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LONG ABSTRACT

**The Effects of Real-World Contexts and Emotional
Support in Geometry Instruction on Mathematical
Anxiety, Self-Efficacy, and Achievement
Among Students in Grades 5-6**

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List of Published Papers

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2. Polacco, D. (2024). Development and pilot testing of an intervention program for teaching geometry with emotional support. *PedActa*², 14(2), 1–10. <https://doi.org/10.24193/PedActa.14.2.1>
3. Polacco, D., & Zsoldos-Marchis, I. (2025). Evaluating the effectiveness of a geometry intervention program through student insights. *Education 21*³, (30), 100–111. <https://doi.org/10.24193/ed21.2025.30.08>
4. Polacco, D. (2025). Teachers' opinion about the effectiveness of a geometry intervention program integrating emotional support. *Acta Didactica Napocensia*¹, 18(1), 114–129. <https://doi.org/10.24193/adn.18.1.10>

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Abstract

Many students around the world struggle with mathematics achievement, particularly in the domain of geometry, which remains a persistent challenge in numerous educational systems. This issue is especially critical during the upper elementary years, a key developmental stage when students' academic self-concept and learning habits are still forming. In response to this need, the present study explores the use of emotional support tools aimed at improving mathematical performance, self-efficacy, and decreasing math anxiety among students in grades 5 and 6. The research focuses on fostering a supportive learning environment that promotes autonomy, motivation, and success in mathematics through developmentally appropriate strategies. A mixed methods approach was employed, combining quantitative and qualitative data to evaluate the effectiveness of a targeted intervention program. This thesis contributes to the field by offering an innovative model for early, emotionally supportive geometry instruction, addressing both cognitive and affective barriers to learning.

Keywords: Math Anxiety, Self-Efficacy, Teaching Geometry, Mathematics Achievement, Intervention Program

Introduction

Mathematics education is a key part of education systems worldwide, shaping countries' economic, social, and cultural development (Cresswell & Speelman, 2020; Foley et al., 2017; Hembree, 1990). Beyond academic achievement, it fosters logical thinking and problem-solving skills useful in everyday life (Ayuso et al., 2021; Falco & Summers, 2021). Despite considerable investment in quality math programs, many studies report no significant gains in student performance (Kazmagambet et al., 2020; Goldan et al., 2022; Nikolić et al., 2019). Geometry, in particular, presents unique mental challenges involving spatial skills and logical reasoning. International tests like PISA and TIMSS often hide geometry-specific issues by combining results with other math areas. Consistently, findings show lower scores in geometry compared to arithmetic or algebra, with countries like Mexico, the Philippines, South Africa, Jordan, and Lebanon scoring particularly low (Mullis, 2020). Similar trends are seen in Israel, France, Italy, and the United States (OECD, 2022), reflecting the difficulty of teaching and learning geometry (Fouze & Amit, 2021).

TIMSS and PISA results reveal ongoing struggles in geometry, including recognizing shapes after transformations such as rotations or reflections (Chen et al., 2021; Van Hiele-Geldof & Van Hiele, 1984) and measuring areas—skills expected at earlier grade levels (Mullis, 2019). These issues emphasize the need for targeted support, as national and global assessments regularly show below-average math achievement in countries like the USA, Israel, and Romania (OECD, 2012, 2019; RAMA). The urgency is heightened by the worldwide educational disruptions caused by COVID-19, which resulted in significant learning setbacks and decreased emotional support for students (UNESCO, 2022; Benner et al., 2024). Extended school closures have worsened academic gaps and emotional stress among young learners, increasing the demand for programs addressing both cognitive and emotional needs.

