches to learning mathematics may reduce career options. For example, mathematics anxiety may influence decisions related to math-related careers if students develop mathematics avoidance behaviors. Therefore, Hackett and Betz postulated designing interventions to increase career-related self-efficacy expectations to alleviate mathematics anxiety.

Student Self-Efficacy

Self–efficacy theory encompasses the underlying assumptions of Bandura's Social Cognitive Theory, which emphasizes two key terms. 'social 'and 'cognitive.' 'Social' refers to an individual's social interaction intertwined with human emotions, thoughts, and actions integral to motivation. The term 'cognitive' refers to the two key elements, thoughts, and corresponding actions, which navigate life challenges (Kendra,2021). Efficacy beliefs are instrumental in developing cognitive abilities that help an individual adapt to an environment (Bandura, 1997).

Self-efficacy affects the academic achievements of students. For example, highly efficacious students are likely to work hard at a given task even when they face difficulties and persist when they have the skills required to accomplish that task (Collins, 1982). In addition, there is evidence that self-doubt promotes learning. "Self-doubt creates the impetus for learning but hinders adept use of previously established skills" (Bandura, 1986, p.394). A study examined students with either high or low efficacy in mathematical and numerical tasks and difficulty levels ranging from simple to complex numerical problems. The findings showed that students with high perceived efficacy beliefs demonstrated a greater degree of accuracy. They were faster in computing, solved more numerical problems, and revisited the difficulties they could not solve compared to students with equal intellectual ability but low perceived self-efficacy. The study also showed that academic scores do not determine students' mathematical knowledge. Further, individuals with a positive mathematical approach likely take mathematics courses, and poor performance may be due to a lack of mathematical skills or low perceived self-efficacy (Collins, 1982).

Similarly, students with higher perceived efficacy are consistent in performance, manage time well, show more persistence, and do not quit when engaged in solving complex mathematical problems (Bouffard-Bouchard et al., 1991). Another study examined how students' perceived cognitive beliefs impact academic achievement. This study showed how a self-directed learning approach could address a deficit in mathematical language skills. The self-directed learning approach helped in the development of cognitive and problem-solving skills. It included reading materials that helped in a smooth transition in solving simple to complex problems, supported with basic principles to solve and constructive feedback on performance that can influence an individual’s ability to improve and set measurable goals (Schunk & Usher, 2012).

Teacher Self-Efficacy.

Teaching is a skill that requires more than a simple transfer of knowledge from the learned to the learner. Instead, it is a complex process where the learned facilitates sharing of knowledge and prior experiences to influence the process of learning (Remesh, 2013). Bandura (1977) believed that teachers with high self-efficacy create a positive and productive learning classroom environment. Moreover, the development of the cognitive competencies of students rests heavily on the talents and self-efficacy of teachers.

Teachers' perceived self-beliefs in their instructional efficacy determine how they organize their regular classroom activities that help shape the intellectual development of students. Conducive classroom environment created by teachers depends on teachers' beliefs in their instructional efficacy (Siegle & McCoach, 2007). Teachers as role models promote self-efficacy in students through effective pedagogical practices and provide their students with mastery experiences. Teachers with high instructional efficacy have the potential to create mastery experiences for their students (Bandura, 1993). Recently, a study showed that teachers with low self-doubts and high self-efficacy have higher job satisfaction, handle students with misbehaviors efficiently, and manage to create an environment that strengthens students' self-efficacy and development of cognitive skills (Barni et al., 2019). "Teachers' ability to handle tasks, face challenges in professional activities effectively, and create a sense of well-being at the workplace play a key role in influencing academic outcomes of students" (Onyema & Igbokwe, 2022). Therefore, students' academic achievement is influenced by teacher efficacy.

Gibson and Dembo (1984) examined teachers' instructional efficacy. The researchers found that appropriate mathematical teaching techniques and positive attitudes are 'tools' to teach even the problematic and less motivated students and conduct academic activities to improve student engagement and accomplishments. In addition, they can engage themselves in guiding students, engage parents, and succeed in decreasing negative community influence. On the contrary, teachers with low instructional efficacy can neither motivate students nor influence students' academic and cognitive development. Instead, unnecessary interventions from home and community may limit their impact on students. School-based professional development activities significantly increased mathematics teaching efficacy in inclusive settings (Aerni , 2008).

Teacher self-efficacy and their perception of students can negatively or positively affect students' attitudes, which can affect their performance (Shahzad & Naureen, 2017). Self-efficacy and attitudes are closely related yet are different (Lui & Koirala, 2009). Self-efficacy is the perception of an individual's capability to complete the desired task successfully, and attitude is an individual's approach towards a given task. For example, a student might consider mathematics a complex discipline yet might enjoy solving mathematics, whereas there might be others who might avoid mathematics. In other words, students with low self-efficacy might have a positive attitude towards mathematics and vice versa. Thus, teachers' influence determines students' attitudes towards the subject. Teachers' perceptions of mathematics can influence students' attitudes towards mathematics. Effective instructional methods and strategies increase student achievement. Highly efficacious teachers have the potential to motivate students, exhibit good classroom management, and make teaching productive (Pendergast et al., 2011). Conversely, teachers who lack subject knowledge and pedagogical skills have low self-efficacy (Chacon, 2005). Highly efficacious teachers set challenging goals and work hard to accomplish them. Bandura (1989) believed that

> "People's [here, teachers’] perceptions of their efficacy influence the types of anticipatory scenarios they construct and reiterate. Those with a high sense of efficacy visualize success scenarios that provide positive guides for performance. Those who judge themselves as inefficacious are more inclined to visualize failure scenarios which undermine performance by dwelling on how things will go wrong" (p.3).

Teachers' ability to create a conducive learning environment can influence students' progress and change their perception of the discipline. Therefore, teachers' self-efficacy and skills affect their ability to create an environment conducive to learning (Bandura, 1993).

Studies have also shown that teacher self-efficacy refers to teachers having a high or low opinion about their teaching skills. It implies perceived self-belief to bring breakthrough improvement in student performance by motivating them, being less critical about numerical task-related errors (e.g., Tschannen-Moran & Woolfolk-Hoy, 2007; Bandura,1977), and supporting positive dispositions toward mathematics (Forgasz et al., 2010).

In the next section of the chapter, I will describe how the three sources of self -efficacy guided the current study and how each source is related to a research question, data collection method , and data analysis procedure (See Figure 2).

Sources of Self-Efficacy

“While effective instructional practices and constructive criticisms foster confidence and build a sense of personal efficacy in students, alternatively, ineffective instructional practices and the inability to cope with academic hardships result in “education inefficacy” (Bandura, 1986, p. 417). According to Bandura (1997), individuals’ beliefs about self-efficacy are constructed from four sources of influence, namely, (i) mastery experiences, (ii) vicarious experiences, (iii) verbal or social persuasion, and (iv) physiological and affective states. I will define only the three sources I intend using in the current study. These sources influence students’ academic and self-regulation efficacy beliefs (Pajares & Urdan, 2006). Below, I define only the three sources I used in the current study, mastery experiences, verbal or social persuasion, and physiological and affective states (See Figure 2) to bring out the relationship between the study and the theory.

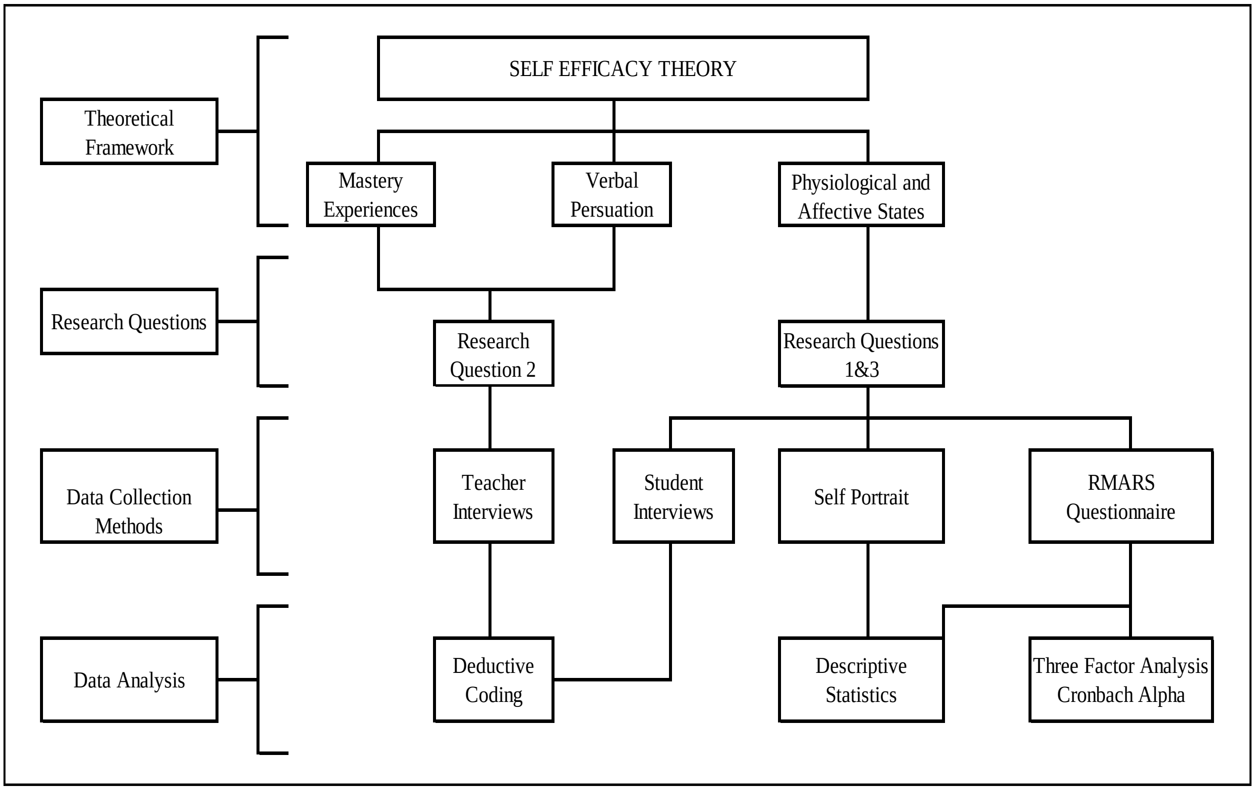


Figure 2

Mapping Relationship: Theory-Research Questions-Data Source

Following each definition, a description of each source is linked theoretically to teachers' and students' perception of mathematics anxiety and avoidance behaviors tendencies.

Mastery Experiences.

Positive and negative experiences can influence the ability of an individual to perform a given task. For example, if one has previously performed well at a task, they are more likely to feel competent and perform well at a similarly associated task [and vice versa] (Bandura, 1977). "It is a scenario in which the teachers share their own success stories; thus, feeling confident about their methods, which proves that they are competent and believe in their capacities."(Shahzad & Naureen, 2017, p.52). The confidence of teachers about their pedagogical skills reflects their capability to instruct students and manage classrooms effectively.

Mastering an activity, a task, or a concept is evidence that one can succeed provided one musters up courage and confidence (Bandura, 1997). Stories of past performance are the most potent source of information about student confidence, and their ability to achieve that gets reflected in their perceived self-efficacy (Bandura, 1997; Schunk & Usher, 2012). Success enhances self-efficacy, and failure weakens it, especially if failures precede the establishment of a sense of efficacy in an individual (Bandura, 1977). Nonetheless, failure plays an important role in the development of self-efficacy. "Difficulties provide opportunities to learn how to turn failure into success by honing one's capabilities to exercise better control over events." (Bandura, 1997, p.80). In other words, failures in life are life lessons that assist individuals in developing the inner strength to rebound from setbacks.

Practicing any skill brings perfection, and positive affirmation leads to behavior change, enhances openness, and builds confidence (Main & Dillard, 2012). Thus, positive thinking and believing that one can complete a task increases efficacy. Mastery experiences boost self-efficacy, especially when individuals overcome hindrances or accomplish challenging tasks. However, the extent to which individuals perceive their efficacy depends on the difficulty level of tasks, the amount of effort exerted to complete the task, the amount of external assistance received under the circumstances, and time of failures and successes one goes through, and most importantly, how an individual remembers these experiences (Bandura, 1997).

Mathematics teachers play an integral role in mentoring students and supporting students during failures (Baştürk, 2016). In addition, creating an environment where students perform an activity and offering constructive feedback on any task undertaken by students enhances students' academic ability (Siegle & McCoach, 2007) and strengthens student confidence. Thus, motivation boosts perceived self-efficacy (Bandura, 1997).

Bandura (1997) explained and a study by Schunk and Zimmerman's (2007) demonstrated that mere application of cognitive strategies and practice in classrooms do not improve children's self-efficacy. Instead, students perform better when they are reminded to exercise control over academic tasks using the strategies they are taught (e.g., Britner & Pajares 2006). Therefore, positive feedback and encouragement enhances children's efficacy and improves academic achievement. In addition, Bandura claimed that teachers with a strong commitment to their students demonstrate positive behavior by supporting their intellectual development and intrinsic interests (Bandura, 1997).

Self-efficacy theory provides a theoretical foundation for understanding the teacher's role in creating a conducive classroom learning environment and supporting mastery experiences. Gawande (2011) suggested that teachers play a crucial role in providing mastery experiences coaching skills, and opportunities. Skill execution is critical since it can diminish or increase an individual's self-efficacy. Similarly, Tschannen-Moran and McMaster (2009) argued that self-efficacy increases when teachers learn to adjust complex tasks. Teachers, therefore, create new mastery experiences through engagement in teaching and learning. In other words, increased mathematics efficacy supports and enhances mastery experiences. Mastery experiences can be "connected to the teachers' work with children, organized around real problems of practice, intensive, sustained, and continuous over time, and supported by coaching, modeling, observing, and feedback" (Darling-Hammond et al., 2013, p.99). As a former high school teacher, I have experienced how offering mastery experiences through constructive feedback, and positive affirmations builds confidence in students. Additionally, mentoring builds trust in the students to perform better which further develops students' self-efficacy.

Verbal Persuasion.

Verbal persuasion as a form of influence can change an individual's self-efficacy (Bandura, 1977). It is defined as "When people are led through suggestion into believing they can cope successfully with what has overwhelmed them in the past" (Bandura, 1977, pg. 198). Self-efficacy is influenced by encouragement and discouragement about an individual's performance or ability to perform (Redmond, 2010).

Bandura (1997) described verbal persuasion as "social persuasion [that] serves as a means [to] [strengthen] people's beliefs that they possess the capabilities to achieve what they seek" (p.101). Sustaining difficulties becomes simpler when people have faith in their abilities. Thus, verbal persuasion is a powerful strategy of mobilizing more significant effort in students who conceal self-doubts yet survive the self-constructed challenges when difficulties arise. Therefore, "to raise unrealistic beliefs of personal capabilities only invites failures that will discredit the persuaders and undermine the recipients' beliefs in their capabilities." (Bandura, 1997, p.101).

Bandura (1997) suggested that the most effective way of increasing "persuasory efficacy" (p.101) is by evaluating performance in the form of constructive feedback. Bandura posited and researchers like Schunk and his colleagues (2007) have investigated the effect of assessing feedback of efficacy beliefs in the past. Students with mathematical and reading deficiencies were assigned self-directed learning tasks and predesigned feedback irrespective of their performance scores. The scholars theorized that repeated positive reaffirmations about students' ability to work hard motivate and influence the subconscious mind to access new beliefs. The study's findings showed that feedback encouraged students to work harder due to a higher perceived efficacy that developed due to repeated positive feedback though not much was reported about their academic progress. The study also showed that hard work motivates students, but students may not be consistent. The gain may be short-term.

The short-term effects of verbal persuasion need to be coupled with real successes (Bandura, 1986). Performance accomplishments and skill development are influenced by high perceived self-efficacy (Bandura, 1997). For example:

> “Teachers can influence their student's self-beliefs about their ability if they provide them with challenging tasks and meaningful activities to master, actively support and encourage them along the way, teach in ways that demonstrate that they believe in their students, and convey these impressions in ways aimed at developing a robust sense of self-confidence” (McPherson & McCormick 2006, p. 337).

In other words, the persuaders' or the mathematics teachers' integrity is a critical component of verbal persuasion. Furthermore, teachers' constructive feedback and encouragement may enhance students' confidence in mathematical competence, especially when they are encouraged by someone [here, the mathematics teachers] students trust. In other words, repeated positive feedback, and assurance of success, developing a sense of accomplishment in students results in consistency and perseverance, which the students can achieve with the assistance of teachers.

Therefore, teachers offering 'mastery experiences' and 'verbal persuasion' can have a significant impact on children, especially adolescents who can decipher verbal persuasion, praise, and attributional feedback more than young children, that is, feedback that focuses on the abilities of students (Pajares, & Urdan, 2006). Thus, mastery experiences' and 'verbal persuasion' provide a theoretical foundation to support the study's second research question, *'How do teachers describe the influence of secondary students' mathematics anxiety on avoidance and enrollment in secondary mathematics?*' Furthermore, the basic assumptions of mastery experiences and verbal persuasion are embedded in the semi-structured interviews described in chapter four. This approach allowed me to demonstrate cognitive and academic support offered by mathematics teachers that can help anxious mathematics students cultivate mathematical competencies and enhance students' perceived efficacy.

Physiological and Affective States

People experience sensations from the body, and how they perceive this emotional arousal influences their beliefs of efficacy (Bandura, 1977, p.143). The individual’s physiological or emotional states influence self-efficacy judgments concerning specific tasks. Emotional reactions to such tasks can lead to negative reviews of one’s ability to complete the tasks (Staples et al., 1998). More specifically somatic information or information about one's emotional and physiological arousals conveys an individual's ability to perform a task (Bandura, 1997). Somatic information indicates personal efficacy that involves physical accomplishments and coping with health and stressors. High emotional and physiological arousals generate stress and debilitating affect mathematics performance and affect the cognitive abilities of an individual. Conjuring up thoughts of failure and inefficacy heightens levels of distress and fear. Physiological indicators of low physical self-efficacy are fatigue, aches, and insomnia. Such arousals affect the temperaments of an individual resulting in an individual's judgment of their efficacy. There are various ways to increase physiological efficacy beliefs that impact affective states. For example, enhancing physical stamina and strength, reducing stress levels and negative approach towards any task or activity one is engaged in, and correcting misinterpretations of their emotional and physiological responses (Bandura, 1977,1991).

> "Moreover, individuals who feel efficacious are hypothesized to expend more effort and persist longer in the face of difficulties than those who are unsure of their capabilities. Efficacious people tend to expend more effort and persist longer because most personal successes require persistent effort. Low self-efficacy becomes a 'self-limiting process.' "To succeed, individuals need a strong sense of task-specific self-efficacy, tied together with resilience to meet the unavoidable obstacles of life" (Artino, 2012, p.78).

Hence, mathematics-anxious students who are less absorbed in tasks and activities accomplish more since they can focus more on their tasks and are less aversive and stressed in any problematic situation. Relentless effort and concentration in mathematics-related activities generate interest, bring stability in performance, increase success expectancy, and help students focus more on the task assigned to them for extended periods (Nuutila et al., 2018).

Students with low perceived self-efficacy are vulnerable to psychological stress which “heightens levels of physiological responses like fatigue, sweating, stomach upsets, bouts of insomnia" (Bandura, 1997, p.107). As a result, such students lose the ability to realize their potential. Bandura also explained that past successes and failures are stored as memories. A history of poor performance in mathematics or an unpleasant mathematics classroom experience lowers self-belief (Ashcraft, 2002). Conversely, a positive mood activates past successes, generates a high perceived efficacy, and boosts confidence. Therefore, "the impact of mood on self-efficacy is at least partially mediated by a selective recall of past successes and failures" (Bandura, 1997, p.113). Physiological and affective states of Bandura's Self-Efficacy, therefore, support the theoretical underpinnings for the first and third research questions, *'Do secondary students have mathematics anxiety, and if so, what is the nature of that anxiety?*' and *'What is the relationship between the different dimensions of mathematics anxiety and secondary mathematics enrollment'*? Student one-on-one semi-structured interviews, self-portraits, and questionnaires described in data collection methods' section, assisted me in identifying the nature of students' mathematics anxiety by voicing and sharing their lived mathematical experiences in different mathematics-related situations and activities.

In the following sub- section, with the help of procedural chart (See Figure 3), I describe the mixed methods research design, data collections methods and analysis.

Research Design

A mixed-methods approach that mixes quantitative and qualitative data guides this research study. Studies using mixed methods employ a research design that involves philosophical assumptions, uses quantitative and qualitative data to answer questions, and integrates both approaches in a study (Johnson et al.2007). For example, researchers use "words, pictures, and narrative to add meaning to numbers" (Johnson & Onwuegbuzie, 2004, p. 21). This combination of qualitative and quantitative methods "involve[s] the collection, analysis, and integration of quantitative and qualitative data in a single or multiphase study" (Hanson et al., 2005, p. 224).

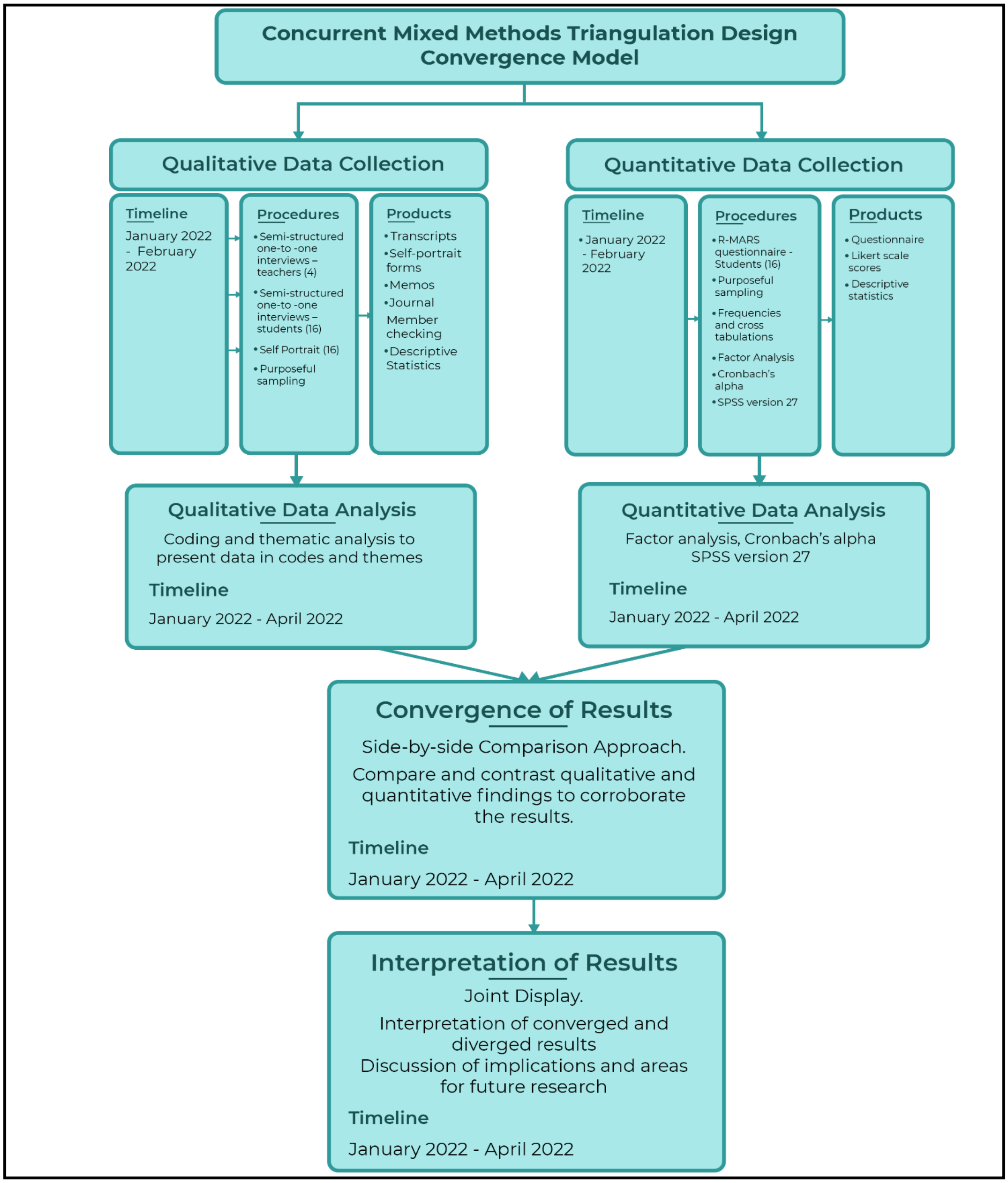


Figure 3

Procedural Chart Summarizing Research Design and Processes

Rationale for Mixed Methods Research Design

I chose a mixed methods research approach for two reasons. The first rationale concerns *complementarity*. The results of the qualitative and quantitative methods when combined supported the findings of one method to elaborate on the other method. Thus data integration of two methods helped me better understand the research problem and the phenomena under investigation (Brannen, 2005). Second rationale concerns collection of data from more than source (Teddlie & Tashkori, 2009). Triangulation design strengthened the validity and enriched the study's conclusions by using multiple data, such as, interviews, self-portraits (qualitative data) and a questionnaire (quantitative data). Moreover, perception of students and teachers during the interviews conveyed the complexities involved in the research problem. "From a psychological perspective, there is a general myth that mathematics is an enigmatic subject" (Belbase, 2013, p. 230). Data collected from self-portraits is an example of 'metaphorical images of mathematics" (Belbase, 2013, p.231) that were created in students' minds about mathematics examinations.

In the following sub-sections, I describe the mixed methods research design, participants and their selection criteria, sampling, recruitment procedure, the methods of data collection, and research design analysis.

Data Triangulation Research Design

Data triangulation is "a process of using multiple perceptions to clarify meaning, verifying the repeatability of an observation or interpretation" (Stake, 2003, p. 148). This study employed data convergence and triangulation, which involved using different data sources to gather information. Triangulation Design allows researchers to compare or validate the qualitative results with the quantitative findings and vice versa (Creswell & Clark, 2011).

Triangulation (See Figure 4) refers to using multiple methods or data sources in qualitative research to develop a comprehensive understanding of phenomena (Patton, 2001). I used different types of data sources for the triangulation of findings: Namely, 1) semi-structured interviews with teachers and students (Creswell, 2007); (2) a questionnaire with students (Richardson & Suinn, 1972); and (3) self-portraits with students (Gupta & Lindt, 2021). These data sources are described in more detail in the subsequent section of this chapter.

Convergence Model

The Triangulation Design is a one-phase design in which researchers collect qualitative and quantitative data simultaneously, giving equal weightage to both types of data. Because data collection happens in the same time frame, the design has been referred to as "concurrent triangulation design" (Creswell & Clark, 2011). The Triangulation Design has four variants, but this study employed the convergence model which is considered the most common model of a mixed-methods triangulation design (Creswell et al., 2003). A convergence model is a single-phase design where qualitative and quantitative data are collected and analyzed followed by comparison of the analysis of both types of data collected to check if qualitative and quantitative data findings confirm or disconfirm each other (See Figure 5).

The convergence model is used when researchers “want to compare results or to validate, confirm, or corroborate quantitative results with qualitative findings” (Creswell & Plano Clark, 2007, p. 65). Although qualitative and quantitative data are collected concurrently, they are analyzed separately by utilizing the expertise of individuals in both quantitative and qualitative approaches. Analyzing the findings of two data sets supports an understanding of the convergence or divergence of results.