In Israel, these academic problems intersect with deep national trauma. The terrorist attacks on October 7, 2023, caused massive destruction, loss of life, and psychological trauma, further increasing anxiety among students (Hasson-Ohayon & Horesh, 2024; Levi-Belz et al., 2024; Sagi & Gilat, 2024). In a society already shaped by historical and ongoing security tensions, such events have further heightened emotional strain, especially for children directly or indirectly affected. This study responds to these

challenges by incorporating emotional resilience strategies into math education, aiming to improve math skills while supporting students' well-being. By linking emotional and academic learning, the program gives 5th–6th graders tools to manage anxiety, build confidence, and develop resilience (Allbright et al., 2019; Dugre, 2019; McCormick et al., 2021). This comprehensive approach addresses the urgent need for innovative solutions that promote both academic achievement and personal growth amid ongoing global and local difficulties.

OECD⁴ (Organization for Economic Co-operation and Development), published by PISA (Program for International Student Assessment). Specific areas of geometry that emerged from the TIMSS⁵ and PISA tests were also identified that one key challenge is identifying and relating geometric shapes, especially when presented with unusual transformations such as rotations or reflections. Students often struggle in these cases because the given polygons appear in atypical orientations, making it difficult to identify their basic properties (Chen et al., 2021; Van Hiele-Geldof & Van Hiele, 1984). International and national assessments, such as OECD, RAMA⁶ (National Authority for Measurement and Evaluation in Education), and TIMSS⁷ (Mullis, 2019), consistently show below-average mathematics achievement in countries such as the United States, Israel, and Romania (OECD, 2012, 2019; RAMA).

The urgency is heightened by global educational disruptions caused by the COVID-19 pandemic, which have led to significant learning losses and reduced emotional support for students (UNESCO, 2022; Benner et al., 2024). Prolonged school closures have

⁴ OECD (Organization for Economic Co-operation and Development)- The OECD is an international organization that promotes policies to improve the economic and social well-being of people worldwide. One of the OECD's key initiatives in education is the Program for International Student Assessment (PISA), which evaluates education systems worldwide by testing the skills and knowledge of 15-year-old students. More details about Mathematics achievements in OECD countries in 2015, 2018 in "1.3 Achievement in Mathematics "subchapter.

⁵ TIMSS is an international assessment that measures trends in mathematics and science achievement at the fourth and eighth grades

⁶ RAMA is the "Israeli National Authority for Measurement and Evaluation in Education" (National Authority for Measurement and Evaluation in Education). RAMA is responsible for carrying out national assessments and evaluations in the education system in Israel. Provides important data on the performance of Israeli students in subjects such as mathematics, helping to identify areas that need improvement and to evaluate the effectiveness of educational interventions.

⁷ The breakdown of mathematical achievements according to TIMSS in "1.3 Achievement in Mathematics " subchapter.

exacerbated academic gaps and emotional distress among young learners, increasing the demand for programs that address both cognitive and emotional needs.

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Problem Statement

Low achievement in mathematics among elementary school students is a global concern, driven primarily by math anxiety and low self-efficacy, which create a persistent cycle of avoidance and poor performance (Ay Emanet & Kezer, 2021; Bandura, 1977; Hembree, 1990). Despite numerous educational reforms and programs, current curricula often ignore the emotional barriers that hinder learning, especially for students in grades 5-6 (Danuri et al., 2023; Pellizzoni et al., 2022). Research suggests a strong link between students' self-concept and academic achievement, with emotional struggles exacerbating academic deficits (Marsh, 2022; Nilsen et al., 2022). The COVID-19 pandemic and ongoing global crises have further deepened academic gaps and emotional distress among young learners (Benner et al., 2024; Moore et al., 2022; Gilet, 2024). Although initiatives such as social-emotional learning (SEL) and STEM have shown potential, their impact on mathematics achievement has been limited due to inadequate training and structural challenges in implementation (Kazmagambet et al., 2020; McCormick et al., 2021).

Elementary schools often lack the tools to identify and support students with math anxiety and low self-efficacy. This study presents an intervention program that integrates emotional support into math instruction to improve achievement and promote emotional balance.