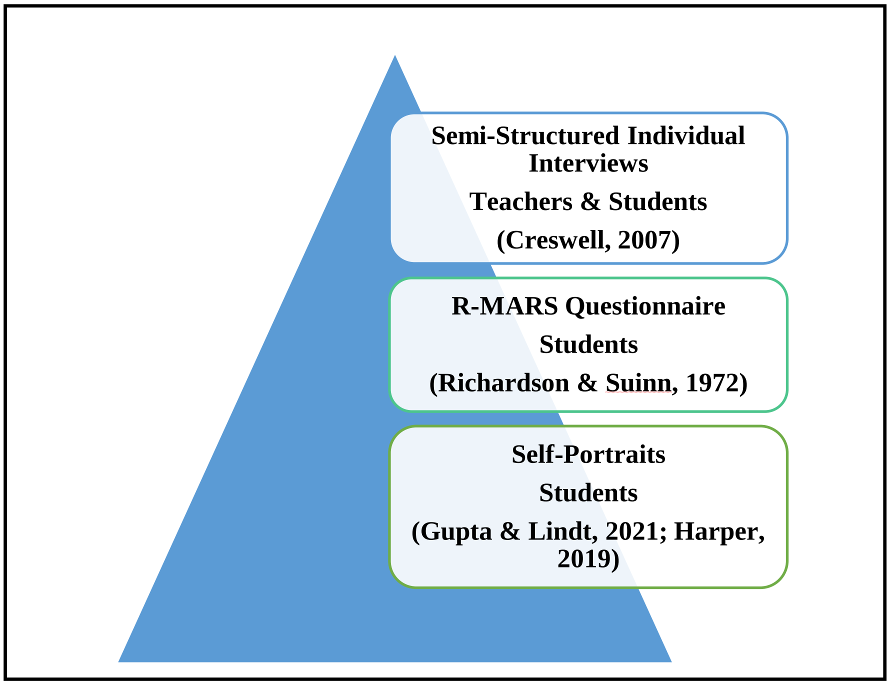


Figure 4

Data Triangulation

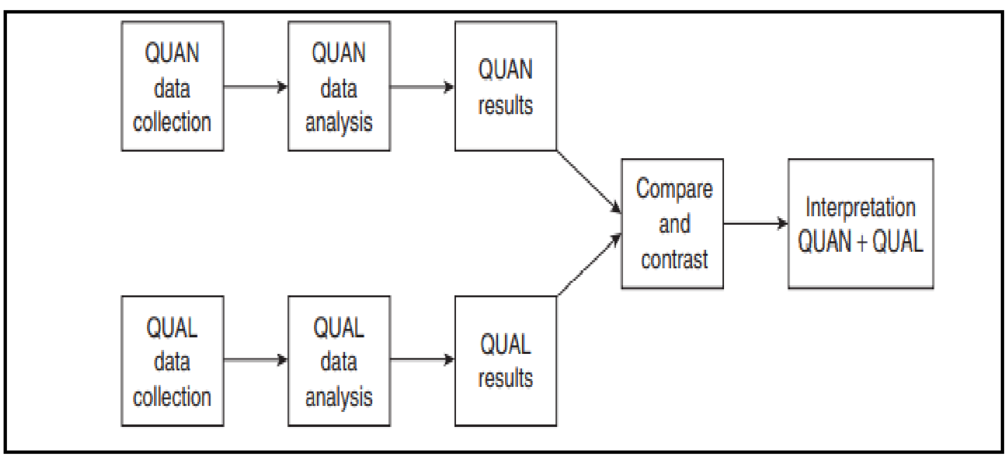


Figure 5

Triangulation Design: Convergence Model

The current study followed a one-phase Concurrent Mixed Methods Triangulation Design to broadly explore and understand the nature of mathematics anxiety in secondary students and how students' avoidance of secondary mathematics impacts enrollment affecting their future lives.

Limitations of the Triangulation Design

Although researchers new to mixed methods prefer using the concurrent Mixed Methods Triangulation Design, due to its intuitive nature, it has some limitations. The qualitative and quantitative data collection happens concurrently, and both the data sets are given equal weight. This approach requires enormous effort, time, and expertise of both qualitative and quantitative research. Moreover, researchers may find it challenging if results do not converge at the interpretation stage.

Research Methods

Research Site Selection Criteria

The site selection context was four K-12 private schools located in an urban setting in an eastern state in India. My prior experience as a high school teacher and K-12 school principal and familiarity with the national board the schools are affiliated with allowed me to choose this context. The four schools are affiliated with a secular national educational board committed to serving the nations' children irrespective of caste, class, gender, religion, and diverse and pluralistic society. Three out of four schools were co-educational, and one was a purely girls' school. Participating schools had children from diverse backgrounds and castes but of the same race. According to the Right to Education Act of the National Educational Policy of India, the reservation of 25% of the seats at the entry level is compulsory for students from low socioeconomic status. Hence, the study's findings may reflect diverse demography and the impact of the students' socioeconomic backgrounds on mathematics anxiety.

Participants

The study had two sets of participants. Primary participants were 16 grade eleven students (aged seventeen), boys (N= 4), and girls (N= 12) from science and Commerce streams who volunteered to participate since they are mathematics anxious (See Table 2). The secondary participants were four secondary mathematics teachers one from each school, who participated in the research study. Students were the primary participants of the study in both the qualitative and quantitative approaches because the study aimed to understand secondary students' mathematics anxiety. Among 16 students, fourteen withdrew from mathematics (N=12 girls and N=2 boys), and two opted (N=2) for mathematics, yet all described anxiety in mathematics. In addition, secondary mathematics teachers' perceptions provide additional information to address the study's questions. Their extensive experience in the subject and ability to evaluate national-level mathematics scripts qualify them as experts in their field of student anxiety; therefore, they were the secondary participants engaged only in the qualitative approach (See Table 1). By secondary level participants I meant grade eleven and twelve students in India.

Purposive Sampling

The study used purposive sampling for recruiting research participants. Purposive sampling is also called purposeful or judgmental sampling. Medenda and Mugenda (1999) observed that "purposive sampling is a sampling technique that allows a researcher to use cases that have the required information"(p.50) and "characteristics of the population of interest" (Johnson & Christensen, 2012, p. 231) related to the research question. In qualitative research, purposive sampling gives the depth and in quantitative research gives the width of understanding of the research problem (Palinkas et al., 2015). Therefore, students with mathematics anxiety who met the inclusion criterion were selected to participate in the research study.

Table 1

Teacher Demographics.

Pseudonyms	**Grade level**	**Years of Teaching experience**	**Educational Attainment**	**National Level Evaluator**
Anthony	Grades 10, 11 & 12	11 years of school teaching and 16 years of out of school teaching.	Master’s in mathematics, Graduation in Education, LLB Graduate in Law. Additional short term and long-term courses in Software & Computers	National level evaluator of grade 12 for seven years.
Arnold	Grades 10, 11 & 12	19 years	Masters in Statistics, Graduation in Education	National level evaluator of grade 12 for seven years.
Brian	Grades 10,11 & 12	21 years	Master’s in mathematics, Graduation in Education	National level evaluator of grade 10 for three years and grade 12 for seven years.
John	Grades 9 through 12	30 years	Master’s in Mathematics, Graduation in Education	National level evaluator of grade 10 for three years and grade 12 for twelve years.

Note: National Level Evaluator are eligible to evaluate answer scripts of national examinations conducted at the end of grades ten and twelve by the National Board.

Table 2

Student Demographics.

Pseudonyms	**Workplace of parents**	**Annual income**	**Parental Educational Background**	**Siblings**	**Guidance at home**	**Caste**
Latoya	father - business, mother - housewife	More than 40 K	both graduates	3	self	general
Roma	Father - business, mother - school teacher	Mother - 15 to 20 k and father - roughly 30-40K	Mother - masters and father - B.com & MBA	1 older sister	self	general
Rahana	Father- employee of construction business, Mother- housewife	between 21-30 K	Father- grade 12, mother- graduate	only child	self	general
Susan	father- Industry, mother - homemaker	More than 40K	Both graduates	1 older sister	self	general
Lucy	Father - Professor, mother - homemaker	no idea	dad - PhD, mom - grade 12	only child	self	general
Marie	father - business, mother- not alive	Between 15 and 25 K	father- class 12, mother - graduate	only child	self	general
Tara	Father- businessman, mother- housewife	no idea	mother was pursuing a degree of MBBS, Left it halfway. Father is MBA	1 older sister	self	general
Henry	Father - CID (govt.), Mother - homemaker	More than 45 K	both graduates	2 sisters	self	OBC
Betty	My mother is a housewife and father work in an industry.	More than 40K	Father – BBA, foundation course in Chartered Accountancy, mother is a graduate.	only child	father	general

Table 2. *Continued*

Pseudonyms	Workplace of parents	Annual income	Parental Educational Background	Siblings	Guidance at home	Caste
Rhea	Father- businessman, mother - housewife	approx. 40K but fluctuates	Father-grade 12, mother -	1 brother and 1 sister	self	general
Richa	Father- businessman, mother - housewife	approx. between 21-25K	father - grade 12 and mother grade 10	1 elder sister	sister	general
Robert	father - Industry, Mother - homemaker	More than 50K	father-B.Tech. mother - graduate	1 elder sister	self	OBC
Sonia	father - Industry, Mother - homemaker	More than 40K	Father- Diploma, Mother - graduate	1 younger brother	self	general
Will	father -employee in a store, Mother- housewife	20-30 K	Father M.com, mother - grade 12	only child	Until class 8, my mother, grade 9- tuition	general
Richard	Father- private company employee, mother -housewife	don’t want to share	both - grade 10	only child		general

Note: Caste -‘OBC’ indicates other backward castes and ‘General’ indicates higher caste
Annual income-‘K’ indicates the numeral ‘thousand’.

Therefore, students with mathematics anxiety who met the inclusion criterion were selected to participate in the research study. Bernard (2002) explained the relevance of the participant's availability and willingness to participate. Articulating experiences is an essential characteristic of purposeful sampling. Therefore, the voluntary participation of students and teachers contributed effectively by articulating their teaching and learning experiences related to mathematics anxiety.

Recruitment Procedures

The outbreak of the Covid-19 pandemic presented unprecedented challenges. Due to a sudden upsurge in the number of Covid cases at the time of data collection, I was forced to collect data virtually via university Zoom. Approval from the university's Institutional Review Board (IRB) was obtained before conducting the current study virtually. The principals of the four schools were informed through email about the research study. The emails had a brief description of the research purpose, instruments for collecting and analyzing data, the anonymous nature of the study, and voluntary participation of respondents. Bilingual (English and Hindi) recruitment scripts and flyers were attached to the emails for distribution to the secondary mathematics teachers, students, and parents. Teachers and students who volunteered to participate sent their confirmation through WhatsApp messages. Since the students were less than eighteen years of age, parents' consent for students' participation was obtained (See Appendix I) before the study. Students were provided with informed consent in an information sheet (See Appendix H). The teachers' consent too was taken before the interview (See Appendix J).The consent forms were emailed to the participants. I did not exert any pressure on the participants to participate in this study. The consent form comprised a description of the study, which included data collection procedures, potential risks, benefits and rights of participants, payment details, and confidentiality protection. In addition, participants were informed that signing the forms indicated their consent to participate in data collection. The participants scanned the signed documents and emailed them to me via the university's secure file sharing system.

Data Collection Methods

Procedures for concurrent data collection happened during agreed upon appointments and as per the availability of each respondent. Time slots for data collection were allotted to the research participants well in advance. The data collection and analysis timeline were from January through March during the academic year 2021-2022. I conveyed information about the timeline and data collection to the participants in advance. Confirmation from the participants was taken to ensure the schedule for data collection was adhered to.

The current study primarily used three data collection tools to gather information about the phenomenon under investigation. Each method elicited responses based on experiences in three mathematics-related situations and activities: mathematics examination, numerical tasks, and mathematics curriculum. Student interviews preceded teacher interviews. Data collection started with 16 secondary level students and four secondary mathematics teachers research who participated in a virtual open-ended semi-structured interview. The interview was followed by student research participants engaging in an art-based technique that provided insight into a child's self-reflection called 'self-portrait.' This technique captured the emotional complexities involved in students lived mathematical experiences. Finally, the Revised Mathematics Anxiety Rating Scale (RMARS), a questionnaire, was administered to all the students to examine their level of anxiety in different mathematics-related situations. In the following sub-section, I will describe the three primary data collection methods, including the procedure, strengths, and weaknesses experienced during data collection.

Qualitative Data Collection Tools

Semi-Structured Interviews. Rubin and Rubin (2005) explained, "Qualitative interviews are conversations where a researcher gently guides a conversational partner in an extended discussion. The researcher elicits depth and detail about the research topic by following up on answers given by the interviewee during the discussion" (p. 4). The interview questions were adapted from the 10-question interview protocol Gresham (2007) developed to study pre-service teachers' mathematics anxiety. Gresham set open-ended questions that would give a better insight into understanding the mathematics anxiety of the participants. Broadly, five interview questions under mathematics examination, mathematics curriculum, and numerical tasks were asked to obtain a deeper understanding of the research objectives. The timeline for each interview was a maximum of fifty minutes. I asked probing questions for the acquisition of relevant and additional data. The interview style was conversational and interactive, focusing on eliciting information on students' mathematics anxiety and how it impacts secondary mathematics enrollment. Since it was an in-depth interview, participants were asked pre-designed open-ended questions (Jamshed, 2014) to prevent influencing the participants' conceptions or experiences of the topic and simultaneously elicit the most befitting responses to study students' mathematics anxiety.

I maintained a journal to note ideas and probing questions for student and teacher participants during the interviews. The notes maintained in the journal were reviewed before subsequent interviews to ensure I obtained relevant responses. Interviews were conducted for 16 students and four teachers via Zoom, video recorded, and transcribed using Zoom cloud recordings. The non-verbal cues and pauses during the interviews were maintained in the journal.

Student Interviews. I explored through interviews students' perception of mathematics anxiety. The students' interviews covered five explorative questions categories (See Appendix E). The interviews were approximately fifty minutes to one hour in length. The first question included demographic information, for example, parents' income and educational background, occupation of parents/guardians, caste, and the number of siblings, to obtain information about students' background. The second question elicited information about students' perception of mathematics anxiety in situations like examination, solving numerical tasks, mathematics curriculum, support from additional textbooks used for references, and participation in mathematical activities. The third question gathered information about instructional practices and strategies adopted by mathematics teachers to alleviate students' mathematics anxiety, followed by questions on students' avoidance tendencies.

Additionally, the questions addressed students' physiological and emotional responses to mathematics anxiety resulting from past mathematical learning experiences. Finally, the semi-structured interview concluded with questions focusing on students' self-efficacy to examine how their sense of self-efficacy helped them bounce back from failure and handle situations rather than worrying about what may go wrong (Bandura, 1977). The fifth interview question was aligned with Bandura's assumptions of self-efficacy. He stated that "low efficacy of students not only find meeting academic demand challenging but are vulnerable to achievement anxiety" (Bandura,1997, p.235). Employing the theoretical assumptions of Bandura's sources of self-efficacy that can influence students, I extracted extensive relevant information from the interviewees that informed my understanding and making meaning about the efficacy of students.

Teacher Interviews. The interview questions required the teacher respondents to share their perceptions about students' mathematics anxiety. "Teachers' evaluative reactions can influence students' judgments of their capabilities and scholastic performances" (Bandura,1997, p.225). Data were obtained through explorative questions structured into five categories for fifty minutes to one hour (See Appendix F). The interview began with demographic questions like years of experience as a mathematics teacher at the secondary level, educational attainment, experience as a national level evaluator. The second question was based on instructional practices and strategies adopted by the teachers to alleviate students' mathematics anxiety. The third question elicited responses on identifying mathematics-anxious students in the class. The fourth question targeted testing the effectiveness of instructional techniques and strategies adopted by mathematics teachers to address students' anxiety and avoidance tendencies. "Teachers' beliefs in their instructional efficacies partly determine how they structure their academic activities in their classrooms and shape the students' evaluations of their intellectual capabilities" (Bandura,1997, p.240). The online semi-structured interviews concluded with questions on teachers' self-efficacy. "The task of creating learning environments conducive to developing cognitive competencies [of students] rests heavily on the talents and self-efficacy of teachers" (Bandura,1997, p.240). Therefore, teachers can create a conducive environment in the classroom to ensure the cognitive demands of the students are met.

Strengths. Semi-structured interviews reduce interviewer bias imposed by more than often asked questions in structured interviews (Bragger et al., 2002). Therefore, interviews allowed me to establish a rapport with the interviewees. Probing questions enabled me to gather additional information and explore ideas and perspectives during the discussion. Interactive interviews promoted honest and creative responses, which was evident from the talks. Moreover, it was easier for me to read non-verbal cues like facial expressions and emotions during the conversation.

Limitations. Conducting an interview requires effective communication skills since it helps the interviewer to develop rapport with the interviewee. Hence the five broad interview questions formulated were short, clear, and crisp for an easy understanding of the research problem. Organizing questions based on the research topic and analyzing data is more complex than structured interviews. Frequent prompts and probing questions helped the respondents express their perspectives effectively. There was a likelihood for me to forget to ask helpful questions. The five interview questions for teachers were drafted in advance and hence had time to plan. Since the semi-structured interviews had open-ended questions, they took longer to conduct when compared to structured interviews and other data collection techniques.

Self-Portrait. Students' self-portrait is a non-verbal aspect of data collection gathered through visuals, captions, and descriptions in qualitative research. Qualitative researchers have employed art-based or self-portrait visualization techniques and tasks to elicit participants' reflexivity and perception of topics under investigation (Gauntlett, 2007). The preferred methods used expressive styles like maps, drawings, and captions (Bagnoli, 2009; Esteban-Guitart et al.,2017). Each self-portrait depicting dreams, stories, emotions, and a symbolic situation through drawing serves as an "ice-breaker' before or after an interview. A study found that the self-portrait technique has been used by people of all groups, social backgrounds, and people with language deficiencies (Esteban-Guitart, 2012).

Drawings, maps, and pictures help participants to communicate experiences more holistically and evoke emotional responses easily (Mitchell, 2011). Similarly, Bagnoli (2009) examined the experiences of migrants by employing the self-portrait technique. Esteban-Guitart and team also used this technique to compare self-portraits through discussions and graphical representations made by aboriginals from different educational backgrounds and age groups (2017). Similarly, based on the social experience of high school students, Aguilar et al. (2016) focused on images of mathematics and mathematicians. Studies have shown that pictorial images are representations of an individual's beliefs, emotions, and feelings (Picker & Berry, 2000).

Moreover, a group of high school mathematics teachers described multiple strategies to combat negative perceptions of mathematics among secondary students. Among the various strategies, self-portrait technique was one of the strategies used to for students to express their feelings and emotions (Gupta & Lindt, 2021). Harper (2019) too designed a graphic elicitation model using relational maps for the interviewees to show their relationships with mathematics (Bagnoli, 2009). Self-portrait techniques complement interviews in collecting qualitative data since not all data from interviewers can be reduced to language or verbal expressions (Eisner, 2008). It is a non-verbal form of expressing the experiences and feelings of students and how these feelings could manifest anxiety. The art-based technique I used in the current study was adapted from a conference presentation shared by Gupta and Lindt, (2021).

An online self-portrait form was administered to 16 students (See Appendix B), and they were given thirty minutes to complete it. Extra time was given to students upon request. Through the art-based technique, I aimed to gather information about students' mathematical learning experiences and describe the reasons for mathematics anxiety in a mathematical situation that was the most unpleasant experience, depriving them from performing and compelling them to withdraw from secondary mathematics enrollment. Accordingly, the self-portrait prompted them to include information about:

1. **What** indicated emotional or physiological arousals students experience during mathematical learning.
2. **Where** the anxiety was experienced, like a home, classroom, after class private tuition.
3. **When** they were mathematics anxious for the first time (e.g., at what age or grade level).
4. **Who** was the person(s) responsible for triggering anxiety in mathematics.

Written responses, along with the diagrams of the mathematical experience, offered insight into the relationship of physiological or emotional arousals with mathematics anxiety in each participant's life. The self-reflection strategy allowed the participants to articulate their mathematical learning experiences through graphical and written expressions. Students were asked to scan the document and email it to me through the university's secure file sharing system.

Strengths. Self-portraits are a creative way of expressing one's views and help the student respondents to communicate their thoughts and emotions through pictures and words. Self-portraits were a robust data collection method for establishing rapport with the students as they can be interesting to capture the participants' perspectives through diagrams. This technique helped me explore students' views on the sensitive issue, especially for participants with language deficiencies (Aguilar et al., 2016).

Limitations. Participants with low creative abilities experienced difficulties expressing their feelings and emotions through this technique. Hence, students with inadequate creative skills were given an option of either drawing emojis or copy-pasting internet pictures. Findings showed that two participants pasted pictures representing their emotional and physiological states of mind. The impact of social desirability on the participants may have inhibited honest responses. In other words, participants are likely to report socially acceptable experiences. Data triangulation facilitated data validation through cross-verification from other data collection methods. In this study, students' interviews and questionnaires helped me to assess consistency in findings. If the instructions are not appropriately worded, participants may not reveal correct information and assess themselves accurately. Hence, the self-portrait document had clear instructions. In addition, I discussed the objective and process of administering the self-portraits for students to clarify the objectives of conducting this method.

Protocol Development. To address potential limitations, a pilot study was conducted in June and July of 2021 to gather data on students' and teachers. Perceptions and experiences on secondary students' mathematics anxiety and the development of mathematics avoidance behaviors. Two pilot phases were conducted. One was part of a university's summer course, and the other was approved as an individual research project by the institutional review board (IRB). The semi-structured virtual interviews and self-portrait pilot tested for the summer course included seven students and two teachers in India. The IRB- approved pilot study in the United States had one student who participated in a virtual semi-structured interview, self-portrait, and questionnaire on mathematics anxiety and an interview with one teacher.

Johnson and Christensen (2012) recommended that "one must 'try out' or 'pilot test' a questionnaire to determine whether it operates properly before using it in a research study" (p. 183). The authors described the 'think-aloud technique' as a valuable technique for a pilot test, which requires respondents to express their views and perceptions about a phenomenon under investigation. Researchers pilot test interviews before preparing the interview protocol for the research study (Seidman, 2006). For the current study, pilot testing of the interviews allowed relevant modifications. Several revisions were made before the questions were finally listed for the final study. Interview questions were reformulated and aligned with the three factors identified for the questionnaire. Moreover, a prompt asking, “Who?” in the self-portrait was included for the final study as it will help identify person or 'persons' responsible for triggering mathematics anxiety in students.

Quantitative Data Collection Tool

Revised Mathematics Anxiety Rating (RMARS) Scale. The RMARS questionnaire had twenty-five items that included eleven items on mathematics examination, seven items on mathematics curriculum, and seven items on numerical tasks. In addition, the questionnaire contained items representing different mathematics related situations and activities that may arouse anxiety and 16 students self-administered questionnaires in an online format in January 2022. After interviewing the students, I explained the objective of the 25-item RMARS questionnaire and provided all details required for students to self-administer the survey. Since the data collection was online, I emailed the questionnaire to the students.

For each statement of the questionnaire, the participants rated their anxiety level. Individually students recorded their responses on a five-point Likert scale. Student response choices were (1) not at all, (2) a little, (3) a fair amount, (4) much, and (5) very much. The final representation of students' mathematics anxiety was divided into three levels. High, moderate, and low. 'Much' and 'very much' from the Likert scale were combined and designated as 'high’ level of anxiety, 'A 'fair amount' as 'moderate' level, and finally, 'not at all and 'a little' as 'low’ level of anxiety (Rayner et al., 2009). Therefore, the three anxiety levels were high, medium, and low. Higher scores reflect higher mathematics anxiety. To ensure clarity and proper understanding of the items in the questionnaire, I read aloud to each student participant after their interviews. Then, students filled each box against every statement and completed the questionnaire. The timeline for completing the questionnaire was approximately ten minutes. After completing the anonymous survey, the participants scanned the filled-up survey and emailed it to me through the university's secure file sharing system. The survey examined students' mathematics anxiety levels under different mathematical situations and determined the impact mathematics anxiety and avoidance behaviors had on secondary mathematics enrollment.

Criteria to Shorten Mathematics Anxiety Rating Scale. The current study used a quantitative approach with a questionnaire to evaluate the mathematics anxiety level of secondary students under mathematics-related activities and situations. The modified and piloted 25-item mathematics anxiety rating scale was adapted from the three-factor analytic studies of Alexander and Martray (1989). The researchers considered three dimensions of students' anxiety as factors to measure the degree of anxiety. The items in their study were based on mathematical instructional practices, but a few were inappropriate for the current study. For example, fundamental mathematical operations like 'Being given a set of division, multiplication, subtraction and addition problems to solve' were not age appropriate. Similarly, conducting a '*pop'* quiz in a mathematics class is not commonly practiced in a mathematics lesson in India for assessing student knowledge. Therefore, to provide content reliability and validity and meet the instrument's goals, I made eleven modifications to the questionnaire to adapt to the age, culture, and curriculum followed by the participating schools. Table 3 shows the revised salient items for this study. The current study revealed three dominant factors to measure mathematics anxiety students usually experience: mathematics examination, mathematics curriculum, and numerical tasks.

Table 3.

Revisions in RMARS

Items in shortened and modified version of RMARS	**Revised/Modified items**	**Reasons for modifications**
Receiving your final mathematics grade in the mail.	Scoring low marks in mathematics final exam.	Secondary students do not receive mathematics grade in the mail.
Being given a "pop" quiz in a mathematics class.	Asked to solve a quiz question in a mathematics class	Students are not familiar with the term ‘pop’ quiz
Taking the mathematics section of a college entrance examination.	Taking the national board mathematics exam	Research participants are secondary students. Therefore, no experience of college exam
Thinking about an upcoming mathematics test five minutes before.	Going to school for mathematics national level board exam	Answering National Board examination will provide more information about anxiety than five minutes before exam.
Reading a cash register receipt.	Dividing a five-digit number by a three-digit number in a short time with pencil and paper	Science students not familiar reading a cash register.
Figuring out your monthly budget.	Clarifying doubts in class.	Monthly budgets are managed by parents.
Having someone watch you as you total up a column of figures.	Watching a teacher work on a complex numerical on the blackboard.	Not too challenging
Totaling up a dinner bill that you think overcharged you	Explaining a mathematics numerical on the blackboard.	Not age specific.
Studying for a driver's license test and memorizing the figures involved, such as the distances it takes to stop a car going at different speeds.	Being given homework assignments of many difficult problems that are due the next class.	Students are not allowed to drive motorized vehicles under 18 years of age.
Being given a set of subtraction problems to solve.	Being given a set of numerical problems involving trigonometry in front of the class on the blackboard.	Not age specific
Being given a set of multiplication problems to solve.	Taking school terminal mathematics exam	Not age specific

Factor one contained RMARS items related to mathematics examination, learning, and evaluation. Factor two included items related to mathematics curriculum and course books and factor three identified as numerical tasks, included items that dealt with regular mathematical and computational activities and making any financial decisions in life,

The three factors used in the current study were based on Alexander & Martray's (1989) study that had items on mathematics examination, numerical tasks, and mathematics curriculum-related experiences of being in a mathematics class. Mathematics anxiety may develop if the curriculum is overloaded. "The 25-items selected met the criterion of either being an item included in an important factor in at least two of the studies" (Suinn & Winston, 2003, p.168). Suinn and Winston predicted that "high scores on mathematics anxiety would be negatively associated with mathematics-related majors or careers because mathematics anxiety leads to mathematics avoidance behaviors" (2003, p.171). Therefore, the findings of the questionnaire will provide in-depth information about the level of students' anxiety in various mathematics-related situations and tasks. Factor one contained RMARS items related to mathematics examination, learning, and evaluation. Factor two included items related to mathematics curriculum and course books and factor three identified as numerical tasks, included items that dealt with regular mathematical and computational activities and making any financial decisions in life,

Strengths. Online collection of surveys was inexpensive and easier to obtain relevant information from a small sample yet represented a large population. Data collection through questionnaires was less time-consuming when compared to other qualitative data collection methods like interviews. Hence, student participants agreed to administer the questionnaire willingly. The data were anonymized for confidentiality (Salters- Pedneault, 2020)**.**

Limitations**.** Participants are typically biased when they respond to responses on the questionnaire since social desirability impacts their responses (Creswell & Plano Clark, 2007). Therefore, after conducting their interviews, I read the questionnaire to the student participants for further clarification and discussed the importance of the survey findings. Unfortunately, the sample for the study was small. Hence, the study's findings may not represent the population (Warner et al., 2011). In addition, the videos were turned off when the surveys were administered to students. Therefore, capturing non-verbal cues like facial expressions and emotions was impossible.