The study, which focuses on low performance in geometry among students ages 10-12, addresses the early onset of math anxiety and self-efficacy issues that lead to avoidance and underachievement. According to Eriksson, this developmental stage is critical for building self-efficacy, as delays can worsen the problem over time (ERIKSON). The additional impact of the COVID-19 pandemic and ongoing security challenges further underscores the need for emotional support in education (Sagi & Gilat, 2024). By identifying these challenges and filling existing knowledge gaps, which will be expanded upon below. The study aims to develop an effective program to improve mathematics achievement in geometry for upper elementary school students.

Gaps in Knowledge

Algebra and geometry are core components of mathematics and critical predictors of academic and professional success (Hembree, 1990). However, research has predominantly focused on arithmetic-related cognitive skills, leaving a notable gap in understanding the specific skills and emotional factors that influence success in geometry, particularly in grades 5 and 6 (Spiller et al., 2023; West, 2021; White, 2022). International assessments such as OECD-PISA, TIMSS, and RAMA consistently show lower performance in geometry compared to other mathematical domains (Mullis et al., 2021; OECD, 2019; RAMA, 2022), likely due to geometry's reliance on spatial and visual reasoning rather than procedural thinking (Nicoloff, 2019; Živković et al., 2023). Despite the implementation of various educational programs, improvements in math achievement remain minimal, pointing to the need for targeted interventions (Kazmagambet et al., 2020). Furthermore, while math anxiety has been extensively studied among older students, the researcher found few studies that paid attention to its impact on younger learners in the context of geometry, where the cognitive demands are significantly different (Huang, 2021; Wahyuni et al., 2024). This study addresses these gaps by developing an intervention program that implements emotional support tools in geometry teaching to fifth and sixth graders. Data from this study revealed that 30% of the 146 participating students exhibited low self-efficacy, as measured by pre- and post-intervention questionnaires,

aligning with findings from similar research (Commodari & La Rosa, 2021; Forsblom et al., 2022; Živković et al., 2022). This study takes a comprehensive approach to understanding the connection between geometry learning, math anxiety, and self-efficacy in young students. Guided by the literature and identified knowledge gaps, it was structured in four research phases, each aimed at improving math achievement, boosting self-efficacy, and reducing math anxiety among 5th–6th graders. Each step was critical in building a comprehensive understanding of the problem and providing solutions, filling the existing knowledge gaps highlighted in the literature review chapter.

Research Aims

This study was developed using a well-structured approach that was based on the review of literature and on the identified gaps. To achieve its optimal goal, the study was designed with four research stages, each of which contributes to improving mathematics achievement, improving self-efficacy, and reducing mathematics anxiety among fifth and sixth grade students. The four stages of the study are: (1) Development of a mathematics teacher survey on mathematics anxiety, (2) A pilot study to test the intervention program, (3) Implementation of the main intervention to evaluate its effect on student achievement, self-efficacy, and math anxiety, and (4) A qualitative study involving student portfolios and interviews to assess students’ personal and academic development. Each stage was critical in building a comprehensive understanding of the problem and providing solutions, in an attempt to fill the existing knowledge gaps raised in the literature review chapter. Each of the four research objectives corresponds to a specific stage of the study.

Table 1: Research Aims

Aim	Description
A1	Investigate teachers’ knowledge and experience with students’ mathematical anxiety.
A2	Develop a geometry intervention plan to reduce anxiety, improve self-efficacy, and increase achievement.
A3	Test the effects of the intervention plan on students’ mathematical outcomes.
A4	Explore the opinions of participating students and teachers about the intervention.

The thesis has 6 chapters. Chapter 1 focuses on the theories behind the research presented in the thesis, and the literature review provides its background. Chapter 2-5 present the studies conducted during the doctoral research, as follows:

Chapter 2 presents a survey study on mathematics teachers' knowledge and experiences with math anxiety, as well as their practices for helping students reduce this anxiety.

Chapter 3 describes the development and pilot testing of the geometry intervention program. The first subchapter details the intervention program's content and the theoretical foundations that guided its design. The second subchapter presents an experimental study conducted to pilot test the intervention program, which informed revisions made for the subsequent extended experiment.

Chapter 4 reports on the evaluation of the intervention program's effectiveness in reducing math anxiety and improving students' self-efficacy and mathematical achievement. Furthermore, Chapter 5 presents a qualitative study that explores students' and teachers' perspectives on the intervention program, including an analysis of student portfolios produced during the intervention.

Chapter 6 provides a summary of the thesis and presents the conclusions drawn from the research.

Chapter 1. Theories and Literature Review

This study is based on a comprehensive theoretical framework that integrates psychology, education, and mathematics to design an intervention program for fifth- and sixth-grade students, aiming to improve math achievement, reduce anxiety, and strengthen self-efficacy. A review of programs in Israel and worldwide showed that while many address either academic or emotional aspects, few combine them. To fill this gap, the study developed a holistic program grounded in positive psychology (Seligman et al., 1998; Carr et al., 2021), positive pedagogy, social-emotional learning (SEL), and Van Hiele's geometric thinking theory, emphasizing resilience, emotional balance, and cognitive growth. The program applies tools such as positive feedback, reflective journaling, achievement tests, and learning portfolios to foster persistence, metacognition, and meaningful progress (Gander et al., 2017; Mitsea et al., 2022; Moon, 2013; Veenman et al., 2006; Carr et al., 2021; Smith, 2018; Long et al., 2022). This integration of theory and practice enables students and teachers to enhance mathematical understanding while reducing anxiety and supporting long-term development.

1.1 Theoretical Insights from Psychology, Education, and Mathematics

This research is grounded in a comprehensive theoretical framework integrating insights from psychology, education, and mathematics to design an intervention for fifth- and sixth-grade students that enhances achievement, reduces math anxiety, and strengthens self-efficacy. A review of existing programs in Israel and worldwide revealed that while many initiatives focus on either academic or emotional outcomes, few integrate the two. To address this gap, the study incorporates four main theories: positive psychology (Seligman et al., 1998; Carr et al., 2021), positive pedagogy (O'Brien & Blue, 2018; Szerencses & Landai, 2019), social-emotional learning (CASEL, 2020; Durlak et al., 2011), and Van Hiele's geometric thinking theory (Van Hiele, 1984; Alex & Mammen, 2018). Together, these frameworks emphasize resilience, emotional balance, self-efficacy, and cognitive growth as foundations for learning.

Drawing on positive psychology and positive pedagogy, the program promotes persistence, self-belief, and well-being through strategies such as positive feedback and recognition of effort, shown to build motivation and growth mindsets (Gander et al., 2017; Mitsea et al., 2022; Waters et al., 2022). Reflective documentation, rooted in Kolb's

experiential learning (1984), fosters metacognition and ownership of learning (Moon, 2013; Veenman et al., 2006; Smith, 2018). Success tests and portfolios provide ongoing formative assessment and encourage students to value personal progress, supporting both self-efficacy and achievement (Carr et al., 2021; Long et al., 2022).

The SEL framework (CASEL, 2019; Jones et al., 2019) contributes by cultivating skills such as self-awareness, self-management, and responsible decision-making, which reduce math anxiety and improve focus (Kamour & Altakhayneh, 2021). Finally, Van Hiele's theory of geometric thinking ensures instruction aligns with students' developmental levels, promoting meaningful and transferable mathematical understanding (Zhu et al., 2023; Korthagen & Lagerwerf, 1995). By combining these theories, the intervention creates a structured yet flexible environment in which students develop academic skills alongside emotional and cognitive tools, supporting long-term resilience, achievement, and growth.