Questionnaire Development. A pilot study of the 30-item Revised Mathematics Anxiety Rating Scale (RMARS) was administered with secondary students (*N=93*) in India whose demographic characteristics were almost like those in the final study. The RMARS 30-item comprised statements derived from three-factor analytic studies reported in previous literature by Alexander and Martary (1989). The pilot study supported the development of a shorter version of the 98-item Mathematics Anxiety Rating Scale developed by Richardson and Suinn (1972). The internal consistency revealed how well the items yielded comparable results (Bordens & Abbott, 2011). I ran a reliability test. For internal consistency I computed in SPSS version 27 and assessed the reliability of the 30-item modified MARS of the current study. A Cronbach alpha of .93 indicated high internal consistency though the findings were consistent with the previous findings of .97 for the MARS 98-item scale created by Richardson and Suinn (1972); and .91 for the 25-item MARS from Alexander and Martary (1989) reported by Suinn and Winston (2003).

To measure content validity, the extent to which the items represented "the construct of interest" (Price et al., 2015, para 15) of the RMARS 30-item version (See Appendix C), I used a three-factor analysis on SPSS version 27 that examined whether the MARS 30-item scale showed similar factor loadings. A principal components solution with oblique rotation was applied (Suinn & Winston, 2003). Pattern Matrix showed five items where the factors were cross-loaded, and all the five items were listed under numerical tasks. Consequently, I did an individual Cronbach alpha to understand the difference it would make if I deleted five items. After deleting five cross-loaded items, I ran the reliability analysis on 25-item MARS factor wise. The Cronbach's alpha value of the 25-item RMARS version was .92. (See Table 4)

George and Mallery (2003) provided the rule of thumb for assessing the Cronbach's Alpha value for a Likert scale instrument. According to George and Mallery (2003), Cronbach's Alpha value above 0.90 indicates excellent internal consistency, above 0.80 is good, above 0.70 is acceptable, above 0.60 is questionable, above 0.50 is poor, and below 0.50 is unacceptable. Therefore, a Cronbach's alpha of .92 revealed that the internal consistency was excellent and considered reliable for research purposes.

Reliability statistics 25-item questionnaire were calculated for individual factors too. Cronbach alpha for mathematics examination was .90; Mathematics curriculum was .85, and Mathematics numerical was .81. The results gave additional evidence that the three factors I examined for the current study can measure mathematics anxiety and the modified version of MARS is a good measurement scale for investigating the mathematics anxiety of my sample. Pilot testing of the questionnaire allowed certain modifications in the wording of specific items. Moreover, I deleted five items (19,20,25, 27 & 28) from the questionnaire. Finally, a 25-item version of the RMARS was administered to a total of (N=16) students in the final study (See Appendix D). The pilot study enhanced the validity and reliability of the 25-item questionnaire.

Table 4

Reliability Test (30-item) Pattern Matrix Using Principal Component Analysis Extraction Method

Items	Component		
	1	2	3
	Examination	Curriculum	Numerical
Q9	0.904	-0.117	-0.152
Q8	0.822		
Q4	0.809		
Q3	0.741	0.31	-0.269
Q6	0.741	-0.319	
Q5	0.718		
Q18	0.705	-0.207	0.149
Q11	0.686	-0.114	0.36
Q21	0.617		0.267
Q2	0.58	0.48	-0.258
Q10	0.55		0.394
Q20	**0.462**	**0.281**	**0.237**
Q22	0.431	0.141	0.382
Q13	-0.16	0.875	
Q16	-0.121	0.865	
Q12	-0.195	0.821	0.136
Q17	0.123	0.798	
Q15	0.108	0.793	

Table 4. Continued

Items	Components		
	1	2	3
	Examination	Curriculum	Numerical
Q14	-0.107	0.697	0.118
Q28	-0.102	0.644	0.172
Q25	**-0.359**	**0.635**	**0.347**
Q7	0.294	0.619	
Q1	0.381	0.56	-0.153
Q23		0.558	0.22
Q24	-0.118	0.136	0.768
Q29	-0.196	0.114	0.724
Q30	0.121		0.666
Q27	**0.406**		**0.506**
Q26	**0.241**	**0.297**	**0.382**
Q19		**0.247**	**0.288**

Note: The bolded items cross-loaded hence deleted to improve the internal consistency of the scale.

Reliability statistics 25-item questionnaire were calculated for individual factors too. Cronbach alpha for mathematics examination was .90; Mathematics curriculum was .85, and Mathematics numerical was .81. The results gave additional evidence that the three factors I examined for the current study can measure mathematics anxiety and the modified version of MARS is a good measurement scale for investigating the mathematics anxiety of my sample. Pilot testing of the questionnaire allowed certain modifications in the wording of specific items. Moreover, I deleted five items (19,20,25, 27 & 28) from the questionnaire. Finally, a 25-item version of the RMARS was administered to a total of (N=16) students in the final study (See Appendix D). The pilot study enhanced the validity and reliability of the 25-item questionnaire.

Data Analysis Procedures

I collected data concurrently and employed qualitative and quantitative data analysis methods. The self-portraits data collection followed student interviews and concluded with administering the survey. The teacher interviews followed student interviews. A four-phase analysis of qualitative and quantitative data helped me arrive at the findings.

In phase one, I qualitatively analyzed student interview responses on secondary students' mathematics anxiety and avoidance behaviors impacting secondary mathematics enrollment. In phase two, examining the graphic and written representation through self-portraits further contributed to my understanding of students' perception of anxiety in mathematics. In phase three, student ratings to the questionnaire on three pre-determined factors, namely mathematics examination, mathematics curriculum, and numerical tasks, were analyzed quantitatively. Finally, in phase four, I analyzed teacher interview responses to capture teachers' perception of mathematics anxiety of secondary students and convergence of findings with student responses.

Mixed methods studies (Tashakkori & Teddlie, 2003) explore how qualitative data can be "quantified" for statistical analysis. Mixed methods studies (Tashakkori & Teddlie, 2003) explore how qualitative data can be "quantified" for statistical analysis. For example, "information from codes could be used in the quantitative follow-up or specific, significant statements or quotes from participants" (Creswell & Plano Clark, 2007, p. 145). In the next section, I offer a detailed description of how I took this approach in the analysis of the data.

Phase1 and 4:Analysis of Semi-Structured Interviews. The study involved data collection for interviews of 16 secondary students and four secondary mathematics teachers via Zoom, video recorded and transcribed into Word documents using Zoom cloud recordings. In addition, the transcribed video files were cleaned, making light edits to text for readability. The interviews were approximately one hour in length.

I created a codebook in Google spreadsheets for organizing the analysis. Then, I conducted two cycles of coding to arrive at the themes. Saldana (2009) described coding as putting names or labels against chunks of data that may be individual words, phrases, or pages from a text that attaches meaning to the pieces of data. In the first coding cycle, I used deductive coding strategies by selecting provisional codes based on the study of Alexander and Martray (1989) and the study purpose. I identified three provisional coding categories that include Mathematics Examination (ME), Mathematics Curriculum (MC), and Numerical Tasks (NT). Teacher and student interview responses were separately listed under the three provisional codes in Google spreadsheets. "Provisional Coding establishes a predetermined 'start list' set of codes before fieldwork" (Miles & Huberman, 1994, p. 58). "[These] codes can be developed from anticipated categories or types of responses/actions that may arise in the data yet to be collected" (Saldana, 2009, p.120). To make meaning of the data, I read the interview responses of students and teachers multiple times, highlighting keywords and phrases. This process resulted in creating and applying words and phrases codes and aligning them with interview statements. The codes were participants' own words. Throughout the analysis process, I maintained notes of excerpts from interview statements with one or more codes as evidence of representing what each code meant. See Appendix G for details on the manual codebook I created for coding and analyzing themes that finally emerged from the inductive analysis.

In the second coding cycle, I used 'pattern coding' that helped me identify patterns of themes that emerged across the interview statements. Since there were multiple pattern codes and a few were overlapping, I condensed the significant pattern codes to capture themes that emerged from them. These themes were short phrases and words. I combined the themes common to student and teacher interviews into broader, overarching significant themes through the process of focused coding. Focused coding "searches for the most frequent or significant initial Codes to develop" (Saldana 2009, p.155) "the most salient categories in the data corpus and required decisions about which initial codes make the most analytic sense" (Charmaz, 2006, pp. 46, 57). Other themes that emerged from the first coding cycle were merged with the major relevant themes. I condensed the themes to develop my findings that addressed the research problem and purpose. Finally, four themes emerged from the inductive analysis: low self-belief, large class sizes, time management skills, and instructional practices.

Combining deductive and inductive coding strategies helped me organize myself and connect the data to findings with existing research. In addition, the process supported the development of the discussion by providing meaningful and actionable implications and recommendations for future research.

The interviews started with demographic questions to explore the background and characteristics of the participants. The responses to the demographic questions were entered in a spreadsheet for commonalities. I observed that factors like caste, annual income, educational background of parents, and size of the family or siblings of both genders did not impact students' performance nor influenced their decision to withdraw or develop avoidance tendencies in mathematics. On the contrary, prior research showed that gender, caste, race, socioeconomic background, and parental educational attainments impact students' anxiety in mathematics.

The subsequent three interview questions were related to instructional practices and strategies, perception of mathematics anxiety-identification of mathematics-anxious students, and how students' avoidance tendencies impacted mathematical learning. Probing questions removed ambiguity and helped obtain more in-depth information and a deeper perspective of the participants' views about the phenomenon under investigation.

The last question addressed the self-efficacy of the participants. The interview responses of students and teachers indicated that students' low self-efficacy and inability to develop the confidence to perform in mathematics were influenced by other factors like myths, lack of practice, and negative attitudes toward mathematics, which resulted in mathematics anxiety. Using phrases like 'I am responsible for low self-belief,' 'low self-perceptions, 'avoid learning opportunities when they come up,' and 'not interested in maths' indicates students felt responsible for developing low perceived mathematics learning competence.

Phase 2: Analysis of Self-Portrait. An online self-portrait qualitative data collection tool was administered to 16 grade eleven students for approximately thirty minutes. The purpose was to explore the nature of mathematics anxiety and understand student experiences in different mathematical situations and tasks through 4Ws: What, When, Where, and Who. The long struggle with anxiety that influenced their decision to withdraw from mathematics at the secondary level was gathered significantly by analyzing responses collected from written statements, drawings, and images. Students with artistic skills chose to describe their experiences through illustrations and statements. Students with low creative skills preferred using images from the internet in addition to statements. I analyzed the responses the four categories '4Ws' of self-portrait. I manually entered the short statements written by students on the self-portrait forms in a Google Spreadsheet for analyzing students' anxiety under four categories: what, where, when, and who. Descriptive statistics in Excel, the frequency of responses for each category of the '4Ws' helped to analyze the findings graphically. Written responses, along with the diagrams of the mathematical experience, further offered insight into the relationship of physiological or emotional arousals with mathematics anxiety in each participant's life. I compared the descriptive statistics of self-portrait responses with the RMARS data analysis using joint displays described in the data integration section for convergence or divergence of the findings.

Phase 3: Analysis of Revised Mathematics Anxiety Rating Scale. The following section will describe the findings of the analyses conducted on the Revised Mathematics Anxiety Rating Scale (RMARS) administered to 16 secondary students. The RMARS comprises 25 items related to anxiety under three mathematical situations. Each item was measured using a five-point Likert scale, with values of each response ranging from 1(not at all) to 5 (very much). The total score of the RMARS questionnaire is 125, calculated from the absolute maximum value of the Likert scale. Specifically, before administering the questionnaire for the final study, I conducted a three-factor exploratory factor analysis and a reliability check in a pilot study (discussed in Chapter Three). Data collected from the questionnaire were entered into IBM SSPS version 27. A two-step analysis was conducted. First, an overall descriptive statistic was computed with the mean details for each item to assess the average performance of students on the questionnaire and the standard deviation to measure the dispersion of student scores. These scores helped interpret the respondents' level of anxiety under three mathematical situations and tasks identified as factors for the questionnaire in the current study.

In addition, the software IBM SPSS version 27 codebook was used to calculate the frequency and percentage of responses indicating high, medium, and low anxiety. 'Very Much' (5 points) and 'Much' (4points) from the Likert scale were combined and designated as '*high* level of anxiety, 'A 'fair amount (3 points) as '*medium* level, and finally, 'a little' (2 points) and 'not at all (1 point) as '*low*" level of anxiety (Rayner et al., 2009). The three anxiety levels were ranked from high-low for understanding the degree of anxiety. An individual can score as low as 25 and as high as 125 on the RMARS. Higher scores reflect higher mathematics anxiety. Study findings showed students responding with high, medium, and low anxiety levels. The percentage and frequency for each item were used to derive graphic visualization of the level of anxiety item-wise and category-wise. The following section will describe the quantitative data analysis under three sub-sections: RMARS categorical results, overall RMARS comparison of categories, and findings.

Analysis of Three Data Sources

The analysis of data collected in the current study used data visualizations, descriptive statistics, and codes and themes emerged from inductive coding after reviewing interview responses statements. For the analysis of the study, I created three sets of joint displays described in data integration section. Data integration combines qualitative and quantitative data analysis through three joint displays. Creswell & Clark (2018) describe: “A joint display (or integration display) is an approach to show the integration data analysis by arraying in a single table or graph the quantitative and qualitative data. This approach facilitates a more distinct and nuanced comparison of the results. In effect, the display merges the two forms of data" (p.228). At the integration level, joint displays helped interpret the qualitative and the quantitative data. The idea behind developing joint display findings of both forms of data at the integration stage was to merge them into a single visual and interpret the display (Guetterman et al., 2015). I compared sample quotes from the interviews to the findings of the surveys displayed in graphs and examined areas of divergence and convergence between the qualitative and quantitative approaches.

I visually reported the survey (quantitative) results through the first joint display. I then examined the findings from the student interviews and self-portraits (qualitative) using themes and sample quotes that emerged from the data to check whether the findings of this database confirm or disconfirm the statistical results. The findings addressed the first and third research questions. The second joint display visually compared the survey (quantitative) results and examined the teacher-interview findings using themes and statements and checked convergence with the statistical results. The findings addressed the second research question. The third joint display compared the teacher and student interview responses with areas of partial agreement.

Validity and Reliability of the Study

The validity of qualitative and the validity and reliability of quantitative approaches are essential research components for ensuring the quality of the data and findings. Further, my keen interest in exploring the mathematics anxiety of K-12 students relates to the role of being a parent and a former principal of a K-12 school. Multiple measures were taken throughout the study to ensure that the results are trustworthy.

Reliability and Internal Consistency of RMARS

The MARS has become the most popular instrument due to its extensive data on its reliability and validity of scores from the scale (Plake & Parker, 1982). The questionnaire was piloted as described in the data collection tool section of this chapter Cronbach's alpha helped evaluate the reliability of the modified 30-item MARS. Also, factor analysis was run to calculate 25-item scale factor loadings as reported for previous researchers' modified MARS 30-item scale. Items were deleted to increase the internal consistency of the scale.

Validity and Trustworthiness.

Qualitative validity comes from researchers, participants, and reviewers (Creswell & Miller, 2000). Therefore, establishing trustworthiness or authenticity (Lincoln & Guba, 1985) is essential. Trustworthiness in the study was ensured according to the strategies recommended by Direko & Davhana – Maselesele (2017).

Credibility. Since I was the sole author of this study, I personally conducted all data collection with the participants via zoom. Each participant was given a time slot and a pseudonym to maintain privacy and preserve the confidentiality of responses. Participants were not obliged to share what they chose to withhold. I obtained permission to conduct the university IRB (Institutional Review Board) study. The protection of human rights was observed during data collection. I employed member-checking the transcripts with the research participants so that the script accurately reflects the true meaning and resonates with the experiences of the participants interviewed. Participants sent their confirmation of being approached for member-checking by messages.

Transferability. Triangulation increases validity and reduces “systematic biases or limitations of a specific source or method” (Maxwell, 2009, p. 93). Therefore, to gain an in-depth and better understanding of the phenomena, data was collected from more than two sources. In this mixed methods study, interviews of teachers and students, self-portraits , and questionnaire were used for analysis and data integration to identify areas for convergence and divergence. Description of data was supported by direct excerpts from transcripts of participants to evaluate applicability. The research participants emailed the scanned copies of the documents using university's file transfer service that allows users to send files quickly and securely.

Dependability. Based on the availability of the participants, I prepared a schedule for data collection and shared with the participants. During data collection, I spent quality time with the participants to gather relevant information about the research problem. Freedom of expression was encouraged during data collection. Since the interviews were anxiety-related issues, consideration was given to ensure that the discussions did not cause any emotional upheaval for the participants who were allotted pseudonyms to maintain confidentiality. The soft copy of the transcripts of the interviews was stored on my university password-protected computer, and hard copies collected after data collection were destroyed post analysis. Interviews were video recorded and were safely stored until analysis. All video and audio recordings and transcripts of the recordings were destroyed after the interpretation and analysis of the results. Triangulation with concurrent quantitative and qualitative data promoted consistency.

Confirmability. Apart from data triangulation, the other way to control bias and inconsistencies is by using a research journal to write memos and notes during the research process (Creswell & Clark, 2018). Writing down notes made me aware of biased ideas or reflections concerning the study and helped clarify unrelated or assuming points of view. Minute details and non-verbal communication observed during the interview were jotted down in the journal. Moreover, informed consent was obtained from the participants and parents of students

Chapter Summary

The chapter began with the description of the theoretical framework, research purpose, and research questions. Next, I described the methodology, research design, data collection and analysis procedures. Finally, I explained the potential ethical challenges and threats to the validity of my study.

CHAPTER FOUR

RESULTS

Introduction

Through the concurrent mixed methods triangulated study, I aimed to understand secondary students' mathematics anxiety and examine the influence of avoidance behaviors on secondary mathematics enrollment. "There is more insight to be gained from both qualitative and quantitative research than either form by itself. Their combined use provides an expanded understanding of research problems" (Creswell,2009, p. 203). Therefore, detailed qualitative and quantitative data were collected from students and teachers in four participating schools in an eastern state in India. Four data sets were used for the analysis of the study. Data sources included one-on-one semi-structured interviews, a self-portrait, and a 25-item questionnaire. The fourth data source was semi-structured interviews with teachers. Due to Covid constraints, the entire data collection was executed virtually.

I have organized the chapter into four sections. First, the chapter describes the five key findings that emerged from the qualitative data analysis of interviews and self-portraits. According to Rubin and Rubin (1995), "themes are statements qua [in the role of] ideas presented by participants during interviews, or conceptual topics developed by the researcher during a review of the data"(quoted by Saldana, 2011). Second, a description of the finding that emerged from quantitative data analysis strengthened the qualitative data analysis information. Third, the chapter provides data integration that includes three pairwise comparisons through joint visual displays between quantitative and qualitative data sets categorized as agreement and partial agreement. Finally, the chapter concludes with a chapter summary.

Findings

Separate analyses across qualitative data sources (i.e., interviews and self-portraits) resulted in five major findings, Namely, (1) students' self-beliefs; (2) large class sizes; (3) students' time management skills; (4) Instructional practices; and (5) mathematics examinations. Separate analyses of the quantitative data sources provided further evidence to support the fifth finding that mathematics examination is a significant source of mathematics anxiety.

The themes that emerged from the analysis of interview responses address the first and second research questions:

1. Do secondary students have mathematics anxiety, and if so, what is the nature of that anxiety?
2. How do teachers describe the influence of secondary students' mathematics anxiety on avoidance and enrollment in secondary mathematics? The research for this dissertation is concurrent yet exploratory. The third research question examines
3. What is the relationship between the different dimensions of mathematics anxiety and secondary mathematics enrollment?

Findings from Analysis of Semi-Structured Interviews with Students and Teachers

Table 5 shows the level of anxiety for each participant in a pre-determined category representing different mathematical situations and tasks obtained from interview responses. Out of 16 students, twelve students experienced the highest anxiety during mathematics examinations. Eight students associated the highest and medium anxiety levels with numerical tasks. Two students shared experiences of low anxiety with the mathematics curriculum. The table also shows the combination of high and medium anxiety in two different mathematical situations.

Table 5

Levels of Students' Anxiety

High anxiety	Medium anxiety	Low anxiety
NT		
ME		
ME	NT	
ME	NT	
ME	NT	
ME	NT	
ME		
ME		
ME		
ME		
ME		MC
ME		
NT		
NT		
NT		
ME		MC

ME- Mathematics examination, MC-Mathematics curriculum, NT- Numerical tasks

For example, four shared experiences of high anxiety related to mathematics examinations, and they also experienced medium anxiety while solving numerical tasks. Similarly, two other students experienced high anxiety in mathematics examinations and low anxiety in the mathematics curriculum. Therefore, it is evident that different students experienced different anxiety levels under different mathematical situations and tasks.

Four major themes were evident from the semi-structured interviews: low self-belief, large class sizes, time management skills, and instructional practices. There was consistency in student and teacher interview responses to questions related to avoidance tendencies, anxiety in mathematics examination, and physiological and emotional reactions toward anxiety. However, inconsistency among students on instructional strategies was evident.

In the subsequent section of the chapter, I describe each key theme and provide excerpts from at least one participant to align interview responses with key themes. Attempts have been made to ensure that the participants' intent is communicated clearly. The findings provided information on how students' anxiety in different mathematical situations and tasks is a barrier that influences students' decisions on secondary mathematics enrollment.

Low self-belief

Students associated mathematics anxiety with low self-belief and confidence. "Self-confidence is a positive factor," a feeling that implies self-belief (Das et al. 2014). Eleven students associated anxiety with the mathematics examination. Students' experiences of low self-belief and negative attitudes towards mathematics resulted in low confidence and mathematics anxiety during an examination. The interview responses showed the influence of negative attitudes of peers and a shared belief that mathematics is difficult. Moreover, a belief that performance in grade eleven is affected due to mathematics lowers confidence and self-perception of students. Student responses that illustrate how they developed anxiety include: *"I won't hold anybody responsible for my anxiety, it was mostly because of myself , if I wasn't able to do solve a sum, I would start panicking or start getting anxious, especially during a test." "I think only I am responsible for the anxiety. I allowed myself to get influenced by people passing negative remarks about math. Most people found math difficult and hearing them all the time I got discouraged and convinced that I wouldn't be able to do it. This way I associated maths with anxiety."*

Student interview responses indicated that low self-belief influenced their decision to withdraw from mathematics in grade eleven. For example, one student specifically named low self -belief as the reason for opting out of mathematics in grade 11 *"Low self-belief is responsible for students withdrawing math in class eleven. I was also one of them with low perception and so did not opt for Math in grade 11."* Other students described how they chose to avoid tracks because they found the required mathematics too difficult. For example, *"As it is in Commerce, we have Accountancy and that involves Maths, again Maths as a subject will be an added burden. Math was too difficult for me. So, I left Math."* These excerpts from students reveal that students were not willing to take up mathematics as an elective subject due to low self-reliance. In addition, the response of the second student indicated that mathematics is more a burden than a subject of relevance in life.

Additionally, myths induce mathematics anxiety in students (Whyte & Anthony, 2012). For example, students expressed how discussion with peers about mathematics being hard or difficult and their fear of poor performance affecting promotion to grade twelve influenced their decisions of withdrawing from secondary mathematics. Excerpts on this issue include: *"I have* *noticed many of my friends didn't opt for Science or Math for the fear of scoring low marks. They say grade 11 math is tough and overall percentage falls due to poor math scores."*

Two students described irrelevance of mathematics in their life indicating negative mathematical identity. For example: *"We only need subtraction, addition, division and multiplication in our daily lives . Where are we going to use algebra, trigonometry, so why are we studying these things?"*

Students' responses indicated how lack of interest affected regular mathematical practices resulting in low scores. One comment that endorsed the impact of lack of interest and practice on mathematics achievement include: "*I was not practicing math every day. Had I practiced at least one sum every day then I would have automatically developed interest in math and not scored low."* Responses of students indicated that struggling to cope with mathematics led to a feeling of inadequacy, and exhaustion only in mathematics. For example:

"I was very lazy so was avoiding math. Moreover, there was so much to do at school, so many subjects and I had to study all of them just not maths alone."

"I never told anyone that I feel so exhausted dealing with this subject. I used to memorize waking up early in the morning at around 4 or 5 am and learnt the formulas so that I remember"

Similarly, teacher responses indicated that students' low interest and lack of practice resulted in low participation in numerical tasks assigned to them in mathematics lessons. The tendency of avoiding being noticed by teachers and fear of participating and answering in class indicated avoidance techniques used by the students. One teacher commented: *"Math anxious students have been avoiding me, they avoid eye contact and are always afraid of any question that I asked. I remember one student fainted when I called him to solve a sum on the blackboard."*

Low self-belief is the belief in one's capability of performing a mathematical task. Students withdrawing mathematics after the first terminal examination in grade eleven indicated low self-perception and endorsed a fixed mindset about their capability to perform. Teacher responses indicated several reasons for students to withdraw mathematics in grade eleven. For example, a teacher commented*: "Most of the students after the first terminal examination, drop math in grade eleven."* Another teacher said, *" A few Commerce students are nervous of solving Math, so they give up Math in grade eleven."*

Additionally, all teacher interview responses indicated students' avoidance tendencies, especially in geometry, which requires reasoning and spatial skills. For example: "*They [students] avoid solving sums. They do not do their homework, saying they could not understand the sum. Then, they say they are not interested and did not try on further probing. This problem is mostly in Geometry. That is why they drop Math in grade 11."*

A secondary teacher expressed the drawback of the National Boards' decision of discontinuing Business Mathematics for Commerce students in grade eleven which might also be a reason for attrition.

> "[A few years back] *Commerce students had Business Maths, which was comparatively easier. Maximum students opted for Commerce as Business Maths was more useful. But the National Board has scrapped that off, and now the students are either struggling or leaving Maths in class 11. Why should they study Calculus? Just Elementary math is enough for them to use in real-life situations and pass the competition for their career. Withdrawing math courses at grade 11 is like giving the students an option to leave Math*."

The first finding that emerged from the interviews of students and teachers indicated that low self-belief was a significant predictor for students withdrawing or not opting for mathematics in grade eleven. Most of the students blamed themselves for developing anxiety in mathematics. They were aware that their negative attitude toward mathematics gradually reduced interest in the subject. They preferred concentrating more on other subjects than mathematics and gave least importance to mathematics in their lives. This attitude affected their performance in mathematics which resulted in low self-belief and mathematics anxiety.

Large Class Sizes.

Responses from student interviews indicated that large class sizes impede understanding of mathematical concepts and reduce possibilities of class discussions, personalized feedback, and support from teachers to overcome difficulties. The current study respondents believed repeated questioning and clarifying doubts were humiliating. Difficulty mounts when peers label anxious students as dull and incompetent. Student responses indicated difficulties and poor performance in numerical tasks due to non-clarification of doubts. Incompetency in solving numerical problems affected students' scores in examinations. A student commented that: *" I lived with the fear of being called ignorant and singled out as a weak student hence never cleared my doubts in class."* Another student commented clearing doubts in large class sizes can be frustrating for mathematics anxious students. For example, *"My problem was with numerical. After solving two to three pages, if I did not get the correct answer, I used to get frustrated and stop solving because clearing doubts in a class of 50 was difficult."*

Students shared the problems associated with understanding mathematical concepts in large class sizes due to differences in learning abilities. Slow learners required more time and attention to understand concepts. Since mathematics anxious students shy away from asking doubts in a large class, their mathematical concepts remained weaker than other students of their class. One student commented:

> *"My teachers did help me, but I do not blame them[teachers] completely because in a class of 40 to 50, say like 75% of them are able to understand when the teacher explains a concept . But the teacher cannot waste time on the other 25% just making them understand the same thing repeatedly. That would amount to waste of time for the other students and waste of teachers' effort also."*

In addition, student and teacher interview responses indicated that to overcome significant gaps in mathematical learning, private tuition after school hours for additional educational inputs helped students. Students expounded on the benefits of private tuition; for example, teachers devoted more time, doubts were cleared, students received personalized attention, and in small group discussions teachers used problem-solving techniques that resulted in increased motivation and improved scores. Excerpts from the student interviews illustrated the impact of large class sizes and improved learning outcomes from private tuition. *"I need private tuition where the teacher can teach me alone,"* and *"I go for tuition and there all my doubts are cleared."* Private tuitions are supplementary education students attend on payment after school, hours.

Another student commented that private tuitions are offered to students in smaller groups hence understanding concepts was easier and learning was more effective. *"In senior classes[grades],teachers cannot give us [each student] in-depth knowledge [due to class size].But in [private] tuition classes there is more clarity in [understanding concepts] smaller groups than in the school classrooms. I go to such tuition classes where there are not more than four students*." Student responses also revealed that distractions of students in large class sizes prevented anxious students from concentrating. Therefore, learning in private tuitions are more peaceful than in a school classroom. An excerpt that illustrates this issue*: "The problem is that due to large class size, in the maths class there are so many disturbances and distractions even when the teacher is teaching. Those who want to study also cannot concentrate. So that disturbs me and that is why I prefer solving problems alone so that I can study in a peaceful environment."*

Students in the current study described how private tuition in mathematics benefitted them academically. A few students described how private tuition improved mathematics performance. *"In math tuition, the teacher put in a lot of hard work to make me understand all the concepts and that was helpful. I saw my grades improving and I remember in class eight, I was able to score in eighties, and so I felt that was an improvement."* Another student also emphasized on the benefits of tuition *"Yes, after school coaching helped me in some ways, because at least I used to get pass marks or else I used to fail in math. For me math tuition was a must."* These two responses of students revealed that the inclination of mathematics anxious students was more towards private tuitions because they felt that large class sizes hindered understanding mathematical concepts and achievement. They believed that private tutors helped them pass the examinations which the teachers were unable to. On the contrary, two students believed that attending private tuition after school hours accounted for a huge wastage of time. For example, "*I am planning to take tuitions classes in grade twelve. But it didn't always work. When I was in grade four, I took tuition, and those classes interfered with my home study hours and timetable*.". Another student described, *"I like to make my timetable for all subjects and accordingly study. Tuition classes are very disruptive because, after school, I cannot study any subject, especially if the time is at odd hours. So, I like to restrict myself to the timetable that I create and study-specific subjects at the specific time I allocate."* This response indicates that private tutoring does not have a positive effect on student learning outcomes. Moreover, additional hours of classes after school have an impact on the emotional well-being of students. Students who prefer self-study and follow a self-made schedule get affected by attending tuitions at odd hours.

Some teachers also questioned the relationship between private tuition and student achievement. They believed that regular practice and not tuitions improve scores. Two teachers described how tuition affects adversely. A secondary teacher commented *"I don't support tuitions. If they[students] practice regularly, it [private tuition] is not required. Students feel school is for attendance and tuition is for extra coaching.*" This statement was supported by another secondary teacher who described private tuition as,

> *"Most of the existing private tutors are neither able to generate interest in Math in the students nor remove their fear. It is the phobia that causes disinterest and must be removed. Just five to ten percent of them are good teachers. Rest only helps students solve the sums and complete their assignments. That is why results don't improve. Despite taking private tuitions, they don't score well.*'

Private tutors may not be skilled enough to generate interest in the students. The focus may be more on helping students complete their assignments, and not building concepts.

On the contrary, two teachers described how academically weak and anxious students may require private tuition after school hours. The use of the word “may” indicate the requirement of private tuition as per the students' needs. The following excerpts are an example of secondary teachers who claimed that students prefer private tuition because: “A f*ew [academically] weak students may require tuition, but not all. Some of them need personal attention which may not be possible on a regular basis in a class of 50. Some topics are difficult,* *and some students don't come up with doubts.*" Another secondary teacher commented on students hailing from less financially secured backgrounds and no parental education and guidance also require private tuition: "*Most of the students in this school are from poor background. They do not get any parental guidance. Most of them fail in Maths. They lack interest in math hence are never able to cope up with the lessons that are taught in class so go to private tutors.*'

Attending to each student regularly affects the quality of teaching. On this issue, a teacher commented:

> *"Students with math anxiety don't know how to approach the sums and don't clarify their doubts in the class. In addition, they need regular personal attention in class which they can't get since the syllabus is vast, and the class is large. We must move on, so they look for help from private tuitions."*

In other words, teacher interview responses indicated how large class sizes become an impediment for mathematics anxious students. Lack of personalized attention in school coupled with the feeling of insecurity for not understanding mathematical concepts in class compels students to seek help from private tutors. The response also indicated that teachers are pressurized with completing a vast syllabus on time, hence attending to each student, and clarifying their doubts on a regular basis seemed difficult.

Time Management Skills

When asked about the most vital aspect of efficient time management in mathematics, common responses from teachers and students included: regular practice increases efficiency, speed, and accuracy; selective studies in a short time help score pass marks and overcome anxiety. The following responses of students provide examples of the impact of time management on mathematics anxiety:

" I am most anxious during examination. Often, due to the shortage of time and lengthy paper, I am not able to complete math question paper.

"Time allotted for examination is very less. In grade eleven and twelve, its[examination]for three hours but in grade nine and ten its[examination]for two and half hours and the question papers are lengthy."

"Many a times, I was not able to complete math question paper during the examination. Being slow, I could not manage time and so could not complete the paper and that made me anxious."

"I think I should take extra help in maths to improve my speed."

Failure in mathematics affects students. Teacher and student participants emphasized the benefits of selective studies for obtaining pass marks in the examination. A secondary student reported, *"To reduce anxiety during the examination and to cope with time, my math teachers advised me to do specific types of questions."* The interview statement was supported by a secondary teacher who stated, *"Teachers teaching grades nine and ten focus on teaching only easy topics, not the entire syllabus to mathematics anxious and academically weak students so that they can do by themselves and score enough to pass the exam. This reduces anxiety."* This response indicated that focusing on easy and selective topics of mathematics syllabus helped students to score a pass mark. In other words, passing mathematics examination reduced anxiety.

Further, the same teacher shared a proposal she had made for students who have anxiety in mathematics, *"I [teacher]had once proposed to make a separate syllabus for these [mathematics anxious] students, where they don't have to cover the whole syllabus, and I would choose the topic for them, which is easy so that they pass."* One way to support mathematics anxious students was to offer a separate syllabus with limited and selective portion for the examination to reduce anxiety, a proposal that does not meet the requirements of inclusive education. Other secondary teachers also supported selective studies. Their responses indicated strong inclination towards selective studies,

> *"Just before the examination, we [teachers]give a selective portion to study, just about ten chapters, and give them[students with anxiety] important questions to work on. So, they find maths easy to learn and perform well in exams."* Another teacher echoed, *"I give them a questionnaire of important questions and tell them to prepare from there, not the entire syllabus, so that they don't get lost."*

A common belief among teacher participants that selective studies, offering limited portion for examination, providing a question bank with possible questions that may come in the examination are effective strategies for performing well in examinations and reducing students' anxiety in mathematics.

Instructional Practices.

Students' responses indicated that appropriate instructional practices and a friendly environment significantly impacted learning styles. Participants' responses indicated that proper guidance and clarity in concepts motivated students and enhanced learning. Findings showed inconsistencies in responses related to instructional practices. During the conversation, the students claimed that they lacked regularity in practice. But, the use of words, “friendly”, “guide”, “interesting” indicated the necessity of creating a supportive learning environment in mathematics lessons. A conducive learning environment created by teachers allows students to participate in mathematical tasks without any stress. Students' learning outcome reduces when they apprehend clearing doubts in the class. Therefore, adopting student-centered teaching and learning in mathematics classes help students to problem solve and analyze critically. One student expressed that *"Teachers should teach and guide the students in the class, then the students can learn independently. If they[students] have any doubts, they must clear them by asking their teacher. They should enjoy math, not get worried or tensed".* Students described the need to have a learner friendly classroom environment: *"Teachers must have a friendly approach while teaching math, use easy teaching methods, and listen patiently to the students so that there is no fear of math in them."* Another student shared *"Teachers should make the class interesting and not teach in the usual boring way."* Therefore, facilitating, and guiding students in learning mathematics through innovative and interesting methods generate interest and remove monotony in learning.

On the contrary, one student preferred not to share her experiences about instructional practices used by teachers at her school but confirmed that the strategies used by the mathematics teachers improved her mathematical proficiency and competency. *"My teacher adopted a strategy. She framed a sentence using mathematical signs. So, I remember the sentence unfolded all the signs to help us remember."*

Summary of Findings. The interview responses of students and teachers indicated agreement in almost all the findings. The results showed that large class sizes and vast syllabus impacted student learning and achievement, triggering anxiety, and reducing interest in the subject. Lack of practice due to low self-belief and negative experiences in mathematics affected scores and increased dependence on private tuition after school hours. Resorting to selective studies reduced apprehension and avoidance tendencies. There were slight inconsistencies in students' views about private tuition. Although most students believed private tuition benefitted and showed improvement in scores, a few felt tuitions were a waste of time.

Although taking private tuition was not recommended by teachers, two felt it ‘may’ be necessary for extra guidance for math-anxious students. The word ‘may’ indicate that tuitions were not advisable. While teachers shared instructional practices and strategies to teach mathematics classes, students’ expectations suggested that using specific innovative techniques may alleviate anxiety, improve mathematical identities, and enhance interest in mathematics and self-efficacy. All four teachers reported attempts to employ various instructional strategies to alleviate mathematics anxiety and support students struggling in academics by motivating them.

Finally, during the student interviews, use of certain words and phrases like private tuition, low self-belief, low confidence, poor time management skills, no interest in mathematics, low math concept, lack of practice, fear of examination, and avoidance tendencies described anxiety in mathematics. Similarly, teacher interviews indicated frequent use of themes like lack of practice, no interest, low self-belief, selective studies, and avoidance tendencies to describe their perception of students’ mathematics anxiety and how they impact enrollment. These terminologies helped in drawing findings from interview responses.

Findings from Analysis of Self-Portraits

The major finding from the analyses of self-portraits showed a significant relationship between mathematics examination with anxiety. Namely, fear of mathematics examination resulted in anxiety. The following section includes details about student experiences related to this finding that are described through illustrations, images, and written statements.

When Anxiety is Experienced

Twelve students talked about high mathematics anxiety in mathematics examination. The illustration describes anxiety in mathematics examination. Ten students described anxiety in secondary high (between grades eight to ten) and in school. Three students expressed anxiety in grade four, and two students described anxiety in grade six. One student preferred not to share but admitted that she had anxiety in mathematics.

Where is Anxiety Experienced

Fourteen students described anxiety in school, mainly in the examination hall, and a few students expressed anxiety while solving numerical problems on the blackboard. Students associated experiences in mathematics anxiety with examination halls. Students shared common examples of not being able to recall formulas during the examination. Students also described their experiences of submitting an incomplete paper and failing in mathematics through statements and drawings. The findings showed that anxiety influences worrisome thoughts, results in poor test scores, mismanagement of time, and inability to recall what one has learned before the examination. The students described anxiety in the hall due to feelings of isolation and lack of communication and guidance during mathematics examinations. The drawings describe anxiety during mathematics examinations in the hall.

What is Experienced when Anxiety is Present

Written responses indicated a strong association of physiological and emotional responses with mathematics anxiety. Student respondents described how mathematics anxiety interacted with physiological arousals like rapid heartbeat, blankness, heaviness in the chest, shortness of breath, fear of public embarrassment, suffocation, sweating, and shaking. In comparison, four students described how emotional arousals overlapped with emotional responses like humiliation, fear, and sensitivity towards comments passed by teachers and peers. The illustrations reveal various responses to anxiety during examination. Nervousness upon seeing peers completing their examination, taking extra sheets, and writing without getting distracted were some of the emotional disturbances described by the students.

Who is Responsible for Anxiety

Results suggested that fifteen students believed low self-efficacy and low mathematical identity led to anxiety. Only one student discussed the role teachers and peers played in mathematics anxiety. Inability to understand mathematical concepts, high confidence level of peers, and the ability of peers to solve sums without any difficulty induced a feeling of insecurity and anxiety in students. The students' drawings and images further strengthened the relationship of anxiety with a specific mathematical situation or task. The images indicated that students primarily associated anxiety with examination though some described they were also anxious while solving numerical tasks. The images and illustrations are examples of students' emotions during examinations, extracted from students' self-portrait forms.

Summary

Students' responses in creating self-portraits indicated that mathematics examinations in the examination halls or rooms induced anxiety. Illustrations and statements under 'What' described the association of anxiety with elevated physiological arousal levels and showed a few symptoms of strong emotional responses to anxiety in mathematics. Most students reported experiencing mathematics anxiety at the secondary level. Responses also indicated that low self-efficacy lowers confidence impacting mathematical competency and identity. Student responses showed the use of words and phrases: low self-belief, fear, headache, blankness, tremors to describe experiences with mathematics learning and examination, mostly in school. The analysis of the responses indicated that 54.5% of students experienced anxiety in examinations, 36.4% in solving numerical tasks, and 9.1% in mathematics curriculum and courses offered in an academic year. About 77.8% of students experienced anxiety at school, and 2.25% of students experienced anxiety out of school, like at home.

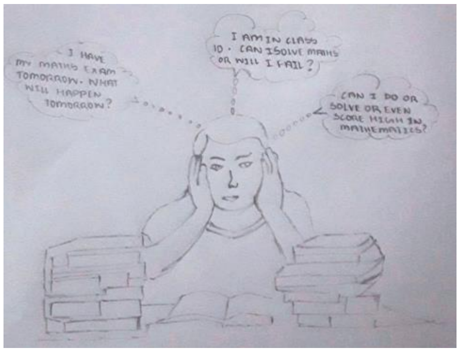
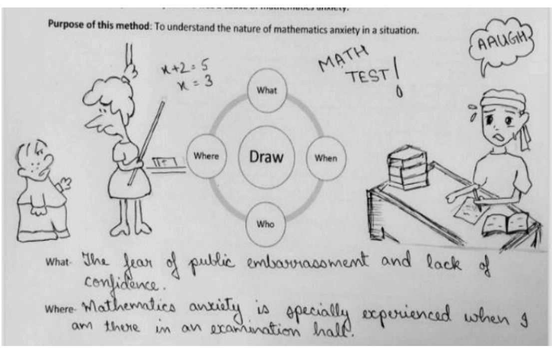


Figure 6 a.

Self-Portrait -When Anxiety is Experienced



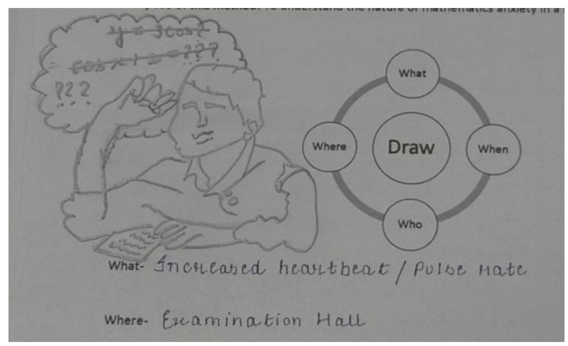
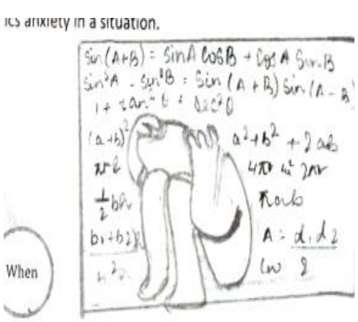


Figure 6 b.

Self-Portraits - Where is Anxiety Experienced



Figures 6 c

Self-Portraits - What is Experienced when Anxiety is Present

About 68.8% of students described anxiety between grades eight to ten, 18.8% in grade four, and 12.5% in grade six. Finally, 93.8% of students blamed themselves for anxiety, whereas only 6.3% described teachers and peers as responsible for anxiety. Findings revealed a few overlapping physiological and emotional arousals to anxiety mostly in examinations and a few while solving numerical tasks.

Findings from Analysis of the RMARS Questionnaire

RMARS Categorical Results.

Mathematics Examination: Graphic representation (See Figure 7) and descriptive statistics (See Table 6) of student responses for items 1 to 11 highlight variation in responses given by students. 75% (*n* =12) of students rated Item 4 (M=3.88, SD=1.15) " Taking the national board mathematics exam," indicating the highest anxiety. Similarly, 68.8% students (n =11) rated high anxiety for item 5 (M= 3.56, SD = 1.26), " Going to school for math national level board exam", item 8 (M= 3.56, SD= 1.36) "Thinking about an upcoming math test one day before" and item 11(M = 3.62, SD = 1.25) "Receiving final math answer script in class." In addition, 56.3% students (*n*=9) rated item 1 (M=2.63, SD= 1.02) "Taking a math test in school" and 43.8 % students (*n*=7) rated item 7 (M= 2.75, SD =1.57) "Thinking about an upcoming math test 1 week before" with low anxiety, and 50% students(*n*=8) rated item 2 (M= 3.23, SD =.93) "Taking school terminal math exam" with medium anxiety. Therefore, from the data, it is evident that students rated seven out of eleven items as having high anxiety in situations related to mathematics examinations. It is quite apparent from the results that students experience more anxiety in mathematics examination related items, specifically answering the national board examination which is conducted at the end of grade ten. Mean ratings of the items in this category ranged from 'a fair amount' (3) to 'very much' (5).

Figure 7.

Comparison of Student Responses (Mathematics Examination)

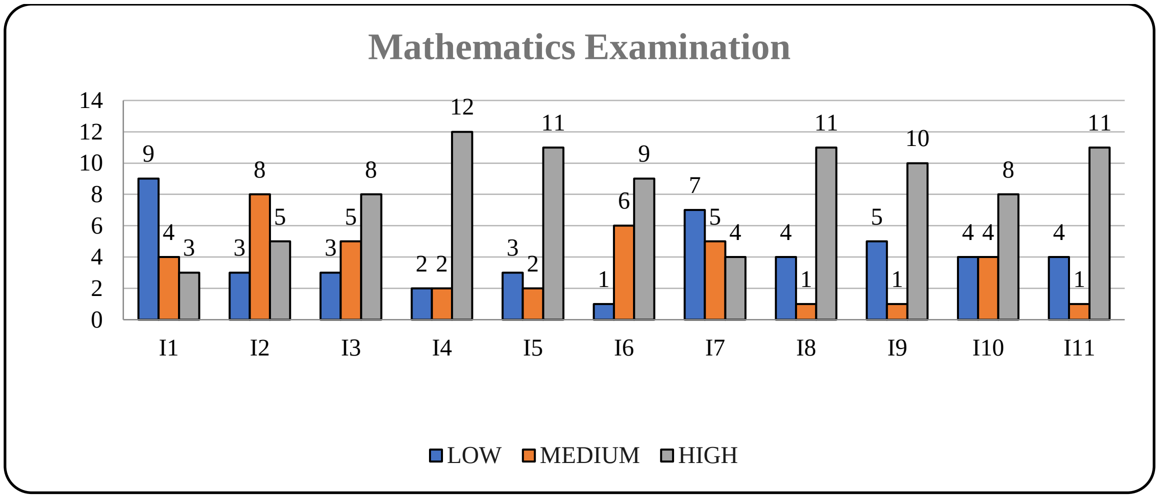


Table 6

Descriptive Statistics Summarizing Mathematics Examination

Mean	Variance	Standard Deviation	N of Items
37.5625	71.463	8.45355	11

Items	Mean	Std Deviation	N
Item 1	2.625	1.0247	16
Item 2	3.25	0.93095	16
Item 3	3.4375	1.31498	16
Item 4	3.875	1.14746	16
Item 5	3.5625	1.26326	16
Item 6	3.875	1.0247	16
Item 7	2.75	1.57056	16
Item 8	3.5625	1.36473	16
Item 9	3.75	1.48324	16
Item 10	3.25	1.29099	16
Item 11	3.625	1.25831	16

The scale statistics of all 11 items of the Mathematics Examination show a composite mean score of 37.562 with a standard deviation of 8.45 and variance of 71.46, indicating how widely "spread out" student responses were.

Mathematics Curriculum: Graphic representation (See Figure 8) and descriptive statistics (See Table 7) of student responses for items 12 to 18 highlight variation in student responses to the mathematics curriculum. Only 37.5% of students (*n*=10) who responded to Item 18 (M=3.63, SD=1.45) showed high anxiety "Not completing portion before the exam." Students described poor time management skills and lack of practice due to low interest in mathematics as their inability to revise the entire portion before the mathematics exam. On the contrary, 81.3% of students (*n*=12) rated low anxiety for item 16 (M=1.63, SD = 1.08), "Referring to a math textbook for self-learning as a part of math project"; 75% of students (*n*=12) rated low anxiety for item 15 (M= 2.19, SD= 1.32) "Picking up math textbook to begin a difficult assignment'. 68.8% of students(*n*=11) rated low anxiety for item 12 (M=2.00, SD=1.26) "Picking up math textbook to begin working on a homework assignment." A similar percentage of students (*n*=11) rated item 13 (M= 2.06, SD= .93) "Asked to refer to a book and take up math classes to assess the understanding of the concept,"; and 56.3% of students (*n*=9) rated item 14 (M= 2.44, SD= 1.26) "Realizing that you must take mathematics to fulfill the requirements in your major in grade 11".These statistics demonstrate the low anxiety of students in six out of seven items under the mathematics curriculum. The mean ratings of the items in this category ranged from 'not at all' (1) to 'fair amount' (3). However, the scale statistics of all seven items of the mathematics curriculum show a composite mean score of 16.625 with a standard deviation of 5.58 and variance of 31.18, indicating the responses were not as widely "spread out" as compared to items 1 to 11 under category 'mathematics examination.'

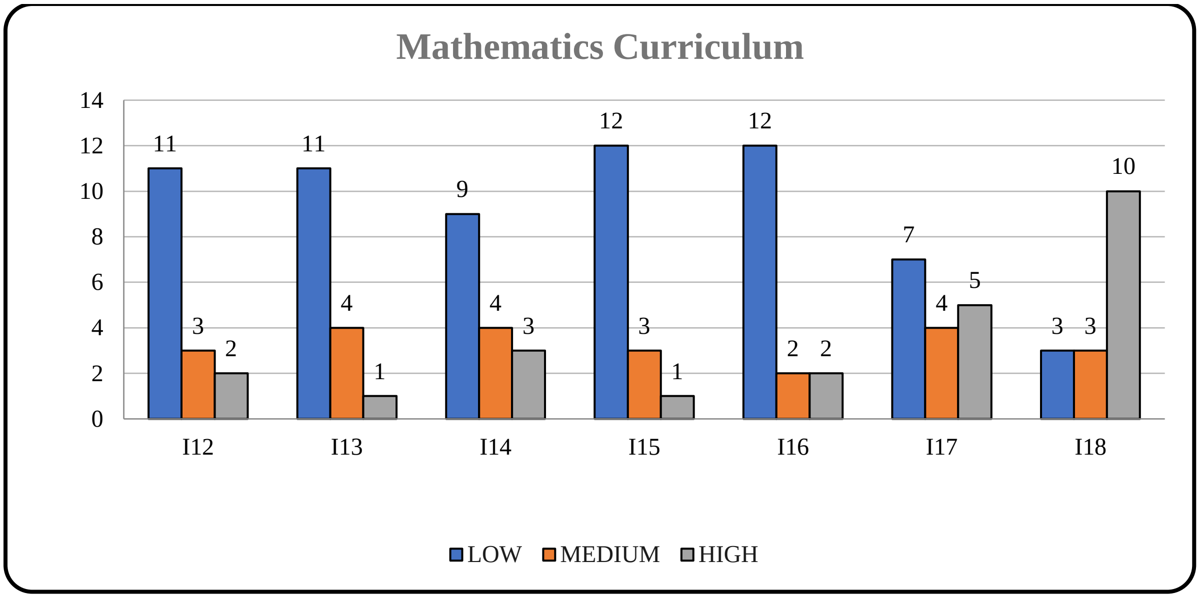


Figure 8.

Comparison of Student Responses (Mathematics Curriculum)

Table 7

Descriptive Statistics Summarizing Mathematics Curriculum

Mean	Variance	Standard Deviation	N of Items
16.625	31.183	5.5842	7

Items	Mean	Std Deviation	N
Item 12	2	1.26491	16
Item 13	2.06	0.92871	16
Item 14	2.44	1.26326	16
Item 15	2.19	1.32759	16
Item 16	1.63	1.08781	16
Item 17	2.69	1.35247	16
Item 18	3.63	1.45488	16

Numerical Tasks: Graphic representation (See Figure 9) and descriptive statistics (See Table 8) of student responses for items 19 to 25 highlight variation in answers given by students on solving numerical tasks. Items 19 (*n*=6), “Being given a set of numerical problems involving trigonometry in front of the class on the blackboard,” and item 20 (*n*=7), “Being given homework assignments of many difficult problems that are due to the next class,” indicate a prominent level of anxiety. 31.3 % of students (*n*=8) showed high anxiety for item 25, “Have someone watch you as you total up a column of figures.” Items 22 (*n*=4) and 24 (*n*=3) were responded to by only 18.8% of students, indicating high anxiety. On the contrary, 62.5% of students’ (*n*=10) “Clarifying doubts in the class” responses indicate low anxiety for item 23. Mathematics anxious students described the impact of large class size prevented them from clarifying doubts in the class. Students believed private tuition replaced classrooms for clarifying doubts. Further, 56.3% of students described low anxiety for item 21 (*n*=9),” Watching a teacher work on a complex numerical on the blackboard,” and item 24 (*n*=8), “Being responsible for collecting dues for an organization and keeping track of the amount”; 50% for items 22 (*n*=8) and 25 (*n*=8), and 25% for items 19 (*n*=4) and 20 (*n*=4). The visual representation demonstrates lower anxiety in five out of seven items on numerical tasks. The mean ratings of the items in this category ranged from ‘very little’ (2) to ‘much’ (4). The scale statistics of all seven items of numerical tasks show a composite mean score of 19.0 with a standard deviation of 5.59 and a variance of 31.20, indicating that the student responses were comparatively more spread out than mathematics curriculum but less than mathematics examination.