1.2 Mathematics Instruction

The current study addresses challenges in mathematics education, with a focus on geometry, an area where international and national assessments (TIMSS, OECD, RAMA) reveal persistent difficulties (Mullis et al., 2023; OECD, 2012, 2019; RAMA, 2022). Mathematics plays a central role in shaping cognitive, social, and economic development (Cresswell & Speelman, 2020; Foley et al., 2017; Hembree, 1990), fostering logical thinking and problem-solving skills essential for everyday life (Ayuso et al., 2021; Falco & Summers, 2021). Despite investments in Israel and globally, improvements in achievement—particularly in geometry—remain limited (Kazmagambet et al., 2020; Goldan et al., 2022; Nikolić et al., 2019).

Geometry is distinct from calculus, as it requires spatial reasoning, visualization, and logical thinking, cultivated through gradual, structured instruction. Van Hiele's theory highlights the need for teaching approaches that align with students' cognitive development. Yet, international studies continue to show underperformance in this field (OECD, 2019; TIMSS, 2019; RAMA, 2022). These findings underscore the urgency of developing effective interventions to improve geometry learning, strengthen achievement, and support broader mathematical growth.

1.3 Achievement in Mathematics

Mathematics education is a cornerstone of national development, influencing economic, social, and cultural progress, and its success hinges not only on knowledge acquisition but also on the ability to apply concepts in real-world contexts (Cresswell & Speelman, 2020; Foley et al., 2017; Hembree, 1990; Ayuso et al., 2021; Falco & Summers, 2021). However, persistent underachievement in mathematics, particularly in geometry, remains a global concern, as evidenced by international assessments such as PISA and TIMSS, and national assessments like Israel's RAMA. These evaluations consistently reveal below-average performance in mathematics across many countries, including Israel and the USA. For example, in PISA 2018, Israel scored 463 in mathematics compared to the OECD average of 489, while in TIMSS 2019, Israeli students scored 531 (Grade 4) and 519 (Grade 8), below top-performing countries like Singapore and Korea. Geometry, a crucial and challenging domain within mathematics, emerged as a particularly weak area, with students scoring lower on geometry-related questions than on other topics in both PISA and TIMSS. RAMA assessments in Israel further confirm these findings, showing lower scores in geometry than overall math scores for both fifth and eighth graders (RAMA, 2022). Despite significant educational investments, these trends suggest that traditional methods have not led to substantial improvements. This study addresses these challenges by proposing a comprehensive intervention that uses emotional tools to enhance mathematical achievement, particularly in geometry. Inspired by successful educational models from high-performing countries, the program emphasizes foundational math skills, collaborative and experiential learning, and ongoing formative assessments, including short success tests at the end of each lesson, to promote a sequence of positive learning experiences and break the cycle of failure (Mikołajewska, 2021).

1.4 Integration of Mathematics in Everyday Life

1.4.1 Real-World Approaches to Mathematics Instruction

Given the persistent gaps in mathematics achievement documented in both international and national assessments, there is a need for intervention programs that foster meaningful and relevant learning experiences in mathematics, particularly in geometry. Various approaches have been developed to address this challenge by connecting mathematics to real-life contexts and interdisciplinary learning. Realistic Mathematics

Education (RME) emphasizes experiential problem-solving in everyday situations, improving motivation and knowledge retention (Freudenthal, 1971; Juandi et al., 2022; Listiawati et al., 2023; Zsoldos-Marchis, 2019). Research demonstrates that RME enhances problem-solving and attitudes toward mathematics, though challenges remain in teacher training and curriculum integration (Khanh et al., 2021; Yuanita et al., 2018; Mariana et al., 2021). Applied mathematics approaches, similarly, show positive effects on student engagement and achievement, particularly when aligned with students' interests and everyday experiences (London, 2022; Asli & Zsoldos-Marchis, 2021, 2023a, 2023b).