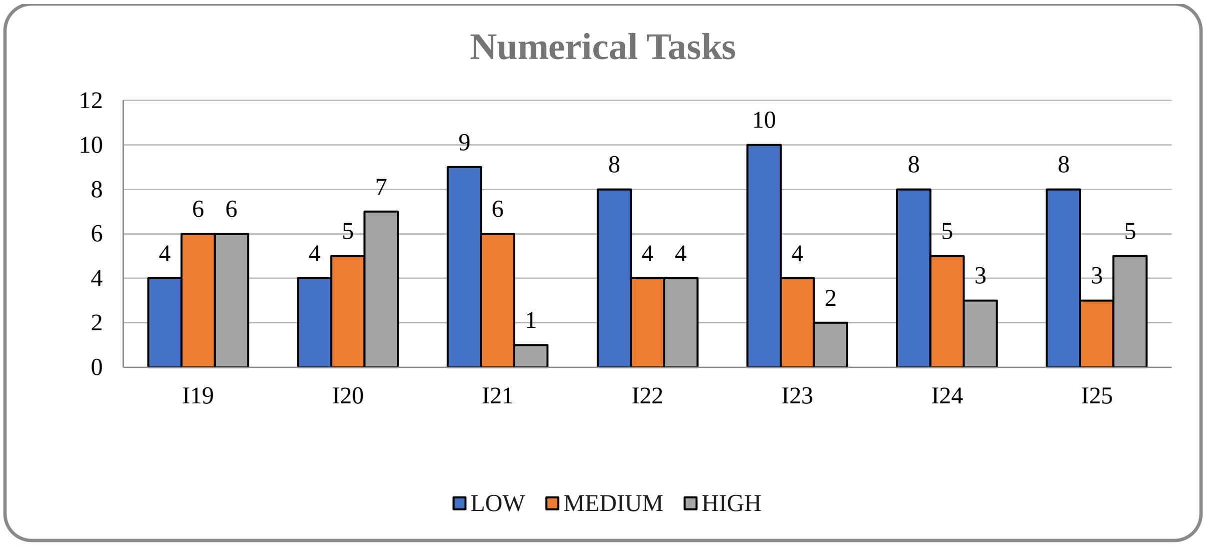


Figure 9.

Comparison of Student Responses (Numerical Tasks)

Table 8

Descriptive Statistics Summarizing Numerical Tasks

Mean	Variance	Standard Deviation	N of Items
19	31.2	5.5857	7

Items	Mean	Std Deviation	N
Item 19	3.125	1.14746	16
Item 20	2.5625	1.20934	16
Item 21	2.5625	1.31498	16
Item 22	2.1875	1.22304	16
Item 23	2.4375	1.20934	16
Item 24	2.8125	1.27639	16
Item 25	3.3125	1.35247	16

RMARS Overall Results

The visual representation (See Figure 10) of the RMARS overall results indicates that 51.75% of student responses (*n*=92) associate mathematics anxiety with an examination, followed by 16.1% responses (*n*=24) indicate high anxiety about the mathematics curriculum, and 27.74% of students (*n*=28) responses indicate high anxiety for numerical tasks. Similarly, 24.40% of student responses (39) associate medium anxiety with mathematics examinations, 20.57% of student responses (*n*=23) associate medium anxiety with curriculum, followed by 25.93% of students (*n*=33) responses indicate medium anxiety for numerical tasks. Finally, 25.62% of student responses (*n*=45) indicate low anxiety for mathematics examinations, 59.86% of student responses (*n*=65) associate low anxiety with curriculum, followed by 46.44% of student responses (*n*=51) indicate low anxiety for numerical tasks.

In the data visualization, I used a trendline, a visual pattern to show the general direction of the values collected for the survey that intends to examine the degree of anxiety through the RMARS questionnaire. The blue trendline indicates an increasing trend from low to high in mathematics examinations. The orange trendline suggests a decreasing trend from high to low in the mathematics curriculum, and the grey trendline indicates a decreasing trend from high to low in numerical tasks. There is a difference between the grey and orange trendlines, though both reveal decreasing trends. The inclination from high to low is less for numerical tasks than in the mathematics curriculum. Therefore, the overall RMARS results indicate a significant relationship between mathematics examination and anxiety. The scale statistics of all 25 items of the RMARS show a composite mean score of 73.187 with a standard deviation of 16.289 and a variance of 265.36, indicating the data sets are widely spread from the mean and each other (See Table 9).

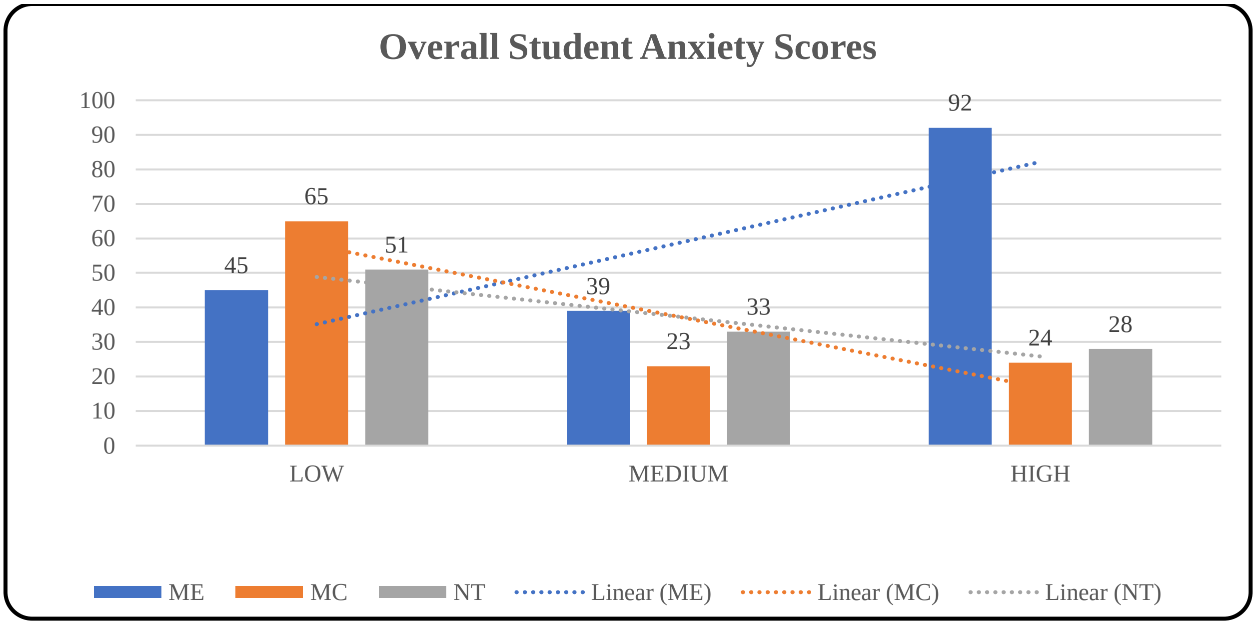


Figure 10

Overall Student Anxiety (Factor-Wise)

Table 9

Descriptive Statistics Summarizing Overall Composite Scores

Mean	Variance	Standard Deviation	N of Items
73.1875	265.363	16.28995	25

Summary

The research for this dissertation was concurrent yet exploratory. The third research question explored the relationship of the three categories identified for the study with the construct under investigation. The quantitative findings showed anxiety levels in all three categories under different mathematical situations and tasks. Results revealed a meaningful relationship between mathematics anxiety and examination. Students rated examination-related statements in the questionnaire the highest in terms of anxiety. The three linear trendlines in Figure 9 show the general direction of the values that further strengthened my understanding of students' anxiety levels rated by students in the RMARS questionnaire. The blue trendline for mathematics examination shows an increasing trend from 25.62% to 51.75%, an increase of 26.13%. The orange trendline signifying the mathematics curriculum shows a decreasing trend from 59.86% to 16.1%, a decrease by 43.75 %. The grey trendline describing numerical tasks shows a decreasing trend from 46.44% to 27.74%, a decrease by 18.7%. These percentages indicate that anxiety experienced by students was maximum in mathematics examinations, followed by numerical tasks and least in mathematics curriculum. The integrated findings indicated that students experienced the highest level of anxiety in mathematics examinations and different situations related to mathematics examinations. Results obtained from students' ratings aligned with the semi-structured open-ended interview responses and findings of the self-portraits. It is evident that anxiety related to mathematics examination lowers self-belief, affects scores, reduces interest in the subject, decreases regularity in practicing mathematics, and increases avoidance tendencies which influence decisions in secondary mathematics enrollment.

Findings from Data Integration

The joint displays created for an integrated data analysis indicated the agreement and partial agreement across separate analyses of data sources.

Table 10. shows the students' perception of mathematics anxiety. The analysis of RMARS (quantitative data) was compared to the analysis of student interviews and self-portraits (qualitative data). The interview response statements indicated that students were more anxious about mathematics examinations than numerical tasks and the mathematics curriculum. Students throughout the interview gave reasons for withdrawing from mathematics in grade eleven, indicating mathematics anxiety resulting in avoidance behaviors impacts enrollment in secondary mathematics. The drawings and images on the self-portrait forms revealed that students were most anxious in mathematics examinations, specifically in the examination hall. Several physiological responses to anxiety-like headaches, nausea, and emotional responses to anxiety, e.g., self-shame, embarrassment, and humiliation, were associated with anxiety during mathematics examination. Except for one student, the other fifteen students blamed themselves for developing anxiety in mathematics due to reasons like believing in myths about mathematics as a subject, low interest, and lack of practice, giving least relevance to mathematics in their regular life. The analysis of RMARS indicated maximum anxiety in mathematics examinations followed by anxiety in solving numerical tasks and least in mathematics curriculum. The data visualizations also aligned with the interview responses.

Table 10. Joint Display Students' Perception About students' Mathematics Anxiety

JOINT DISPLAY I Students' Perception – Mathematics Anxiety(Agreement)	
Quantitative values showing levels of students' mathematics anxiety (based on RMARS questionnaire)	Qualitative notes- sample excerpts from student interview response statements.

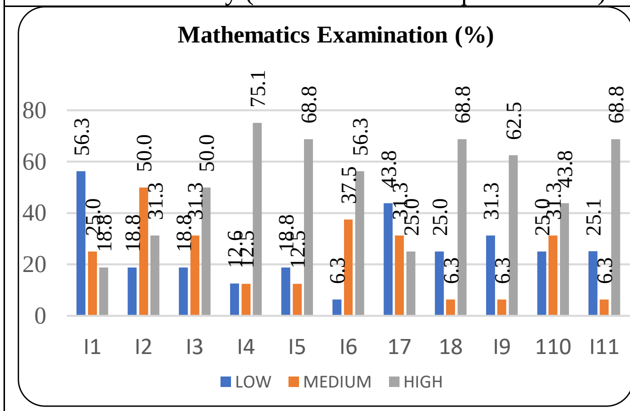


Figure 1. Points in percentage students rated for items 1 to 11 under situations related to mathematics examination. Students rated mathematics examination as the cause for the highest anxiety (75.1%) when compared to numerical tasks and mathematics curriculum.

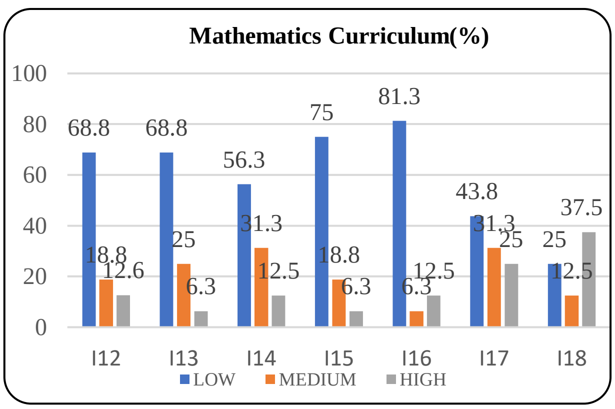


Figure 2. Points in percentage students rated for items 12 to 18 under situations related to mathematics curriculum. Students rated mathematics curriculum as the cause for the least anxiety (81.3%) when compared to numerical tasks and mathematics examination.

<u>Mathematics Examination</u>:

Student: **Math exam** has been difficult for me.

Student: I hold myself responsible for anxiety in maths because it is me who gets confused and forget all the formula and then suffer from anxiety during **examination**. I forget formulas during examination

Student: I always doubted my capability. I never told anyone that I feel so exhausted dealing with this subject. I used to memorize formulas for the exam early in the morning for retention. But during **examination**, I used to panic, and my legs used to tremble.

Student: Math classes were fine and even interesting , but during **exams** due to nervousness I could not complete the paper and made many silly mistakes.

Student: The fear of writing wrong answers during **examination** and the fear of wasting time in solving the questions I didn't know and leaving out the questions that I could get right out of fear was the reason for opting out of mathematics in grade 11.

Student: It especially happened in the **maths test** when I would see others writing so much and taking extra sheets and I was stuck with one sheet only and cannot complete the paper .

Student: I am most anxious during **examination** and a day before the examination, or I can even say, while preparing for the examination.

Student: Plenty of times get stuck in the middle of an **examination** when I am not able to recollect a formula which I had learned or try to apply a concept that I learned but may not have understood.

<u>Mathematics Curriculum</u>

Student: Grades seven and eight were quite easy, scored above 90% but grade 9 onwards the syllabus started getting very complex.

Student. Difficulty arose from grade nine onwards when the syllabus started expanding and the sums started growing more intense but mostly Geometry part started scaring me.

Student: Before my board exam I did refer to a few guidebooks and sample test papers because it was so difficult to finish the book we had in school.

<u>Numerical Tasks</u>

Student: I didn't enjoy solving numerical sums when all the chapters came together for exam

Table 10. Continued

JOINT DISPLAY I Students' Perception – Mathematics Anxiety(Agreement)

Quantitative values showing levels of students' mathematics anxiety (based on RMARS questionnaire)	Qualitative notes- sample excerpts from student interview response statements.

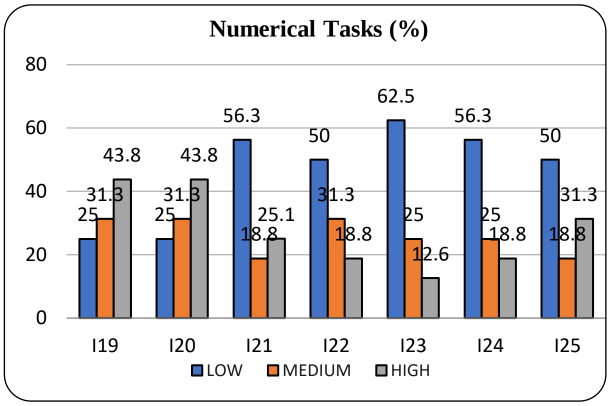


Figure 3. Points in percentage students rated for items 19 to 25 under situations related to numerical tasks. Students rated numerical tasks as the cause for the low anxiety (62.5%) but when compared to mathematics curriculum, the responses are higher and lower than mathematics examination.

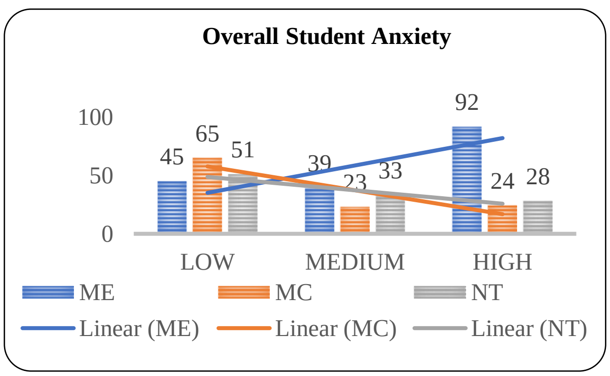


Figure 4. The above data indicate the number of responses the responders specify their level of agreement to a statement for an individual point. Mathematics examination received maximum responses. High values indicate high anxiety.

Likert Scale 1	Not at all	Low anxiety
Likert Scale 2	A little	Low anxiety
Likert Scale 3	A fair amount	Medium anxiety
Likert Scale 4	Much	High anxiety
Likert Scale 5	Very much	High anxiety

Student. My problem was with numerical sums. After solving two pages to three pages If I did not get the correct answer, it used to be very frustrating for me and I would just stop solving.
Student. I memorized formulas and practice solving, but it wouldn't last for very long in my mind. I would panic for not recalling.
Student. I enjoyed as long as I could solve. I practiced maths very hard and could solve a lot of it and I enjoyed .
Student. Trigonometry was very challenging. I practiced a lot with increasing durations, but lengthy sums were challenging.
Student. I used Google and YouTube to understand numerical problems.

<u>Self-Portrait</u>

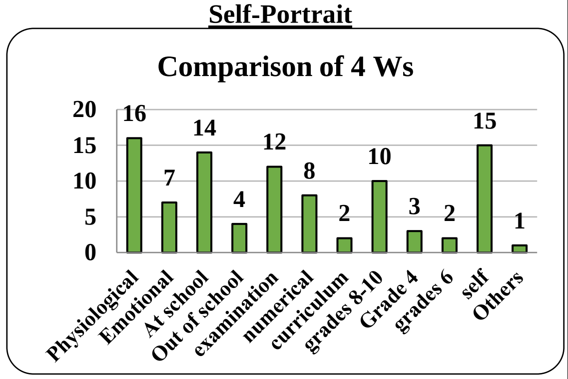


Figure 5.The above data indicate students' description of responses to mathematics anxiety

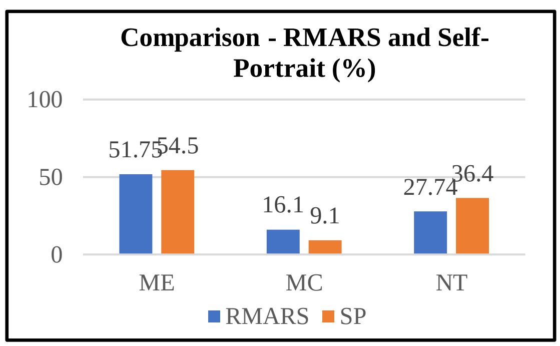


Figure 6. The above data shows convergence of findings between RMARS and Self-portraits . Students were most anxious in mathematics examinations

Table 11. Data integrated analysis shows the teachers' perceptions about students' mathematics anxiety. The analysis of RMARS (qualitative data) is compared to the analysis of teacher interviews (qualitative data). Teacher responses suggested that students were most anxious about mathematics examinations. Lack of practice, low interest in mathematics, and low mathematics concepts were evidence of avoidance behaviors shared by teachers. Hesitation in solving numerical problems, specifically geometry and trigonometry, indicated anxiety in numerical tasks. Teachers commented on adopting strategies for students who do not cope with the entire syllabus for the examination, In this regard, teachers shared strategies for securing pass marks in the examination. The analysis of RMARS revealed maximum anxiety in mathematics examinations, entirely in agreement with the teacher interview response statements.

Table 12. Data integrated analysis through joint display indicated partial agreement of the interview responses of teachers and students on two points, i.e., private tuition and instructional practices. First, most of the students believed private tuitions helped improve mathematics scores and concepts since their doubts were cleared easily in private tuitions due to small class sizes. On the other hand, a few students believed that private tuitions were disruptive and took away self-study time. Similarly, teachers' responses revealed that anxious mathematics students who were low in achievement required assistance of private tutors. Conversely, two teachers believed that private tutors did not help students build concepts in mathematics but rather assisted them in completing assignments. Additionally, teachers even shared that those private tutors failed to generate students' interest in mathematics. For example, *"solving numerical sums and regularity in practicing mathematics improves performance, not tuition."*

Table 11. Joint Display Teachers' Perception About Students' Mathematics Anxiety

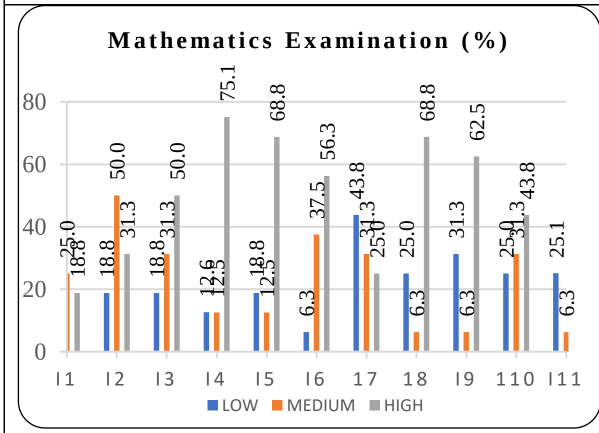
<table>
<tr><th colspan="2">JOINT DISPLAY II Teachers' Perception on Students Mathematics Anxiety (Agreement)</th></tr>
<tr><td>Quantitative values showing students' level of mathematics anxiety (based on RMARS questionnaire)</td><td>Qualitative notes- sample excerpts from teacher interview response statements. Common response about students' anxiety was about examination anxiety.</td></tr>
<tr><td>


Figure 1.Values in percentage students rated for items 1 to 11 under situations related to mathematics examination. Students rated mathematics examination as the cause for the highest anxiety when compared to numerical tasks and mathematics curriculum.

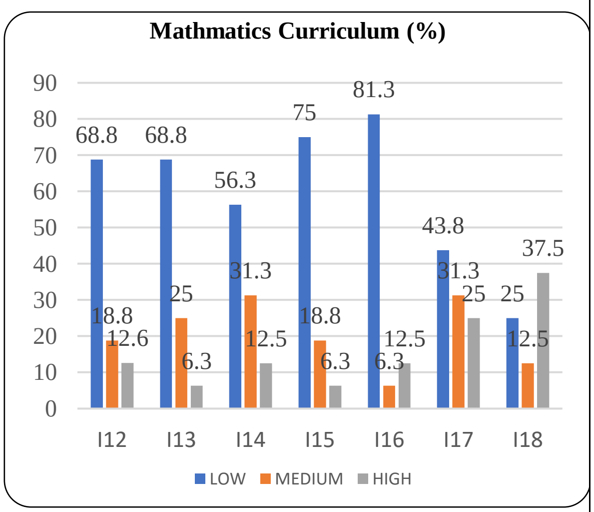


Figure 2. Values in percentage students rated for items 12 to 18 under situations related to mathematics curriculum. Students rated mathematics curriculum as the cause for the least anxiety when compared to numerical tasks and mathematics examination.
</td><td>
Teacher: Students expressed their fear and disinterest in Math every time I entered the class. They were hesitant to solve numerical problems on the blackboard. I would engage and encourage them. They have exam anxiety (Mathematics examination & numerical tasks).
Teacher: Lack of individual attention by the teacher in a class of 50 or 55 was inevitable. The students felt lost in asking their doubts. (Numerical tasks)
Teacher: Math is a compulsory subject till grade 10. Some of the Commerce students are so nervous doing Math that they would give it up in grade 11 for the fear of failing in exam (Mathematics examination & mathematics curriculum)
Teacher: Avoidance tendencies related to assignments was common with all the students it even if it's not a math anxiety. They don't like to do their homework or practice math which is a major problem. That's how they score poor marks in exam (Numerical tasks)
Teacher: I tell my teachers teaching grades nine and 10 to teach only easy topics so that they can do by themselves. Not the entire syllabus so that they score enough to pass the exam. Once they pass, their anxiety reduces.(Mathematics examination & mathematics curriculum)
Teacher: Some students I came across who got confused They would sweat, tremble with fear and anxiety just before the exams. The phobia of Math would prevent them from performing in the exams. However, I counseled them. The other category of students would suddenly go blackout during an exam and could never even attempt do the next sum. (Mathematics examination)
Teacher: Till grade 10 Math is compulsory so somehow, they study to score a pass mark since they have no option. Those students who have decided not taking Math in classes 11 and 12, are ones, who try to avoid math in class 10.(Mathematics examination)
Teacher: The Commerce students who are Math-anxious, specially participate in the class asking peculiar questions like what the use of learning Binomial Theorem is, and Exponential in day-to-day life.(Numerical tasks)
Teacher: Children tend to avoid theoretical, analytical, and proving questions, which require understanding and application of concepts in class and exam. They
</td></tr>
</table>

Table 11. Continued

JOINT DISPLAY II Teachers' Perception – Students Mathematics Anxiety (Agreement)

Quantitative values showing students' level of mathematics anxiety (based on RMARS questionnaire)	Qualitative notes- sample excerpts from teacher interview response statements. Common response about students' anxiety was about **examination anxiety.**

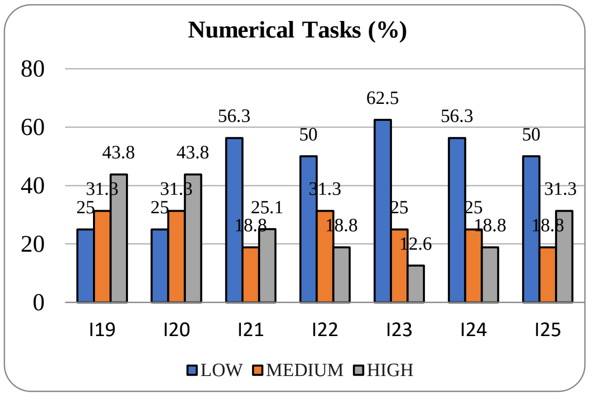


Figure 3. Values in percentage students rated for items 19 to 25 under situations related to numerical tasks. Students rated numerical tasks as the cause for the medium anxiety when compared to mathematics curriculum and mathematics examination.

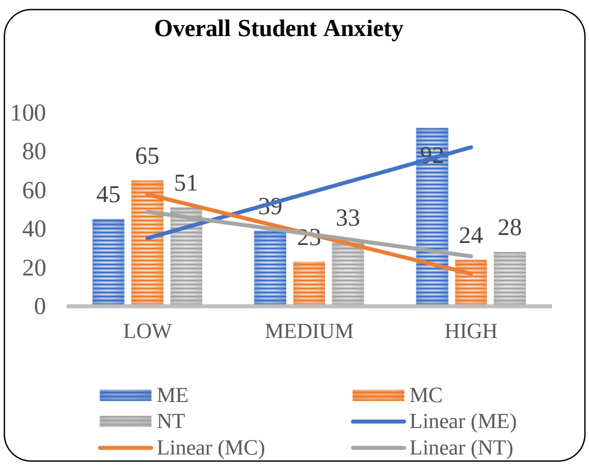


Figure 4. The above data indicate the number of responses the students specify their level of agreement to a statement for an individual point. Mathematics examination received maximum responses.

Likert Scale 1	Not at all	Low anxiety
Likert Scale 2	A little	Low anxiety
Likert Scale 3	A fair amount	Medium anxiety
Likert Scale 4	Much	High anxiety
Likert Scale 5	Very much	High anxiety

prefer direct application of formulas. Rest they avoid.**(Numerical tasks)**

Teacher: Syllabus is vast, and we do not have the time to teach again and again to students who do not understand concepts. So, it is a syllabus problem and time barrier. **(Mathematics curriculum)**

Teacher: I don't support tuitions .If they practice, it is not required. The students here feel school is for attendance and tuitions is for extra coaching. Otherwise, it is not required. **(Numerical tasks)**

Teacher: I tell them to attempt questions from a few topics. With practice when they gain mastery over it, they develop interest in Math. So, we must first motivate them by giving them confidence of solving sums then they will overcome all anxiety in exam too **(Mathematics examination & Numerical tasks)**

Teacher: For math anxious students I take test after each chapter. Their performance shows the effectiveness of the teaching method used for them.: Repetitive discussion and assessment of a topic in the class is most helpful and effective in making progress in a student by scoring good marks in the exam.**(Numerical tasks and mathematics examination)**

Teacher. Mainly during examination students go blank on seeing the questions. That's due to anxiety. They need guidance all throughout. At school they solve with the guidance of the teacher, but at home they are left to themselves, and they get stuck. (**Mathematics examination & numerical tasks)**

Teacher Definitely vast syllabus is one reason for anxiety. They must learn to integrate and remember. (**Mathematics curriculum)**

Teacher. In my opinion max anxiety in students is while preparing for their exams. Exam is like a big mountain they must cross ; only then will they reach their destination. I mean in the examination hall they are full of stress and anxiety**(Mathematics examination)**

Teacher. I think angles, finding perimeter sums are not a problem for students. But analytical and proving sums, where they draw a diagram to prove, they find it very difficult. Proving problems about 50 to 60% find it difficult in class and exam.**(Mathematics examination & numerical tasks)**

Furthermore, interview responses of teachers and students showed partial agreement in instructional practices. Students’ interview responses indicated adoption of interesting instructional strategies to generate interest in mathematics. Creating a learner-friendly environment removes fear in mathematics. Teachers should be more approachable and be ready to clear the doubts of students. Conversely, teachers emphasized using various instructional strategies e.g., storytelling, problem-solving in groups, role play. In Table 12, I described how the interview responses statements of the teachers and students showed partial agreement on private tuitions and instructional practices adopted by mathematics teachers to alleviate anxiety of students and improve scores.