In parallel, STEM programs integrate science, technology, engineering, and mathematics to cultivate innovation, problem-solving, and critical thinking, while addressing gender gaps in self-efficacy and test anxiety (Ayuso et al., 2021; Ozkizilcik & Cebesoy, 2024). Other influential models include Everyday Mathematics, grounded in constructivist learning with proven though mixed results (Vaden-Kiernan et al., 2015; Isaacs et al., 2001; Kar et al., 2018), and the Singapore method, which emphasizes mastery, deep conceptual understanding, and progression from concrete to abstract learning (Lindorff et al., 2019; Cuasapud Morochó et al., 2023). Insights from these diverse frameworks highlight the pivotal role of teachers in fostering motivation, self-regulation, and resilience (Raikhelgauz, 2022). Drawing on the strengths and limitations of these models provides essential principles for designing effective programs that improve mathematical achievement, strengthen self-efficacy, and reduce math anxiety.

1.4.2 Games, Visual Elements, and Creative Activities

Games, movement, and visual elements enhance students' engagement and create active learning experiences that foster interest and participation. Mental exercises and games are recognized for improving knowledge retrieval, cognitive skills, and positive learning experiences (Zsoldos-Marchis, 2020; Branei et al., 2019). While their integration poses challenges such as time management, they deepen knowledge and support students' sense of success. Visual literacy, defined as the ability to interpret and understand visual information (Dondis, 1973), also plays a key role. Tools such as diagrams, charts, and illustrations help translate mathematical concepts into images, promoting meaningful learning, reducing negative emotions, and strengthening logical thinking and communication skills (Botha et al., 2019; Brackett, 2022; Eutsler, 2021; Katranci & Şengül, 2019). Additional strategies, including body movement, computer-based

visualizations, and creative drawing, further support comprehension (Synergy, 2002; Watzman, 1999). Gardner's (1987) theory of multiple intelligences emphasizes adapting instruction to diverse learning strengths, highlighting that students best absorb information through varied channels such as movement, music, language, and interpersonal interaction (Gardner, 1987; Prasetyawan & Gunawan, 2020; Dias et al., 2021; White & McCoy, 2019). Integrating experiential learning and multiple intelligences in geometry creates inclusive, diverse, and personalized learning environments that strengthen students' competence, enjoyment, and resilience, while reducing negative attitudes and math anxiety (Carr et al., 2021; Laakso et al., 2022). This is especially important given the prevalence of emotional challenges that students face, such as math anxiety, discussed in the next section, which often stems from their experiences of repeated failure and a lack of confidence. Providing students with meaningful and successful learning experiences can reduce anxiety and improve overall academic achievement (Carr et al., 2021; Laakso et al., 2022). This is especially important given the prevalence of emotional challenges that students face, such as math anxiety, discussed in the next section, which often stems from their experiences of repeated failure and a lack of confidence. Providing students with meaningful and successful learning experiences can reduce anxiety and improve overall academic achievement (Carr et al., 2021; Laakso et al., 2022).

1.5 Mathematics Anxiety

Mathematics often serves as a source of anxiety for many students, with mathematics anxiety recognized as a significant barrier to learning and achievement. It is distinct from general or academic anxiety, yet is considered a specific type of state anxiety that emerges in contexts related to learning or testing mathematics, sometimes appearing as early as elementary school when students transition from concrete to abstract thinking (Commodari & La Rosa, 2021; Živković et al., 2022). Research shows that math anxiety affects core cognitive processes such as working memory, attention, and information processing, leading to stress, avoidance, decreased performance, and even physiological symptoms such as increased heart rate, tension, or nausea (Ashcraft & Ridley, 2005; Chernoff & Stone, 2014). State, trait, and social anxiety are interconnected, with temporary emotional experiences significantly influencing students' anxiety levels (Pedro et al., 2024). Contributing factors include knowledge gaps, negative experiences, pressure from teachers and parents, and broader cultural or social attitudes toward mathematics (Ramirez