Conclusion

The research participants of the four schools participated in concurrent mixed methods triangulated data collection. The quantitative data analysis offered insight into students' anxiety levels in different mathematical situations. Findings revealed that students experience a high level of anxiety in situations related to mathematics examinations.

Two qualitative data analyses were conducted. The first analysis was the semi-structured interviews of students and teachers. The interview responses highlighted students' and teachers' perceptions of secondary students' mathematics anxiety. In addition, the analysis helped examine how avoidance behaviors like reduced practice in mathematics, preference given to other subjects over mathematics, selective studies, and lack of interest as an outcome of mathematics anxiety impact secondary mathematics enrollment.

Table 12. Joint Display Pair Comparisons of Interview Responses

JOINT DISPLAY III. Pair Comparisons of Qualitative Data (Partial Agreement)		
Themes	**Student Interview Responses**	**Teacher Interview Responses**
Private Tuitions	Tuitions are helping me. May not be 100% but at least 50% and 50% I learnt in school. Private tuition is important for me, because at school we are made to prepare only for Board exams but at coaching classes we are prepared for Board exams and for Entrance exams. So Coaching classes are extremely important. In grades 11and 12 the syllabus is vast, so I must take coaching classes for completing the syllabus. Tuition classes are very disruptive, so after returning cannot study any other subject especially if the time is in odd hours.	Most of the dozens of existing private tutors are not able to create interest in Math in the students or remove their fear. It is the phobia and anxiety that causes disinterest and must be eliminated. Just 5 to 10 % of them are good teachers. Rest is only help students solve the sums. That is why results don't improve. So, despite taking tuitions, they don't score well. It may be needed for weak students, but not for all. Some of them need personal attention which in a class of 50, they cannot get. Some topics are very difficult, and some students don't come out with doubts, then the private tuition teachers can do justice to them. Yet, not all, but just a few weak students may need it.
Instructional Practices (Major theme)	Teachers would say just copy the sums and we would copy all the sums. Teachers must have a friendly approach towards teaching of math , use easy methods of teaching , listen patiently to the students so that there is no fear of math in them. From class eight I was anxious. Teachers did not adopt any innovative practice, something new, different strategies, you know, to reduce anxiety of students. challenges in understanding concepts of mathematics depends on the teachers, one of them did not explain the concept well or cleared my doubt in math. That was a big problem. Would ask my doubts repeatedly to my teacher and if still not clear I understand from the YouTube videos. Because teachers, don't make the class interesting instead they teach in the usual boring way. Teachers should make the chapter easy and teach in a friendly and interesting way so that students learn and don't forget the formulas.	As the head of the department, I give instructions to the teachers of 6 to 12 to teach the chapter of Mensuration with the help of practical examples. Like measurements of a cylinder, flat sheet of paper etc. Then the students understand better. I create one story about an official market where you own a company, and you want it to expand with people's money and not your profit. That makes it easier and more interesting too. Divide a question in 2 or 3 parts and involved group of students in drawing out information regarding the problem asked in it, Different students worked on different parts of the question. Then they found out the solution to those problems. This interaction of the students generated interest and then practice. I tell my teachers teaching grades nine and ten to teach only easy topics and not the entire syllabus so that they

Table 12. Continued

JOINT DISPLAY III. Pair Comparisons of Qualitative Data (Partial Agreement)		
Themes	**Student Interview Responses**	**Teacher Interview Responses**
Instructional Practices and strategies (Major theme). Continued	When I couldn't understand something in the class I would go to my teacher after the class. So, she arranged for Extra classes for the students who had doubts. A lot of time was given to each chapter that had the doubts, the topics were taught properly and in detail with individual attention, and this went on for a month. Every morning before school these extra classes helped a lot and then of course at home my father was thee to teach. This is how I handled the challenges. In classes 9 and 10, in trigonometry there are many formulas and signs. These were difficult to remember. So, my teacher adopted a strategy by which she framed a sentence using the signs. So just remembering the sentence unfolded all the signs and helped us to remember.	score enough to pass the exam. Once they pass, their anxiety will reduce. Sometimes they cannot do all 10 chapters but whatever little they practice in selective chapters; they manage with average marks in exams. There are students with high IQ score 60 to 70% in exams due to reasons like, lack of practice due to shortage of time, or anxiety , or inattentiveness in class. When given this help, they labor hard and score 95% marks. I make my students solve the question paper in the class and then I discuss for the students to understand and improve upon them.

The Self-Efficacy framework that guides the study provides a valuable lens for making sense of how teachers perceive, and students experience mathematics anxiety. The responses to data analysis results in four themes: large class sizes, low self-belief, time management, and instructional practices and strategies. Each of the themes focuses on the three sources of Bandura's Self-Efficacy Theory selected for the current study: mastery experiences, verbal persuasion, and physiological and emotional states. The themes that emerged from the interview statements are based on the assumptions of Bandura's Self-Efficacy theory, which states an individual's belief in their capacity to perform and accomplish a given task.

The interview responses indicated students' low self-perception caused by a lack of interest, practice, and a history of poor performances. The success stories of good performance in middle school get overshadowed by the high level of anxiety in high school. Pfitzner (2016) claims that experiences of success increase self-efficacy beliefs, while failure lowers them. This quote explains the influence of mastery experiences of students to alleviate mathematics anxiety. To achieve this, Bandura's second source of self-efficacy, namely, verbal persuasion by teachers, peers, or 'significant others' (Bandura, 1997, p.101), has the potential to convince an individual of their ability to perform. Teacher interview responses confirmed positive affirmations to promote student participation in class discussions, generate interest in mathematics through stories, group discussions, problem-solving methods, scaffolding, and provide a question bank for selective studies. These were some of the methods teachers claimed they employed to motivate and generate students' interest.

The struggle with mathematics anxiety involves various physiological and emotional arousals that further aggravate students' disruptive behavior like avoidance tendencies. Bandura's third source of self-efficacy is "Physiological and affective states provide information about physiological and affective arousal during situations in which the capability in the domain is demonstrated. In stressful situations, people tend to read this somatic information as an indicator of dysfunction, thus impacting negatively on self-efficacy beliefs." (Pfitzner Eden, 2016, p.2). Student responses indicated several emotional and physical arousals that lower students' self-belief and attribute to one's inadequacy. Teacher interview responses also indicated reasons for withdrawal from mathematics at the secondary level, such as low self-belief, reduced interest, and low mathematical identity. Therefore, the results show how mathematics anxiety leading to avoidance tendencies greatly influences students' decision to withdraw from secondary mathematics.

While these results represent the experiences of 16 secondary students and the perception of five secondary mathematics offering insight into the understanding impact of mathematics anxiety on secondary mathematics enrollment, further research is needed to confirm if the findings are valid for a larger population. Nevertheless, despite a limited number of participants, the results suggest several recommendations for school leaders and teachers to address mathematics anxiety and the development of measurable interventions to alleviate students' mathematics anxiety.

Chapter Summary

In chapter four, I described the key findings from interviews of teachers and students, self-portraits, and RMARS analysis. Next, I presented the results of the four data sources by integrating data using three joint displays to identify the areas of convergence and divergence of findings. Finally, the chapter concluded with a chapter summary.

CHAPTER FIVE

DISCUSSION AND CONCLUSION

Introduction

Mathematics anxiety is a construct, an age-old phenomenon that has received considerable attention in educational research. One could argue that mathematics is an integral part of STEM education and the relevance of mathematics literacy in our lives is beyond estimation. Therefore, proficiency in STEM education and mathematical competence is crucial for future careers(Claessens & Engel, 2013; Konvalina et al.,1983). In the current study, I aimed to understand the mathematics anxiety of secondary students in India. Subsequently, in this study also examined how students' avoidance behaviors influenced secondary mathematics enrollment. In essence, the qualitative and quantitative data analysis provides an opportunity to review and give insight into how this study contributes to the existing literature on mathematics anxiety and avoidance techniques of secondary students' impact on secondary mathematics enrollment.

The concluding chapter of the dissertation begins with a summary of the study's overall findings, followed by a discussion of the key results obtained from four data collection methods. First, one-on-one semi-structured interviews with open-ended questions were conducted to capture students' and teachers' perceptions about mathematic anxiety. Second, the results of self-portraits provided information on the nature and other related effects of anxiety. Third, the qualitative data collection tools addressed research questions one and two. Finally, RMARS addressed the third research question, a quantitative data collection tool that provided information on students' anxiety levels in different mathematical situations and tasks. The current study attempted to address the following research questions:

1. Do secondary students have mathematics anxiety, and if so, what is the nature of that anxiety?

2. How do teachers describe the influence of secondary students' mathematics anxiety on avoidance and enrollment in secondary mathematics?

3. What is the relationship between the different dimensions of mathematics anxiety and secondary mathematics enrollment?

The chapter ends with practical implications and suggestions for three sub-groups: school leaders, mathematics teachers, and students; offers recommendations for future research, and concludes with concluding thoughts.

Summary of Overall Findings

The study findings are intended to understand the mathematics anxiety of secondary students (grades eleven) and how avoidance behaviors impact secondary mathematics enrollment. Student respondents agreed that they have mathematics anxiety, and teacher participants also agreed that students suffer from varying anxiety levels in mathematics. Although focused coding resulted in four major themes, an overarching theme that resonated with all three research questions guiding this study was fear of mathematics examination. Student responses indicated that fear and frustration resulted in physiological and emotional responses to anxiety. Therefore, avoidance tendencies have implications on mathematics performance resulting in reduced mathematics practice, poor scores, increased anxiety, and higher levels of avoidance. This chain-reaction created due to anxiety influenced students' decisions in secondary mathematics enrollment (See Figure 11). Despite the theoretical implication of mathematics avoidance in educational research and empirical evidence for anxiety and mathematics avoidance (Choe et al., 2019), theoretical evidence for mathematics anxiety-avoidance behaviors-impacting secondary mathematics enrollment link is still not explored in

India. The current study's findings have the potential to draw attention to this pressing issue in secondary schools and STEM fields in India.

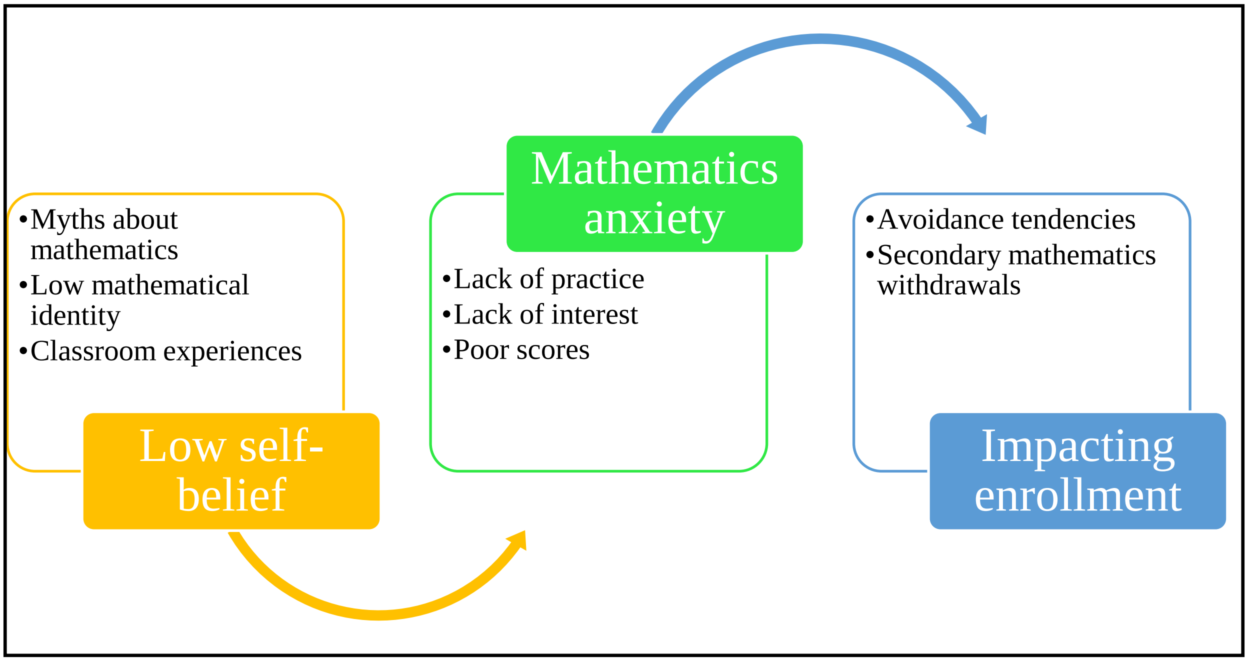


Figure 11

Mathematics Anxiety-Avoidance Behaviors-Enrollment

Discussion of Qualitative Data Analysis.

Two qualitative data sets were employed to address research questions one and two. The study involved 16 secondary students and four secondary mathematics teachers. The participants were recruited through purposive sampling for one-on-one semi-structured interviews and the art-based technique called 'self-portrait.' which was taken only by students. Responses revealed that students have the highest anxiety levels in mathematics examinations in the examination hall. First, I discuss the four key findings of semi-structured interview responses.

The first finding focused on students' low self-belief. The data supports Bandura's Self-Efficacy theory, to which I subscribed in the current study. Self-Efficacy is an individual's set of beliefs in their ability to perform and accomplish in a particular situation (Bandura, 1977). The analysis identifies that low self-belief caused anxiety and avoidance behaviors. Fifteen participants agreed that low self-belief impacted their learning and performance levels. Students also believed that low mathematical competency due to low self-efficacy led to reduced interest in mathematics. Findings showed that irregularity in mathematical practice resulted in poor scores. Students' performance levels influenced their behavior, especially during challenging times (Bandura, 1977), like making decisions related to mathematics enrollment in grade eleven. Bandura and Wigfield's research support this finding that mathematic self-beliefs influence students' choices of courses they take or career paths, emotions, and levels of perseverance and motivation (Bandura, 1997; Wigfield & Eccles, 2000). Moreover, low self- beliefs influencing students' decision of withdrawing from or avoiding secondary mathematics were clearly stated by the participants. The study findings thus confirm previous research.

Bandura (1997) indicated mastery experiences influence the behavior of an individual. Incidents of poor performance and misconceptions about mathematics led the students of the current study to believe that careers without mathematics could be an alternative option. Despite teachers' motivation sessions, students' decision to withdraw from mathematics in grade eleven was unaltered. Research shows that through mastery experience, teachers can motivate students, discuss success stories, and help students envision success. While good scores in mathematics enhance levels of self-efficacy, students with low self-efficacy due to a history of poor scores have the risk of underperformance in mathematics and require motivation to improve engagement in a mathematical task (Bandura, 1997; Klassen & Usher, 2010). Therefore, the study results confirm prior research findings that mathematics self-beliefs and low self-efficacy affect students' performance behaviors (Lee, 2009; Wigfield & Eccles, 2000).

Respondents of Yelkpieri’s study believed that a “small class size is good for effective teaching and learning because it enables students to participate in the class activities fully and makes it possible for the teacher to evaluate the lesson taught easily” (2012, p.331). Additionally, data analysis revealed how large class sizes increased students' dependence on private tuitions for personalized attention and improved scores. Private tutors offer supplementary education to students on additional payment after school, mostly at odd hours. Previous research support this finding. Evidence of private tuition and the impact of extended hours of study in private tuition on the students' minds has received attention from research. For example, Chingtham's (2015) case study on the causes and effects of private tuition in a state in India shows that it affects students' physical and mental health. The author also highlights the culture of rote learning, reduced time for self-study, the increased economic burden on parents, and less time for recreation for students.

Moreover, the Indian National Curriculum Framework of 2005 emphasizes an approach to education where the learner creates learning and new knowledge based on experiences and ideas

(Brau,2020). However, teachers in private tuitions follow a non-constructivist approach. Private tutors reduce analytical and logical thinking and "slowly cultivate[s] a mindset of dependency among young students who cannot think of solving any problem without the teacher's assistance." (Chingtham, 2015, p.7).

In the current study, teacher interview response statements indicated that the stress of covering a vast syllabus prevents them from offering individual attention to students regularly. Although the teachers did not recommend private tuition, two teacher participants suggested that despite remedial classes conducted in schools, academically weak and mathematics anxious students may require extra guidance from private tutors after school hours. Dongre and Tewary (2015) stated that "Students who attend private tutoring are likely to differ systematically from those who do not take tuitions on various observable and unobservable dimensions such as ability, motivation, parental concern for education."(p.72). A few students and teachers discussed the adverse effects of large class sizes like difficulty in completing syllabus if each student were to be given personalized attention, disruptive behavior of students, hesitation of mathematics anxious students to clarify doubts in mathematics class. In the Indian context, lack of parental guidance due to low educational background, or working parents prefer sending their children to a private tutor. Parents believe that personalized attention may prevent their children from falling behind academically (Dongre & Tewary, 2015). The current study findings highlight the benefits of private tuition. However, how private tutors replace school mathematics teachers in alleviating mathematics anxiety and improving mathematical proficiency, thereby encouraging Indian students to enroll in secondary mathematics, needs attention. Therefore, divergence and convergence of study findings with existing literature are evident (Bose, 2015; Sinha, 2018).

The third finding highlights the relevance of time management skills in mathematics examinations. Students who value time experience low anxiety levels, have higher confidence levels and are conscious of utilizing time effectively (Liu et al., 2009). Conversely, mismanagement of time is a key indicator of poor study habits, a lack of balancing studies and life, and high levels of anxiety (Kearns & Gardiner, 2007; Van der Meer et al., 2010). Poor time management affects students' achievement behaviors, primarily when assessed. According to Krause and Coates (2008), managing time efficiently lays the foundation for focused study habits and strategies for success. The current study's students' interview responses indicated that lengthy question papers and the timeline for answering mathematics examinations affected test scores and increased anxiety levels. However, interventions on allowing students to compete against their previous times of taking tests and opportunities to develop strategies to improve timing without getting stressed about scores were not evident from the interview responses. Previous literature confirmed that strategizing time can predict success, but how examination time pressure and lengthy question papers affect anxiety has not received attention in the Indian academic literature. Students deserve time to understand concepts and require support to develop conceptual understanding but communicating how to manage time is important (Caviola et al. 2017). Hence, supporting students to strategize time in mathematics through selective studies was shared as a strategy by teachers.

Furthermore, although researchers have identified the effect of a vast syllabus and curriculum on educational achievements, several potential sources of physiological and emotional anxiety have concluded that an extensive curriculum is a stressor for medical students in India (e.g., Gupta & Venkatarao, 2015; Chakraborty et al., 2021). Data on syllabus load as a reason for unsatisfactory performance in mathematics that may further result in low self-efficacy and reduced effort to complete answering the examination papers of the students in a secondary school is lacking. Responses of research participants in the current study suggest that a vast syllabus has an undesirable effect on anxious students. Students deserve time to understand concepts and require support to develop conceptual understanding but communicating how to manage time is important (Caviola et al. 2017). Hence, supporting students to strategize time in mathematics through selective studies was shared as a strategy by teachers. Therefore, according to both teachers and a few student participants, selective studies are a strategy to combat the vast syllabus and have the potential to alleviate mathematics anxiety and improve performance. How selective studies as a strategy can address students' emotional well-being, reduce anxiety levels, generate interest, improve performance, and assist in increasing secondary mathematics enrollment in India lacks clarity. Therefore, comprehensive, and longitudinal studies will provide valuable insights into this issue.

The fourth finding of the interview responses has slight disagreement among teachers and students, but the results confirm previous literature. Blazer (2011)found that students overcome mathematics anxiety when instructions are modified and are based on students' learning ability. Blazer's study demonstrated that rote learning strategies deprive students from making meaningful connections with mathematical ideas and objectives of a lesson. Few students believed that teachers need to employ more interesting strategies. Students further suggested that engaging students would remove monotony and boredom, which is a constraint due to large class sizes and vast syllabus. On the contrary, four teachers and one student shared effective instructional practices and strategies for teaching: storytelling, group work, solving question papers, scaffolding, recapitulation before starting each lesson, connecting concepts to new tasks, remedial classes, and sentence building to learn formulas. These strategies enhanced mathematical learning and improved the mathematical competency of students. However, the teachers reported that although they employed instructional strategies, tools to assess the effectiveness of the instructional strategies do not exist.

Teacher interview response statements indicated scores as the only key performance indicator to identify students with mathematics anxiety and determine student selection criteria for remedial classes. However, prior research has revealed that factors like gender (Rodríguez-Brown, 2009), parental educational background, negative attitudes to mathematics, scores (Maloney & Beilock, 2012), and environment can cause anxiety in mathematics. Therefore, the lack of assessment tools to identify students with mathematics anxiety and evaluate the effectiveness of the instructional practices for different learning abilities in participating schools was evident. Moreover, how instructional techniques and strategies impact student learning and alleviate student anxiety demonstrate uncertainty and unwarranted results.

Analysis of the self-portrait data revealed an overarching theme: mathematics examination anxiety. The findings of the self-portrait have significant relevance to the results of other data collection methods in the study. Student responses and illustrations of self-portraits reveal the nature of anxiety during the examination. Research shows physiological (e.g., Increased heartbeat, shiver, headache) and emotional (e.g., humiliation, shame) morbidity in the form of anxiety among medical students (Chakraborty et al., 2021). Unfortunately, data on the physiological and emotional morbidities among secondary students with mathematics anxiety in India are lacking. The students stated that answering the examination in the examination hall gave them maximum anxiety. Feelings of isolation and low support during examination resulted in fear and power of retention, especially when the numerical problems were lengthy and remembering formulae or arriving at a correct answer was complicated.

Therefore, there is an urgent need for student counseling about careers and relevance of mathematics and ways to curb physiological and emotional problems during mathematics examinations. Measuring the impact of anxiety on students' mathematical learning and competency to increase enrollment needs considerable attention. The findings of the current study are consistent with prior research that poor performance in mathematics examination at the secondary level is accompanied by physiological and emotional responses and has a debilitating effect on mathematical proficiency in the west (Zwettler et al., 2018; Ping et al., 2008; Beilock & Maloney, 2015; Cipora et al., 2015). However, in India, similar findings and evidence of high anxiety while answering mathematics examinations in the hall are lacking. I am intrigued that answering mathematics in the examination hall caused anxiety to students. Further research on environmental factors impacting students' anxiety in examination halls may offer greater insight into the current study. The excerpts used in the current study show usage of the terms' math' and 'maths' instead of 'mathematics' since research participants used the terms during interviews.

Discussion of Quantitative Data Analysis

A close-ended questionnaire was administered to 16 students. The purpose was to test students' level of anxiety under three mathematical situations: mathematics examination, mathematics curriculum, and numerical tasks. An in-depth analysis of students' ratings on a Likert Scale of one (not at all) to five (very much) supported the qualitative data findings revealing mathematics examinations caused the highest level of anxiety among students. The analysis of the questionnaire indicated that 51.75% of student responses (n=92) associated mathematics anxiety with the examination, followed by 27.74% of students (n=28) responses indicated high anxiety in numerical tasks, and only 16.1% of responses (n=24) indicated high anxiety in the mathematics curriculum. The current study's findings are consistent with prior studies that found mathematics examinations caused anxiety in students (e.g., Zwettler et al., 2018; Ping et al., 2008; Beilock & Maloney, 2015; Ashcraft, 2002; Cipora et al., 2015). In addition, most of the respondents reported high levels of examination anxiety while answering the National Board Examination. However, the cause of high anxiety levels of Indian students during the National Board Examination in grade ten lacks clarity. National Board Examinations conducted at the end of grades ten and twelve are regarded as two critical examinations in Indian schools. Therefore, going to school to answer the National Board examination also caused them anxiety. Future research on factors related to anxiety while going to school and answering the National Board Examination would contribute to the literature of the current study.

Discussion of Joint Displays.

Table 10 shows the students' perception of mathematics anxiety. The statements indicate that students are more anxious about mathematics examinations than numerical tasks and the mathematics curriculum. Students throughout the interview gave reasons for withdrawing from mathematics in grade eleven, indicating mathematics anxiety impacts enrollment in secondary mathematics and avoidance behaviors affect enrollment. The data visualizations also align with the interview responses. Table 11 shows teachers' perceptions about students' mathematics anxiety. Teacher responses suggest that students are most anxious about mathematics examinations. The anxiety is due to lack of practice and low interest in mathematics which are evidence of avoidance behaviors. Table 12 shows statements where students and teachers agree and disagree on instructional techniques and strategies.

Implications of the Study

The study intended to examine secondary students’ mathematics anxiety. A great deal of responsibility lies with the school leaders and mathematics teachers in alleviating students’ anxiety, generating interest in mathematics, and encouraging students to enroll in secondary mathematics that will affect their future lives. Therefore, in light of the study's findings, the next section of the chapter includes significant implications for three groups: school leaders to formulate interventions and training programs for mathematics teachers, for teachers to design innovative instructional techniques to alleviate students' mathematics anxiety, and finally, offer practical ideas to students to make a conscious effort in reducing mathematics examination anxiety.

School Leaders: Interventions

Implementation of appropriate interventions to alleviate the anxiety of students is essential. The challenge is to determine 'what works, for whom, and in what circumstances' (Pawson & Tilley, 1997). A pragmatic worldview underlies these mixed-methods studies focusing on the practice and "what works" for the student participants (Creswell & Plano Clark, 2018). "The art of teaching does not merely involve a simple transfer of knowledge from one to other. Instead, it is a complex process that facilitates and influences the process of learning" (quoted by Anthonia, 2014, p. 184). In order to prepare mathematics teachers to address different classroom experiences and anxious students in mathematics lessons, the study will help implement teaching techniques that teachers can practice with teaching a concept of a lesson and a small number of students. For example, the microteaching technique has the components of remedial classes that aim to reteach lessons to students for an in-depth understanding of concepts in small groups. Anthonia found that microteaching is a teacher training technique to build teaching skills and confidence in lecturing or tutoring styles, to learn and practice giving constructive feedback and improves instructional experiences (2014). However, the technique can be equally effective for students who fail to grasp mathematical concepts in large class sizes.

Training mathematics teachers to use microteaching techniques, building more vital teaching skills for novices and experienced mathematics teachers, and focusing on students who require additional guidance in smaller groups within a timeline will benefit students and teachers (Anthonia, 2014). Moreover, implementing teaching techniques like microteaching may eliminate dependence on private tuition and reduce educational inequality between children of varying socioeconomic backgrounds (Buchmann et al. 2010).

A study found that teachers need to identify innovative methods and strategies to elicit questions for clarifications from students and examine their understanding (Burgh et al., 2018). Anxious students prefer remaining silent and avoid participation in mathematical tasks and discussions. Therefore, engaging students in small groups in school may encourage students to clarify doubts typically affected in large class sizes, which has been identified as a critical finding from student and teacher interview responses.

Mishra (2020) reported that "A search on the different databases regarding 'research in teacher education [in India] returns with a clear message 'lack of quality research on teacher education issues in India' (p.87). Although induction programs effectively train teachers to meet the performance standards but Mishra (2020) claims that induction programs are not widely recognized in schools in India. Therefore, the dissemination of mandatory teacher training programs and professional development should be instituted by school leaders. According to a report of Forbes India (2016), the Verma Commission[3] (2012) and the NCERT[4] have condemned the curriculum of degree programs for teachers that provides basic pedagogical skills and fails to address the socio-emotional aspects of students that contribute to a better understanding of

[3] Verma Commission was constituted to recommend amendments in Teacher Education (August 2012)
[4] The **National Council of Educational Research and Training** (NCERT) is an autonomous organization set up in 1961 by the Government of India to assist and advise the Central and State Governments on policies and programmes for qualitative improvement in school education.

concepts. Therefore, students' responses reveal the need and urgency for the school leaders to train teachers on techniques that can improve teaching skills in mathematics and address the socio-emotional needs of anxious mathematics students.

Teachers: Strategies

The findings of the study revealed that students' mathematics anxiety usually begins around the age of fourteen or in high school (grades eight and nine). The study will help teachers introduce real-world mathematics activities to teach the importance of numbers, relate mathematics lessons to real-life scenarios, and help students connect mathematical ideas to real-life situations through multiple instructional practices, which will generate interest in mathematics through student participation and mathematical thinking. For example, everyday mathematics practices like grocery shopping, paying bills, understanding investments in banks, and taxation will support learning the school mathematics curriculum and increase learning opportunities for students from diverse backgrounds. Student and teacher interview responses have indicated that students fail to understand the application of mathematics in real life and hence develop a low interest in the subject. However, one teacher participant reported using real-life mathematics activities to teach and engage students in mathematics lessons. Other teachers can also connect school mathematics to everyday activities and support positive dispositions towards mathematics.

Student responses have indicated that mathematics learning experiences in classrooms are monotonous. The study's findings will help teachers understand the significance of diversifying learning styles in the classroom, including role play, essays, manipulatives, and group discussions to encourage critical thinking and problem-solving. Therefore, developing a constructivist approach in teaching creates a more student-centered classroom that promotes active participation of students, generates a feeling of ownership for learning, and ensures mathematical learning is a positive experience in classrooms.

Student responses in interviews and self-portraits and findings of the RMARS questionnaire have shown that students are anxious about mathematics examinations. Therefore, the study findings will encourage teachers to design simple assessment tools to evaluate the mathematics performance of anxious mathematics students and reduce avoidance behaviors. In addition, a research study has shown that assessing students through observations, projects, cooperative learning, verbal questioning, and performance tasks can effectively assess students (Furner & Berman, 2003), which teachers can also adopt to leverage learning opportunities.

It takes a teacher to create mathematics anxiety for life (Jackson, 2008). On the contrary, only a teacher can motivate students, enhance self-efficacy, and connect self-belief with success in mathematics (Geist,2003; Cavanaugh,2007). The current study's findings show that students suffer from self-blame and feel responsible for low self-efficacy in mathematics. The literature review reveals some practical ways of reducing mathematics anxiety and avoidance behaviors: modifying teaching styles as per the learning ability of students, providing alternative ways of engaging student participation, offering positive and constructive feedback (Blazer, 2011), clear mathematics misconceptions (Jackson, 2008). Teachers are integral in encouraging students to develop a positive mathematics identity and enhance mathematics enrollment at the secondary level. The study findings hope to see a positive change in classroom instructional practices.

Students: Practical Ideas

Mathematics anxiety and avoidance behaviors interfere with mathematics learning and achievement (Blazer, 2011). Student interview responses have indicated that low self-belief results from lack of practice, negative attitude toward mathematics, and reduced interest in mathematics. However, the current study has shown several ways for students to adapt themselves to strategies to balance work-life that can alleviate anxiety. For example, dedicating time to mathematics regularly (Cavanaugh, 2007), effective pacing (Furner & Berman, 2003), connecting real-life applications to mathematical ideas, focusing on understanding concepts and not speed and accuracy (Blazer, 2011) will improve mathematical proficiency.

In addition, ignoring past failures and thinking about little successes in life (Furner & Berman, 2003) will enhance self-efficacy. Less emphasis on rote learning (Ahmed & Ahmad, 2017), exploring learning techniques as per the individual learning styles like self-study, videos, and small group discussions are other ways of generating interest in mathematics.

Recommendations for Future Research

While conducting this mixed methods research, the lack of academic studies on secondary students' anxiety and avoidance behaviors impacting mathematics enrollment in the Indian educational context was apparent. Therefore, the present study's findings provide insight into students' anxiety, primarily physiological than emotional, and offer valuable information about students' anxiety in mathematics examinations, especially in the examination hall. Furthermore, the study findings also highlight the impact of low self-efficacy on students' decisions in opting for mathematics at the secondary level. Therefore, several recommendations based on the study findings are described in the next section.

For future research, I believe schools should try to design data collection instruments on identifying students with anxiety without focusing on student scores as a determinant factor for anxiety in mathematics. For example, in the current study, teacher interview responses indicated that remedial classes are conducted for students with poor scores in mathematics, showing scores are the key indicators for identifying anxiety.

Teacher interview responses indicated that several instructional strategies are adopted to improve students' mathematical competency. However, the participants reported the absence of a systematic process of testing the effectiveness of the instructional practices in alleviating students' anxiety. Therefore, thorough research on measuring instructional strategy's efficacy, validity, and reliability would ensure the accuracy and rigor of teachers' pedagogical approaches to addressing mathematics anxiety.

Student participants emphasized the benefits of private tuition, but how reliable private tutoring is, lacked clarity. It is reasonable to presume that private tuitions provide additional guidance since students receive personalized attention in small groups. However, it would be unreasonable to admit that private tutors conduct classes with small class sizes. Anecdotally, through my time working as a K-12 school principal and a parent, I came across private tutors tutoring approximately forty students at a time. Do large class sizes in private tuition replace actual class sizes? Therefore, extending the current research on how private tuition benefits anxious students and encourage enrollment in mathematics and STEM fields needs to be explored. Additionally, the findings may help schools design interventions to prevent students from attending private tuition after school hours that take away valuable self-study time and financial burden on the parents. Moreover, appropriate age-specific interventions will help teachers understand how to combat the issue of mathematics anxiety.

Building on the current study's findings, future research should also focus on developing teachers' professional programs and preparing them for planning more significant ideas in this field. Additionally, research on the implementation of mastery experiences and verbal persuasion as a tool for reducing students' anxiety and enhancing teachers' efficacy will contribute to preparing new and experienced teachers to handle classroom experiences and students' anxiety.

The findings of the RMARS questionnaire that involved 16 participants indicated that mathematics anxiety begins in grades eight and nine. I piloted the current study with ninety-three participants for measuring the reliability and validity of the RMARS instrument. As per the thumb rule, a large sample leads to more accurate results when administering the survey. Therefore, future research should validate the study's findings by employing more statistical assessment tools with a larger sample size representing students from grades eight to ten to measure the degree of mathematics anxiety and establish the relationship between avoidance tendencies and secondary mathematics enrollment. Due to Covid restrictions, during data collection, schools were closed. Unfortunately, increasing the sample size with greater emphasis on statistical tests was a constraint.

Finally, responses of research respondents indicated selective studies help reduce anxiety. I believe selective studies as a strategy to reduce anxiety are contextual. Testing the strategy's effectiveness in enhancing students' interest in mathematics and influencing students to make decisions in favor of secondary mathematics enrollment would be an essential step and a way forward for this research.

Conclusion

Mathematics anxiety of secondary students has been a topic of concern for me as a researcher and as a K-12 school principal. The idea behind interviewing students and teachers was to get a clear perspective on the nature of anxiety and what influences students to withdraw from enrolling in secondary mathematics. The current study results were possible because the participants voluntarily participated in offering an insight into the research problem. Considering that mathematics is an important subject that integrates all other sciences and technology, the need to increase enrollment in secondary mathematics is paramount.

Mathematics anxiety has been an age-old phenomenon. Therefore, a collective effort of school principals, teachers, and parents will enhance students' self-efficacy, dispel mathematics misconceptions, increase students' engagement in mathematical tasks, and make mathematics more fun through innovative methods. Schools need to take responsibility for students to understand that mathematics learning should be more conceptual and not through rote learning since it will enhance their proficiency and confidence in their abilities. It will also encourage students to think more critically and make mathematics a way of life.

The current study offers several opportunities for me to conduct research in the future: first, design interventions in line with microteaching, a teacher training technique to explore an association between students' anxiety and understanding of mathematical concepts besides helping teachers improve their teaching skills. Second, develop an instrument to measure students' mathematics self-efficacy and anxious mathematics students without regard to scores. Third, using statistical tests to explore the relationship between factors that increase students' examination anxiety and its impact on secondary mathematics enrollment will further help me understand all that remains ambiguous in the study findings. The results of this study can help bridge the gap in the existing research and influence the future researchers in India take this study forward, preventing or reducing mathematics anxiety in future students. and collectively explore increasing enrollment in mathematics and STEM fields at the secondary level.

Chapter Summary

Chapter 5 began with a discussion on the overall findings before going into the details of the individual conclusions. Next, the chapter discussed the implications and recommendations for future research and ends with concluding thoughts.

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APPENDICES

Appendix A.

Comparison of boards across India

	State Boards	**CBSE**	**ICSE**	**NIOS**	**CIE**	**IB**
Establishment Year	Various	1962	1958	1989	1858	1968
Country of accreditation	India	India	India	India	Britain	Switzerland
Type	Government	Government	Private	Government	Private	Private
Recognition	National	National & International	National	National & International	International	International
Methods	Rote	Rote	Application based	Varied	Application based	Application based
Focus	State based	Math/Science	Maths/Languages, arts	Self-paced learning	Varied	Critical thinking
Ease of Learning	Easy	Moderate	Hard	Easy	Moderate	Hard
Teacher training provided in India	Minimal	Moderate	Moderate	Moderate	High	High
Flexibility(ease of changing boards)	Tough across India and abroad	Easy across India, tougher abroad	Easy across India and abroad	Easy across India, limited abroad	Tough across india, easier abroad	Tough across India, easier abroad
Extended to preschool	Yes	Yes	Yes	Yes	Yes	Yes
Fees	Low	Medium	Medium	Low	High	High

Source: Education board websites, expert inputs, First Crayon analysis

Appendix B.

Mathematics Anxiety: Secondary Students' Avoidance of Elective Mathematics
PAPER SELF -PORTRAIT

Name: - -- (pseudonym)

Draw a portrait of yourself an **emotion** associated while learning mathematics. The portrait can be an emoticon, a metaphor indicating 'WHERE', 'WHEN', and 'WHAT 'emotion you experienced while learning mathematics through captions. You may use an extra sheet for drawing. Kindly elaborate on the captions in the space given below the visualization. After completing, kindly scan the document and email it back to me through UT Vault (in case of virtual) or hand it over to me soon after you complete it (in case of in-person).

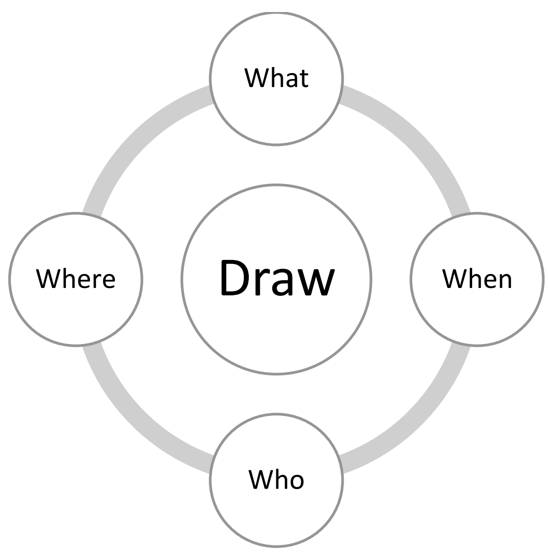
When describes grade or age you discovered mathematics anxiety.

Where describes situation you experienced mathematics anxiety.

What implies the emotion that best describes the nature of your mathematics anxiety.

Who implies the person in your life was the cause of mathematics anxiety.

Purpose of this method: To understand the nature of mathematics anxiety in a situation.



What-

Where-

When-

Who -

Sample Physiological and Emotional Responses

Physiological Responses

1. Increased heartbeat / pulse rate
2. Heaviness in the head
3. Dizziness
4. A more frequent breathing activity
5. Breathlessness
6. Blankness
7. Heaviness in the chest
8. Restlessness
9. Facial tension
10. Stomachache
11. Twisted stomach
12. Difficulty in swallowing
13. Nausea
14. Increase in body temperature
15. Often asking for permission to use the restroom
16. Redness in the face
17. Sudden sweaty hands
18. Cold sweats
19. Muscle ache
20. Teething teeth
21. Unstable Voice
22. Trembling
23. Prevent eye contact
24. Any other

Emotional responses

1. Humiliation
2. Fear
3. Shame
4. Sensitivity towards comments
5. Distractive
6. Extreme emotional effect -A condition that increases a person's propensity to cry
7. Any other

Appendix C.

MATHEMATICS ANXIETY SURVEY QUESTIONNAIRE FOR STUDENTS (PILOT STUDY)

Please indicate (put a X) the level of your anxiety in the following situations. Please choose ONE box on each line.

S.No:		Not at all 1	A little 2	A fair amount 3	Much 4	Very much 5
1.	Taking a math test in school.					
2.	Taking school terminal math exam					
3.	Taking an examination school (final) in a mathematics course.					
4.	Taking the national board math exam					
5.	Going to school for math national level board exam					
6.	Scoring low marks in math final exam.					
7.	Thinking about an upcoming math test 1 week before.					
8.	Thinking about an upcoming math test 1 day before					
9.	Thinking about an upcoming math test 1 hour before.					
10.	Waiting to get a mathematics test returned in which you expected to do well.					
11.	Receiving your final math answer script in class.					
12.	Picking up math textbook to begin working on a homework assignment.					
13.	Asked to refer to a book and take up a math classes to assess the understanding of concepts.					
14.	Realizing that you must take mathematics to fulfil the requirements in your major in grade 11					
15.	Picking up math textbook to begin a difficult assignment					
16.	Referring to a math textbook for self-learning as a part of math project.					
17.	Opening a math textbook and seeing a page full of problems.					
18.	Not completing portion before the exam.					
19.	Figuring the sales tax on a purchase that costs more than 500 /-.					
20.	Asked to solve a quiz question in a math class					
21.	Being given a set of numerical problems involving trigonometry in front of the class on the blackboard.					
22.	Being given homework assignments of many difficult problems that are due the next class.					

23.	Watching a teacher work on a complex numerical on the blackboard.					
24.	Dividing a five-digit number by a three-digit number in a short time with pencil and paper.					
25.	Adding 97639 + 777 mentally.					
26.	Asked to sign up for a math Olympiad.					
27.	Explaining a math numerical on the blackboard.					
28.	Clarifying doubts in class.					
29.	Being responsible for collecting dues for an organization and keeping track of the amount.					
30.	Having someone watch you as you total up a column of figures.					

Three factors /categories of mathematics anxiety

- **Mathematics examination** (ME-11 items)
- **Mathematics curriculum (MC- 7 items)**
- **Numerical tasks (NT- 12 items)**

4 & 5 – High levels of anxiety
3 – Medium levels of anxiety
1 & 2 – Low levels of anxiety

Appendix D.

MATHEMATICS ANXIETY SURVEY QUESTIONNAIRE FOR STUDENTS (Revised)

Please indicate the level of your anxiety in the following situations. Please choose ONE box on each line.

S.No:		Not at all 1	A little 2	A fair amount 3	Much 4	Very much 5
1	Taking a math test in school.					
2	Taking school terminal math exam					
3	Taking an examination school (final) in a mathematics course.					
4	Taking the national board math exam					
5	Going to school for math national level board exam					
6	Scoring low marks in math final exam.					
7	Thinking about an upcoming math test 1 week before.					
8	Thinking about an upcoming math test 1 day before					
9	Thinking about an upcoming math test 1 hour before.					
10	Waiting to get a mathematics test returned in which you expected to do well.					
11	Receiving your final math answer script in class.					
12	Picking up math textbook to begin working on a homework assignment.					
13	Asked to refer to a book and take up a math classes to assess the understanding of concepts.					
14	Realizing that you must take mathematics to fulfil the requirements in your major in grade 11					
15	Picking up math textbook to begin a difficult assignment					
16	Referring to a math textbook for self-learning as a part of math project.					
17	Opening a math textbook and seeing a page full of problems.					
18	Not completing portion before the exam.					

19	Being given a set of numerical problems involving trigonometry in front of the class on the blackboard.					
20	Being given homework assignments of many difficult problems that are due the next class.					
21	Watching a teacher work on a complex numerical on the blackboard.					
22	Dividing a five-digit number by a three-digit number in a short time with pencil and paper.					
23	Clarifying doubts in the class.					
24	Being responsible for collecting dues for an organization and keeping track of the amount.					
25	Have someone watch you as you total up a column of figures.					

Four factors of RMARS were determined based on data using 29 items. These are:

- **Mathematics examination** (MTA-11 items)
- **Mathematical curriculum related anxiety (MCRA- 7 items)**
- **Numerical tasks (PSA- 7 items)**

4 & 5 – High
3 – Medium
1 & 2 – Low

Appendix E.

Student Interview Questions

Hello! Thank you for consenting to be a part of this interview! Remember that your participation is voluntary. You only must answer questions that you want to answer, and you can leave anytime. You will be given an amazon gift card of $ 15 even if you stay for most (about 3⁄4) of the interview.

1. **Introduction – Demographic questions(students may call their parents for information on questions 1.1-1.4)**

1.1 Are your parents/ guardian working? Yes / No
1.2 Where do they work? - Father - Mother - /Guardian-
1.3 Monthly income - Father - Mother - /Guardian-

- Less than 10k
- Between 10k-20k
- Between 21-30k
- Between 31-40K
- More than 41k
- Fluctuates
- Don't want to share

1.4 Educational background
Mother –
Father-
Guardian-
1.5 How many siblings do you have? brother/s- sister/s-
1.6 Which grades are they in – brother/s - sister/s
1.7 Are the siblings in the same school? Yes / No
1.8 How far is your school from your residence?
1.9 Who teaches you at home?
1.10 Who takes decisions related to your education?
1.11 What mode of transport do you take to reach school?
1.12 How long have you been in this school?
1.13 What is your caste – General / SC / ST/ OBC / others / Don't know

2. **Students' perception about mathematics anxiety(***examination, numerical, and curriculum)*

2.1 What are you most anxious in - Geometry, Algebra or Arithmetic?
2.2 Have you ever consulted elders for math anxiety?
2.3 Do you memorize formulae or numerical problems during exam? What is your reaction when you are not able to recall, and the clock starts ticking down?
2.4 Who do you think is responsible for your anxiety the most? What suggestion would you like to give him/her?

3. **Instructional practices and strategies for math-anxious students** (*numerical and curriculum)*

3.1 Do/did you face any challenges in understanding concepts in class? How do/did you handle such situations?
3.2 Any specific teaching strategies helped you overcome anxiety? If so, which grade and how did it help you? If not, why?
3.3 How much time do/did you invest in solving math numerical beyond classroom learning?
3.4 How many books did you refer for practicing math beyond the textbook recommended in high school?
3.5 How did you get to know about the book you refer/ referred to?
3.6 What problems did / do you face while solving numerical from textbooks?
3.7 Do you believe in after school coaching? Did you require? Does/did it help?

4. **<u>Avoidance and withdrawal of mathematics in diverse situations</u>** (*examination, numerical, and curriculum*)

    4.1 Do you have math in secondary level? What are your post-secondary plans of university admissions?
    4.2 Did you enjoy practicing math in the past? Which subject did you prefer studying over math?
    4.3 Did you experience not completing math examination paper? What were the reason/s?
    4.4. Did you experience not completing math assignments? What were the reason/s?
    4.5 Did you experience not revising the entire syllabus before the examination? What were the reason/s?
    4.6 How confident were you before an examination, after completing regular homework/ assignments?
    4.7 Would you like to share any experience of motional and physiological responses to math in the past?
    4.8 Do you believe in the system of handholding / self-study? Yes/ No
    Please answer the following questions to answer this question.

5. **<u>Concluding questions - students' self-efficacy</u>**

    5.1 How do you motivate yourself to do schoolwork related to mathematics?
    5.2 How do you feel when the math is too hard?
    5.3 Do you like doing math problems with a partner, in a group or alone?
    5.4 What do you think when another student gets finished with a math problem before you?
    5.5 What according to you would enhance students' self-belief in mathematics?

    Is there anything else that you'd like to share before we end the interview?
    Thank you for participating. I shall share the final transcripts with you before it goes into my dissertation.

Appendix F.

Teacher Interview Questions

Hello! Thank you for consenting to be a part of this interview! Remember that your participation is voluntary. You only must answer questions that you want to answer, and you can leave anytime. You will be given an amazon gift card of $ 35 even if you stay for most (about 3⁄4) of the interview.

1. Introduction - Demographic questions

1.1 Gender- M/F/ Don't want to mention

1.2 Educational Background

- Bachelor's
- Master's
- PhD

1.3 Professional Seniority

- 1-5 years
- 6-10 years
- 11+ years

1.4 Evaluator at the national board – yes/no. If yes, how many years?

- 1-5 years
- 6-10 years
- 11+ years

1.5 Is teaching your first career? Yes/ No

1.6 What was your major in college?

2. Instructional Practices and strategies (*numerical and curriculum)*

2.1 Can you share an important instructional strategy you normally adopt for introducing new concepts?

2.2 How do you engage students with avoidance tendencies?

2.3 Does self-study and solving numerical beyond what is covered in the class address avoidance behaviors?

2.4 What follow up mechanisms do you adopt to assess math anxious student preparation for examination?

2.5 How do you encourage math anxious student participation in class?

2.6 Please share how you provide an alternative explanation or examples when math anxious students avoid math?

2.7 How effective are after school coaching for math anxious students?

2.8 Do students avoid doing homework? How do you follow up on a regular basis?

2.9 How do you encourage students referring to other books for practice?

3 **The effectiveness of instructional techniques and strategies on students** (*numerical, curriculum, and examination*)

3.1 How do you assess your teaching effectiveness?

3.2 To what extent can you use a variety of assessment strategies? Share a few

3.3 How often do you assess student understanding of concepts?

3.4 How do you deal with students who fail to understand concepts in class?

3.5 Do you analyze student performance? If so, what POA do you take to improve student scores?

3.6 How do you implement alternative strategies in your classroom?

4. **Identification of math-anxious students** [*emotional and physiological responses (Self—Efficacy) to mathematics that would be the outcome of the examination and numerical anxiety*]

4.1 How do you identify math anxious students? Please emphasize on emotional and physiological responses to math you observe in class

4.2 What percentage of class strength are math anxious while solving numerical in each academic year?

4.3 What avoidance behaviors do you notice in students?

4.4 What measures do you take to alleviate student anxiety while:
- In numerical tasks
- Preparation before Examination

4.5 Does anxiety impact student enrollment in secondary mathematics?
4.6 Share experiences of student anxiety on anyone situation - examination or solving numerical.
4.7 Among the three – examination, solving numerical or self-study, in which situation are students most math anxious? How do you resolve?
4.8 How do you motivate math anxious students?
4.9 Does socioeconomic status (SES) impact the acquisition of mathematical skills and competency of students?

5. **Concluding questions: - Teacher self-efficacy**

5.1 How confident do you feel in teaching IIT or Medical aspirants?
5.2 How do handle difficult questions?
5.3 What is your approach towards students who have high self-efficacy and low self-efficacy?

Is there anything else that you'd like to share before we end the interview?
Thank you for participating. I shall share the final transcripts with you before it goes into my dissertation

Appendix G
Qualitative Data Analysis (Codebook)

A combination of Deductive and inductive coding helped in analyzing the findings of the interview responses. The findings were based on the four themes that emerged from inductive analysis. The entire of coding was done in primary two cycles.

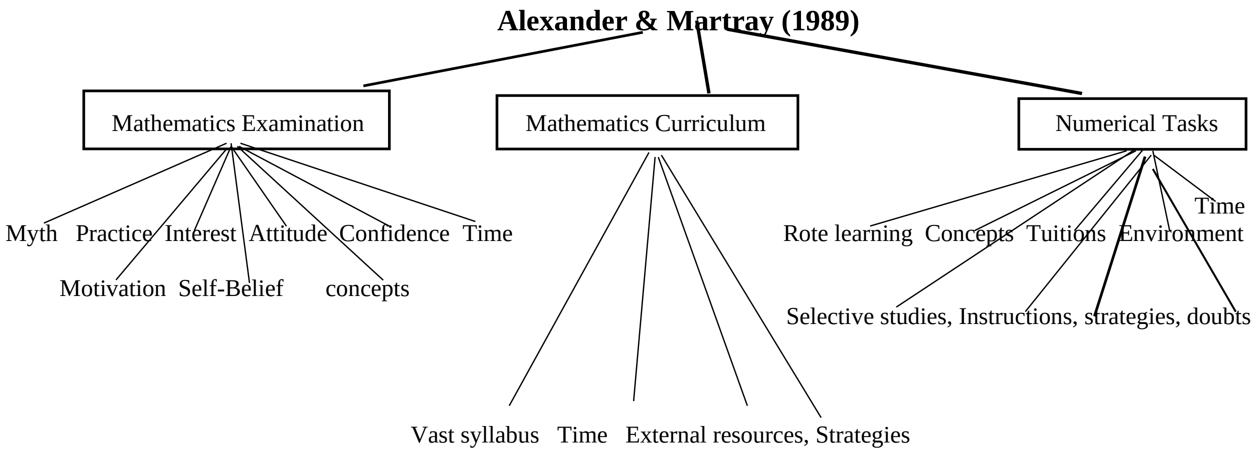
First cycle of coding- Deductive Coding Strategy

Step 1: Provisional codes. In the current study, deductive or a priori analysis involved developing codes drawn from literature. Three predetermined provisional codes were developed from the study of Alexander & Martray(1989) that helped in understanding mathematics anxiety of secondary students. Several primary codes were created at the initial cycle of coding.

Provisional codes	Definition
Mathematics examination	Anxiety related to answering mathematics reflects anticipating taking a test, preparing for the examination, receiving grades (Alexander & Martray,1989), and anxiety on receiving the corrected answer scripts.
Mathematics curriculum	Anxiety component that reflects taking mathematics course(Alexander & Martray, 1989), vast and overloaded curriculum, inability to complete revising the course independently, difficulty in understanding concepts since the standard is higher than other national boards.
Numerical tasks	A dimension of anxiety that involves fear in executing numerical tasks (Alexander & Martray,1989) ,e.g., quiz, solving on the blackboard, completing assignments, anxiety about manipulating numbers (Alexander & Martray,1989) in regular life.

Step 2: Primary codes. **Inductive Coding Strategy**. I read through every interview response statement thoroughly, and each response received at least one code. Therefore, multiple codes were applied to the interview responses to understand what the respondents were trying to imply. In other words, an exhaustive list of codes was created. A few codes were overlapping (i.e., were associated with other provisional codes). Therefore, I used the most significant primary codes to design a code tree diagram and understand the relationship between each primary code and the predetermined provisional codes.

CODE DIAGRAM



Several primary codes were applied to every interview statement to show what each statement indicated and how they were related to the provisional code. This helped in capturing the overlapping and significant codes. In addition, it helped identify the pattern of themes that emerged across the interview statements. Therefore, I selected only significant codes in the table below and excluded the less relevant ones.