et al., 2013; Supekar, 2015). Teachers and parents play a critical role: rigid explanations or negative responses to mistakes can intensify anxiety, while adaptive instruction and emotional support can reduce it (Ng, 2012; Gresham, 2007). Math anxiety is also closely linked to low self-confidence, diminished self-concept, and reduced motivation, creating a cycle of avoidance, failure, and heightened anxiety (Hembree, 1990; Barroso et al., 2021). Gender differences present a complex picture: while girls in some cultural contexts report higher anxiety, other studies show no differences or even the opposite trend (Beilock & Willingham, 2014; González de San Román & de la Rica, 2021). Addressing math anxiety requires a multi-system approach involving teacher awareness, parental involvement, diverse pedagogical tools, and intervention programs that integrate emotional regulation, mindfulness, and positive education (Pizzie & Kraemer, 2017; Ergas et al., 2018). Such strategies provide students with positive learning experiences, strengthen self-efficacy and confidence, and reduce negative attitudes toward mathematics, especially when implemented at an early stage, such as in 5th and 6th grade.

Thus, math achievement is skewed for a variety of reasons, some of which can be attributed to math anxiety, test anxiety, or low self-efficacy. Addressing these issues with effective tools and strategies can help mitigate the negative effects of such anxiety and support students in reaching their full potential in math.

1.6 Self-efficacy in Mathematics

Understanding the emotional challenges students face in mathematics requires not only addressing math anxiety but also considering the critical role of self-efficacy, which influences motivation, persistence, and performance (Bandura, 1977; Abdullah, 2019; Luttenberger et al., 2018). Self-efficacy, defined as one's belief in the ability to succeed in specific tasks, is central to overcoming fear, reducing anxiety, and fostering academic achievement. Low self-efficacy often results in avoidance, decreased persistence, and heightened stress, while high self-efficacy promotes resilience, confidence, and long-term growth (Macmull & Ashkenazi, 2019; Mazzocco et al., 2018; Arens & Niepel, 2023). Bandura's social-cognitive theory emphasizes that self-efficacy is shaped by prior success, observation, and reinforcement, with self-regulation—planning, monitoring, and reflection—playing a central role (Bandura, 1986a, 1991, 1993). Academic self-efficacy, closely tied to academic self-concept, directly affects students' willingness to engage in challenging tasks and their eventual performance, while mathematical self-efficacy

specifically predicts confidence, persistence, and success in problem-solving (Marsh, 1998, 2005; Greenstein & Zhang, 2022; Commodari & La Rosa, 2021; Živković et al., 2023). Research shows that self-efficacy tends to decline between grades 4–12, especially after grade 6, highlighting the importance of early interventions that build on small successes and supportive feedback (West et al., 2020; Marsh, 2022). Within this framework, the current study incorporates tools such as portfolios and reflective practices to enhance self-regulation, self-confidence, and academic resilience, aligning with Bandura’s principles and positive psychology to reduce barriers and strengthen achievement in mathematics (Bandura, 1977, 1993; Bishara, 2018; Boyd & Ash, 2018).

From a pedagogical perspective, the ideal time to implement interventions is when students are in the fifth and sixth grades, as math anxiety and low self-efficacy tend to develop and intensify in the higher grades. With the tools detailed below, skills that students can continue to use later in school can be taught, and emotional problems related to geometry lessons can be eliminated or reduced.

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1.7 Emotional Aspects of Teaching Mathematics

Emotional aspects are often overlooked in mathematics teaching due to time constraints or limited teacher training, despite their critical role in academic success (Asli & Zsoldos-Marchis, 2021). Addressing students’ emotional development is essential for fostering engagement, resilience, and personal growth in mathematics. Mindfulness exercises, such as breathing techniques and guided imagery, help students focus, manage anxiety, and approach mathematical tasks with calm and confidence (Ergas, 2018). Reflective writing, based on Flavell’s metacognition theory (1979a, 1979b) and Kolb’s experiential learning cycle (1984), allows students to assess their emotional and cognitive progress, promoting self-awareness, deeper learning, and problem-solving skills (Boyd & Ash, 2018; Lindorff et al., 2019).