Provisional codes	Sample excerpts from interview response statements with primary codes highlighted
Mathematics Examination	People have always been saying that maths is a difficult subject so that has been in my mind, since childhood (Myth) -Misconception I feel I am responsible for anxiety and that's because I don't practice maths every day but 2 or 3 days in a week (Lack of practice)- Irregularity I didn't enjoy solving numerical sums because that was not my area of interest (interest)- Lack of interest As soon as I enter the class, they express their fear and disinterest in learning Maths-Low interest I knew that maths is not important, so I didn't push myself to get good marks,(relevance) – negative attitude I knew that maths is not important, so I didn't push myself to get good marks, this feeling crumbled my self confidence that I just couldn't regain (confidence)- low self-belief The fear of writing wrong answers during examination and the fear of wasting time in solving the questions that I didn't know.(time) – time management Teacher told me to keep practicing and not to give up. This was his strategy to encourage the students (encouragement)-motivation I have low self-efficacy so I motivate myself by telling myself that i have to do it, I can do it. And I must keep practicing and give all my best(self-efficacy)- self-belief Challenge was understanding concepts of mathematics depends on the teachers, one of them did not explain the concept well or cleared my doubt in maths(understanding concepts)- math concepts My father said that I must train my mind to be confident and remove the fear and unnecessary stress on seeing the question paper(Fear)- fear of examination paper.
Mathematics Curriculum	The problem was with vast syllabus and textbook (syllabus)-vast syllabus. I get motivated actually by seeing some special videos on YouTube-(external resources)-source of motivation I motivated them in adopting strategies to do well. Give them examples of candidates who worked hard and became successful. (Motivation)

	I was stressed only during examination because we got only two and a half, at that time, though we had got many options, I couldn't complete my question paper (time)- lack of time management There were also Remedial classes for weak students (strategy) – instructional practice
Numerical tasks	I would memorize formulas and practice but It wouldn't last for very long in my mind (memorization)-rote learning when I actually started reading those pages , line by line, I started understanding the concepts and then I could prepare those chapters for the examination.(understanding concepts)-building math concepts We also study a lot more in depth in every chapter in the tuition classes (inclination towards private tuitions)-private tuitions. Most of the dozens of existing private tutors are not able to create interest in Maths in the students or remove their fear.(Tuitions) I prefer solving problems alone only so that I can study in a peaceful environment without any disturbing elements(environment) – class size This subject needs individual attention which is not possible in a class of 40.(Large class size) To reduce anxiety during examination and to cope up with vast syllabus, my math teachers advised me to do specific types of questions, because they will be surely come in the examination(limited portion to cope up with anxiety)-selective studies I tell my teachers teaching grades nine and 10 to teach only easy topics that they can do by themselves-Selective studies Gave them good selective and important questions from the Board exam point of view and identified some of them in their boo- strategy Would ask my doubts repeatedly to my teacher and if still not clear I understand from the YouTube videos(absence of appropriate instructions) -instructional practices , clarification of doubts

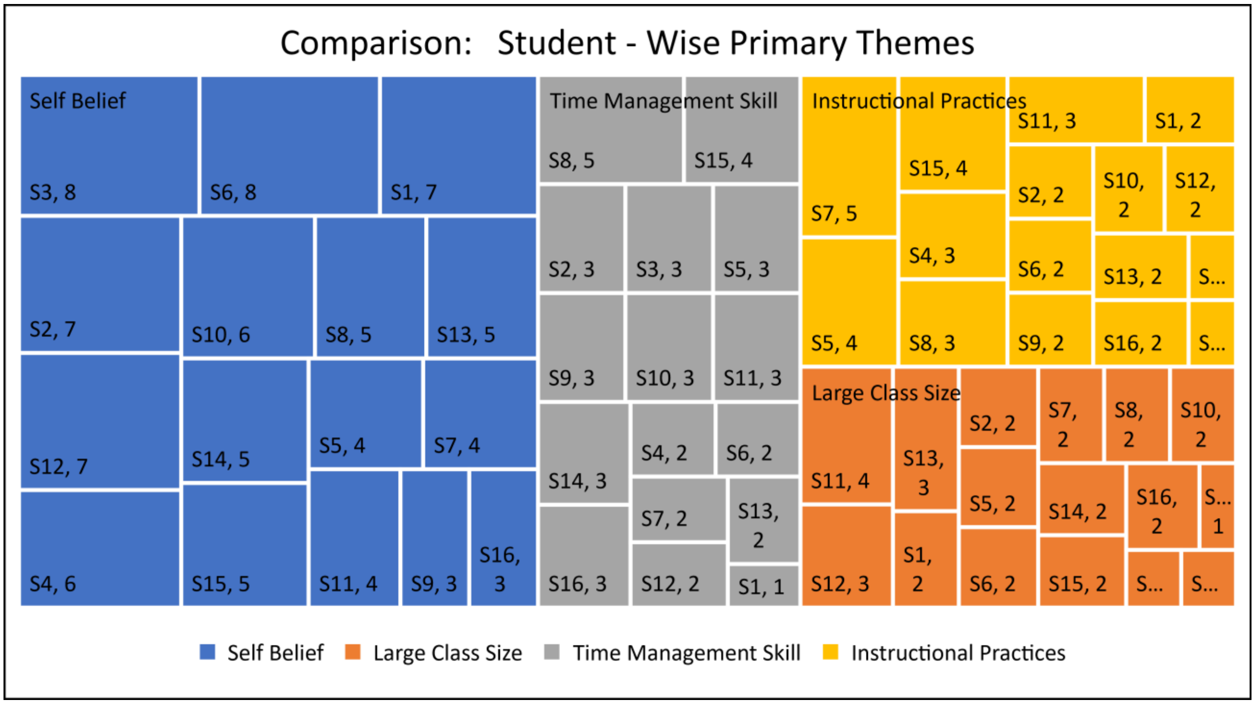
Definition and Significance of Primary Codes

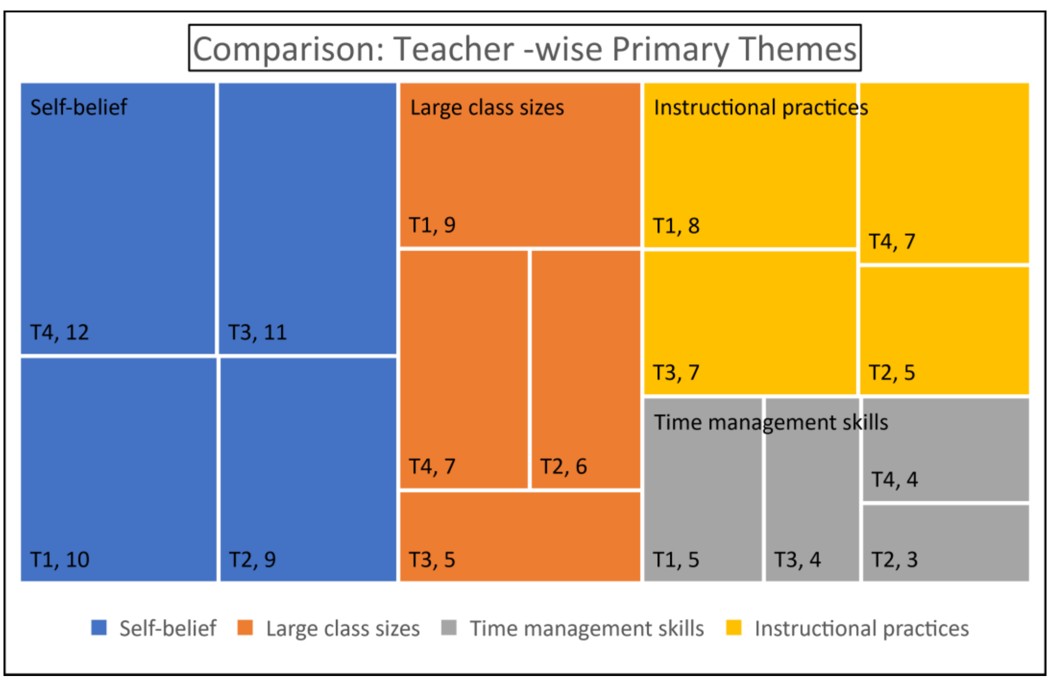
Primary codes	Description	Significance
Misconception	This code refers to an incomplete understanding that develops due to mathematical experiences	It is important to address misconceptions since it holds students from understanding and performing well in the subject.
Irregularity	Irregularity in practicing mathematics imply focusing on other subjects and not giving importance to mathematics.	Irregularity results in low mathematical concepts, affects scores and level of confidence.
Lack of interest	The code refers to lack of focus students develop due to several reasons like misconceptions about mathematics, poor scores, teachers not able to generate interest	Generating students' interest in the subject is important because students do not pay attention and tend to avoid the subject
Attitude	Attitudes can be positive or negative. It refers to how students perceive mathematics in their life.	In the study it is important to address negative attitudes of students towards mathematics since it builds negative mathematical identity or dispositions towards the subject which impacts their achievement.
Confidence **Self- Belief** **Motivation**	The code refers to growth mindset, a conviction 'I can do it' and not get affected by any past failures or experiences, rather learn from failures.	Confidence helps students to learn from mistakes, take up challenges, build a positive attitude, and improves mathematical skills. Students' building confidence in their ability to do mathematics, not get dejected with failures is important.
Time	The code refers to students' understanding the value of time in life.	Students' inability to solve or complete answering the question paper on time reflects

	Any examination will always have a timeline.	lack of practice hence unfamiliarity with concepts, resulting in submitting an incomplete paper. This leads to failures, loss of confidence , developing misconceptions.
Rote learning	The code refers to memorization without understanding concepts.	Students in the study commented on how memorization of formulas did not help in understanding concepts. They believed that forgetting formulas gave them anxiety and applying correctly was more important than memorizing formulas.
Private Tuitions	The code refers to supplementary education given to students by private teachers after school hours on payment.	The code matters to the study because most students believed and were convinced that private tutors are more effective than school mathematics teachers in building concepts. The private tutors gave personalized attention, and students learned in small groups and had fewer distractions. Schools need to design instructional practices that can engage students so that the learning is more effective, engaging students, and less financial burden on the parents. More importantly, India has a population of more than 1.3 billion. Class sizes will be significant since the number of schools is not proportionate to the population.
Environment **Class size** **Clarification of doubts**	Mathematics learning in classrooms depend a lot on the talents and teaching skills of teachers. The ability of a teachers to create learner friendly environment is a strength a teacher.	This code matters in this study since schools in India have a 1:45 or 50 student-teacher ratios. Therefore, improving mathematical learning experiences and generating students' interest in mathematical courses in post-secondary education depends on the kind of environment teachers create in mathematics classes.
Instructions Practices or Strategies	The code refers to teachers' instructional practices adopted to alleviate anxiety and improve scores. .	As I read through the interview statements, I noticed students showed high expectations from mathematics teachers in using more innovative and friendly strategies to remove their fear of the subject. Teachers mentioned practicing them, but the effectiveness in alleviating anxiety and scores was not evident.

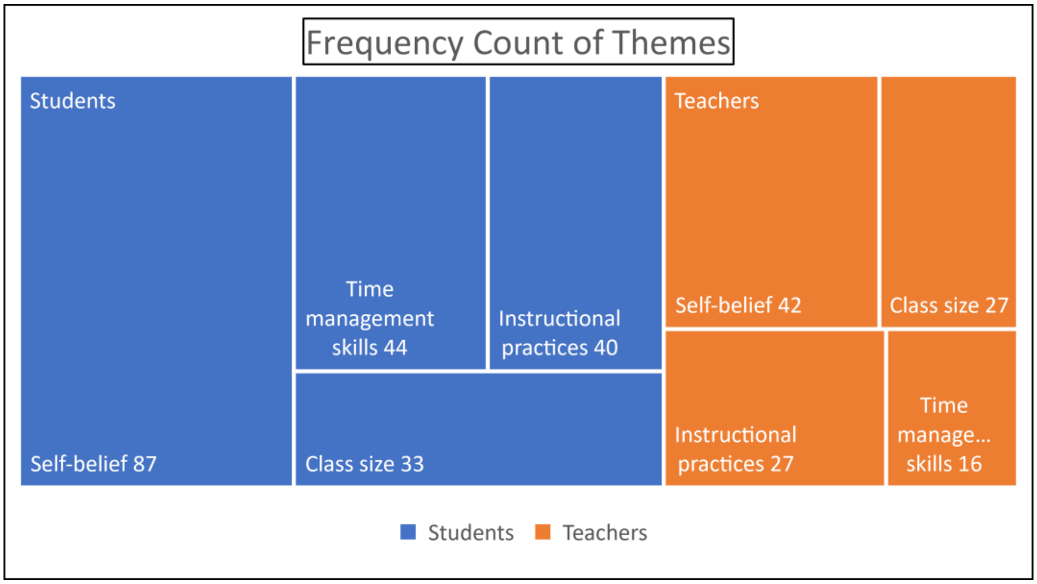
Step 2: Second cycle of coding: Focused Coding

In this stage, I narrowed down the primary codes to develop themes. The frequency of co-occurrences of significant codes was calculated, and the frequently appearing ones emerged as final themes. Finally, four themes emerged from the inductive analysis: low self-belief, large class sizes, time management skills, and instructional practices. Among the four themes that emerged from the interviews of teachers and students, self-belief emerged as the most frequently quoted by the participants. This theme aligns with the Self-Efficacy theory guiding the current study.





Participants	Self-belief	Class size	Time management skills	Instructional practices
Students	87	44	32	40
Teachers	42	27	16	27



Final themes Sub-themes merged	**Description**
Self-belief Self-belief, Myths, lack of interest and practice, negative attitudes towards mathematics,	An individual's belief in their ability to perform a mathematical task. Factors like misconceptions about the subject result in low interest and relevance in life, reducing mathematics practice, and impacting scores. Students develop different avoidance tendencies resulting in students' low self-perception about mathematics. This low Self-belief influences students' decision in enrolling in mathematics-related courses. The physiological and emotional responses to anxiety due to low self-belief results in low enrollment.
Large class sizes Impact of large size, doubts, private tuitions	The large class sizes in the Indian context impact the level of interest of students in the subject. Distractions and disturbances make it difficult for math-anxious students to clear their doubts, so they seek guidance outside school hours. The students shared the concept of private tuition and its benefits though not all students and teachers were in support of private tuition. Initiatives to reduce the tendency of students to opt for private tuition will attract students towards paying more attention in class and develop a liking for the subject.
Time management skills	Time management refers to students' inability to complete numerical sums during examinations. They believed the timeline given to answer is short and

Low math concepts and speed due to irregularity, poor scores, vast syllabus	not uniform in grades ten and twelve. The consequences of a vast syllabus and low self-belief and the factors impact students' time management skills. The teachers also believed that time is a constraint, and students need to learn how to manage time.
Instructional practices Environment, strategies, motivation	Teachers pointed out implementing several instructional practices and strategies like role-playing, storytelling, problem-solving, question bank, monitoring, and motivational talks. However, students felt that the environment needs to be more friendly. Different learning styles should be implemented so that mathematics students who scored less can take up the challenge of attempting to solve more numerical and not get scared of the subject. Therefore, teachers' mastery experiences and verbal or social persuasions play an essential role in generating interest in students and helping increase enrollment in secondary mathematics.

Appendix H

Mathematics Anxiety: A Mixed Methods Approach to Understanding Secondary Students' Avoidance of Elective Mathematics

Student Assent Form

My name is Indrani Singh I am conducting research at the University of Tennessee, Knoxville, to see how mathematics anxiety plays a role in secondary students' avoidance of selecting mathematics as an elective subject at the secondary level. We also want to understand whether low enrollment in elective mathematics courses is due to mathematics anxiety.

What we will do in this research is analyze the individual interview, survey on measuring mathematics anxiety and your experience of learning math through drawing a portrait of yourself with captions on what , where and when do you experience anxiety whole learning mathematics. Your parent has given their permission, and so I'm asking if it's OK with you for us to use these materials in my research.

If you agree to be in the research, we will assign you a pseudonym and use that instead of your name on all the materials. Your real name will never be used in any articles or books or presentations unless you and your parent say it is OK.

If you have any questions about this research, please ask me before you sign this form. If you think of questions later, please contact me, Indrani Singh**, isingh3@vols.utk.edu**, 865-583-9738 (English) or my advisor, Frances K. Harper, **francesharper@utk.edu**, 865-974-4040 (English only)

If you have any complaints or concerns about being in this research, you may contact the Institutional Review Board (IRB) of the University of Tennessee, Knoxville, at utkirb@utk.edu or 865-974-7697. It is their job to protect the people who are in research studies.

It is completely up to you to decide to be in this research study. Even if you decide to be part of the study now, you may change your mind at any time and stop participating by contacting the me for discontinuing participation. You can keep being in research project Mathematics Anxiety: Secondary Students' Avoidance of Elective Mathematics, even if you do not want to be in the research.

If you agree to be in the research, please sign the **Assent** section, on both copies of this form. Return one copy to me or my advisor and keep one copy for your records. If you do not wish to be in the research, you don't need to do anything, as we cannot use your materials without your assent.

Child/Youth Assent

I agree that Indrani Singh may use my information for research purposes. If I change my mind, and decide not to participate later, I only need to contact Indrani Singh for discontinuing participation.

Youth Name (printed) ____

Youth Signature ____ Date _______________

Assent for use of images

I agree that audio-recordings of me from research project on Mathematics Anxiety: Secondary Students' Avoidance of Elective Mathematics may be analyzed for research purposes.

Youth Signature ____ Date _______________

Appendix I.

Mathematics Anxiety: Mixed Methods Approach to Understanding Secondary Students' Avoidance of Elective Mathematics

Consent Form (Parents or Caregivers)

Your child is invited to be part of a research study being conducted by Indrani Singh at the University of Tennessee, Knoxville, United States of America. Being in this research study is voluntary, and you should only agree if you completely understand the study and want to volunteer to allow your information to be used. This form contains information that will help you decide if you want your child to be part of this research study or not. Please take the time to read it carefully, and if there is anything you don't understand, please ask questions.

Why is the research being done?

The purpose of the study is to explore how mathematics anxiety plays a role in secondary students' avoidance of selecting mathematics as an elective subject at the secondary level. We also want to understand whether low enrollment in elective mathematics courses is due to mathematics anxiety.

What will we do in this study?

If you agree for your child to be in this study, your child will participate in a one-to-one interview which should take 60 -90 minutes. You will be informed about the date, location, and time to participate in the interview. The interview will be followed by completing a students' survey form on mathematics anxiety. The survey includes questions about your child's perception about mathematics anxiety and should take him/her about 15-25 minutes to complete. Your child can skip questions that he/she do not want to answer, and he/she can choose not to answer any demographic questions that he/she believes may identify your child. After completing the survey, your child will complete a paper self-portrait to express his/ her experience with learning math through images and captions which should take 20 minutes.

Can I say "No"?

Being in this study is up to you and your child. You can stop up until you and your child submit the survey. After your child submits the survey, and completes the paper self-portrait model, she/he will have to scan the filled-up survey for and the paper self-portrait and mail it in the contact address of the researchers. After your child submits the survey, and paper self-portrait model we cannot remove your child's responses because we will not know which responses came from them. Either way, your and your child's decision won't affect your family's relationship with the school.

Are there any risks to me?

Some of the survey questions are personal in nature and may make your child feel uncomfortable.

Are there any benefits to me?

We do not expect your child to benefit from being in this study. His/her participation may help us to learn more about how mathematics anxiety plays a role in secondary students' avoidance of selecting mathematics as an elective subject at the secondary level. and how it affects students' enrollment in elective mathematics at the secondary level. We hope the knowledge gained from this study will benefit others in the future.

What will happen with the information collected for this study?

If you agree to allow your information from the interview to be used in the pilot research study , we will assign you a pseudonym instead of your name on all of the materials before we begin analyzing them for the pilot research study. The survey, and paper self-portrait is anonymous, and no one will be able to link your child's responses back to them. Your child's responses to the survey, and paper self-portrait will not be linked to email address or other electronic identifiers. Please do not include any names or other information that could be used to identify you or your child in your survey responses. Information provided in this survey, and paper self-portrait model can only be kept as secure as any other online communication. Your information will not be used or shared with other researchers for future research, even if identifiers are removed.

Will I be paid for being in this research study?

Your child will be given a $15 gift certificate for a large retailer (such as Amazon).

Who can answer my questions about this research study?

If you have questions or concerns about this study, or have experienced a research related problem or injury, contact one of the researchers:

- Frances K. Harper, francesharper@utk.edu, 865-974-4040 (English only)
- Indrani Singh, isingh3@vols.utk.edu, 865-583-9738 (English and Hindi)

For questions or concerns about your rights or to speak with someone other than the research team about the study, please contact:

Institutional Review Board
The University of Tennessee, Knoxville
1534 White Avenue
Blount Hall, Room 408
Knoxville, TN 37996-1529
Phone: 865-974-7697
Email: utkirb@utk.edu

Voluntary Participation

It is completely up to you and your child to decide to be in this pilot research study. Even if you or your child decide to be part of the study now, you may change your mind at any time by contacting the researchers for discontinuing participation. You or your child will not lose any services, benefits, or rights you would normally have if you chose not to volunteer, or if you change your mind and stop being in the study later. If you or your child do not wish to be in the research, it is not necessary to do anything, as we cannot use your materials without your consent.

Consent

I have read the above information. I have received a copy of this form. If I have more questions, I have been told who to contact. I agree to be included in this study.

Parent's or Caregiver’s Name (printed) ____

Parent's or Caregiver’s Signature ________________________________ Date _________________________

Consent for Use of Video-Recordings

I agree that videorecording of my child for the pilot research study on mathematics anxiety may be analyzed for research purposes.

Participant's or Caregiver’s Signature _____________________________Date ___________________

Acknowledgement

To parent or caregiver: Please discuss the study with your child.

Child/Youth Assent:

I have talked about this research with my parent(s) or caregiver(s). I agree that the researchers, Frances K. Harper, and Indrani Singh at the University of Tennessee, Knoxville, United States of America may use my information for research purposes.

Participant’s Name (Printed)____

Participant’s Signature_____________________________Date ________________________________

Appendix J.

Mathematics Anxiety: Secondary Students' Avoidance of Elective Mathematics
Informed Consent Form (Teacher)

You are invited to be part of a research study being conducted by Indrani Singh at the University of Tennessee, Knoxville, United States of America. Being in this research study is voluntary, and you should only agree if you completely understand the study and want to volunteer to allow your information to be used. This form contains information that will help you decide if you want to be part of this research study or not. Please take the time to read it carefully, and if there is anything you don't understand, please ask questions.

Why is the research being done?

The purpose of the study is to explore how mathematics anxiety plays a role in secondary students' avoidance of selecting mathematics as an elective subject in secondary level. We also want to understand whether low enrollment in elective mathematics courses is due to mathematics anxiety.

What will we do in this study?

If you agree to be in this study, you will participate in one-to-one interview. You will be informed about the date, location, and time to participate in the interview. If you agree to be in the study, your participation will last for 60-90 minutes. You will be asked to answer questions about your knowledge of secondary students' mathematics anxiety and whether low enrollment in elective mathematics courses is due to mathematics anxiety. You can decide not to answer questions that you do not want to answer.

Can I say "No"?

Being in this study is up to you. Either way, your decision won't affect your relationship with the school. Even if you decide to be in the study now, you can change your mind and stop at any time. If you decide to stop before the study is completed, contact one of the researchers. Tell the researcher/s that you no longer want to be in the study and give them your pseudonym. Your responses will be deleted from the transcript of the recording.

Are there any risks to me?

It is possible that someone could find out you were in this study or see your study information, but we believe this risk is small because of the procedures we use to protect your information. These procedures are described later in this form.

Are there any benefits to me?

We do not expect you to benefit from being in this study. Your participation may help us to learn more about secondary students' mathematics anxiety and how it affects students' enrollment in elective mathematics at the secondary level. We hope the knowledge gained from this study will benefit others in the future.

Who can use or see the information collected for this research study?

We will make every effort to prevent anyone who is not on the research team from knowing that you gave us information or what information came from you. However, other participants in the interview will know that you participated and hear your responses. We will ask all participants not to share any information about the interview, but we cannot guarantee that others will not share information from the interview. We will protect the confidentiality of your information by:

- Separating the audio from the video recording of the interview; destroying the video recording and using the audio recording to create a written transcript. Then we will destroy the audio file.
- Using a pseudonym (fake name) instead of your real name in the written transcript.
- Destroying any identifying images of you.
- Storing consent documents and drawing entries separately from the written transcript.
- Storing all data securely in locked filing cabinets in the researchers' offices, in password-protected computers, and stored in password-protected university-owned servers.

If information from this study is published or presented at scientific meetings, your name and other personal information will not be used.

Although it is unlikely, there are times when others may need to see the information, we collect about you. These include:

- People at the University of Tennessee, Knoxville who oversee research to make sure it is conducted properly.
- Government agencies (such as the Office for Human Research Protections in the U.S. Department of Health and Human Services), and others responsible for watching over the safety, effectiveness, and conduct of the research.
- If a law or court requires us to share the information, we would have to follow that law or final court ruling.

What will happen with the information collected for this study?

If you agree to allow your information from the interview to be used in the pilot research study , we will assign you a pseudonym instead of your name on all of the materials before we begin analyzing them for the pilot research study. Your information will not be used or shared with other researchers for future research, even if identifiers are removed.

Will I be paid for being in this research study?

You will be given a $ 35 gift certificate for a large retailer (such as Amazon).

Who can answer my questions about this research study?

If you have questions or concerns about this study, or have experienced a research related problem or injury, contact one of the researchers:

- Frances K. Harper, **francesharper@utk.edu**, 865-974-4040 (English only)
- Indrani Singh, isingh3@vols.utk.edu, 865-583-9738 (English and Hindi)

For questions or concerns about your rights or to speak with someone other than the research team about the study, please contact:
Institutional Review Board
The University of Tennessee, Knoxville
1534 White Avenue
Blount Hall, Room 408
Knoxville, TN 37996-1529
Phone: 865-974-7697
Email: utkirb@utk.edu

Voluntary Participation

It is completely up to you to decide to be in this pilot research study. Even if you decide to be part of the study now, you may change your mind at any time by contacting the researchers for discontinuing participation. You will not lose any services, benefits, or rights you would normally have if you chose not to volunteer, or if you change your mind and stop being in the study later. If you do not wish to be in the research, it is not necessary to do anything, as we cannot use your materials without your consent.

Consent

I have read this form, been given the chance to ask questions and have my questions answered. If I have more questions, I have been told who to contact. By signing this document, I am agreeing to be in this study. I can print or save a copy of this consent information for future reference.

Participant's Name (printed) ____

Participant's Signature ____________________________________ Date ______________

Consent for Use of Videorecording

I agree that videorecording of me from pilot research study on mathematics anxiety may be analyzed for research purposes.

Participant's Signature ________________________________ Date ______________

VITA

Indrani Singh is a native of India. She received two graduate degrees, BA in Academic Law in 1991 from Mangalore University and BA in Education in 1994 from Annamalai University in India. She completed her Master's in English from Annamalai University in 2007. Her experience as an educator in K-12 schools spans over twenty-seven years in India. She served as a high school geography teacher at Dakshin Bharat Mahila Samaj from 1994 to 2007, followed by a K-12 school Principal from 2007 to 2019. With her extensive experience in education and as a parent, she realized that mathematics anxiety is a serious issue that needs thorough investigation. A burning desire for higher studies brought her to the University of Tennessee in Knoxville in 2019 for Ph.D. in Teacher Education. Her research interests focus on mathematics anxiety of secondary students and avoidance behaviors impacting secondary mathematics enrollment. Post Ph.D., she intends to disseminate the findings of her research through designing assessment tools and professional development programs for teachers, engaging in academic publications, and conducting workshops in educational institutions. She hopes to move forward in her life and work towards seeing an increase in enrollment in secondary mathematics and promote awareness among the students of the relevance of mathematics in their lives.