Positive psychology, as developed by Seligman (1998, 2005, 2009), emphasizes optimism, personal strengths, positive relationships, and achievement. Applying these

principles to education improves self-efficacy, hope, and motivation, while reducing anxiety and stress (Park & Peterson, 2008; Schiavon et al., 2020). Interventions that incorporate positive feedback, empowerment exercises, and reflective journaling help students identify their progress, overcome negative self-talk, and build resilience (Carr et al., 2021; Gander et al., 2017; Mitsea et al., 2022; Weare, 2020). Portfolios provide tangible evidence of growth, reinforce success, and foster motivation, while encouraging students to actively engage in both the academic and emotional aspects of learning (Long et al., 2022; Pecorari & Sutherland-Smith, 2021; Laakso et al., 2022).

By integrating mindfulness, reflective practice, positive psychology, and structured self-assessment tools, students develop a stronger sense of competence and emotional resilience, which supports both academic performance and personal growth in mathematics. Portfolios combine these elements by collecting students' academic and emotional work, allowing for reflection, tracking, and observation of improvement in achievement across lessons.

1.8 Key Concepts

This study explores the key concepts underpinning an intervention program designed to enhance mathematics achievement and self-efficacy among fifth- and sixth-grade students in Israeli elementary schools. The program integrates real-life mathematics instruction, experiential learning, educational games, Van Hiele's (1985) theory of geometric reasoning, and emotional support tools, addressing both cognitive and affective dimensions of learning. Student achievement was assessed using standardized tests, including RAMA, and benchmarked against international assessments such as PISA and TIMSS, which reveal generally low levels of proficiency in mathematics and geometric reasoning in Israel and globally (OECD, 2019; TIMSS, 2019; RAMA, 2022).

Teaching mathematics through everyday contexts, such as cooking, sports, or budgeting, was employed to enhance relevance, engagement, and understanding (Haigh, 2016; Nova & Putra, 2022; Freudenthal, 1971; Asli & Zsoldos-Marchis, 2023a).

Experiential learning principles (Kolb, 1984; Uyen et al., 2022) guided the design of activities that encourage reflection and knowledge transformation, while educational games promoted motivation, persistence, problem-solving, and cognitive development (Branay et al., 2019; Zsoldos-Marchis, 2020; Dias et al., 2021; White & McCoy, 2019; Zsoldos-Marchis & Hari, 2020; Zsoldos-Marchis & Juhász, 2020). Van Hiele's theory

supported the development of students’ geometric reasoning and spatial understanding (Van Hiele, 1985; Alex & Mammen, 2018; Korthagen & Lagerwerf, 1995).

The intervention also targeted affective factors, addressing math anxiety—a cognitive-emotional response that inhibits performance and participation (Ashcraft & Moore, 2009; Beilock, 2008; Caviola et al., 2022; Commodari & La Rosa, 2021)—and fostering self-efficacy, which influences learning behavior and achievement (Bandura, 1977b; Luttenberger et al., 2018; Rutherford et al., 2020; MARCH, 2022; MICROKOLA, 2020; Lei et al., 2022; Macmull & Ashkenazi, 2019). Emotional support tools, including mindfulness, guided imagery, goal-setting, and social-emotional learning, were incorporated to help students manage stress, enhance engagement, and support personal growth (Ergas, 2018; Dugre, 2019; Elias et al., 2019; McCormick et al., 2021). Positive psychology principles guided reflective practices, constructive feedback, and the development of persistence and emotional resilience (Seligman, 1998, 2019; Seligman et al., 2005, 2009; Carr et al., 2021).

Overall, this integrated framework fosters meaningful learning, emotional resilience, and enhanced mathematical achievement, creating a holistic approach to education that simultaneously addresses academic skills and socio-emotional development. The following section details the research methodology and the implementation of the intervention, grounded in the relationships among these key concepts and their influence on the study’s dependent and independent variables.

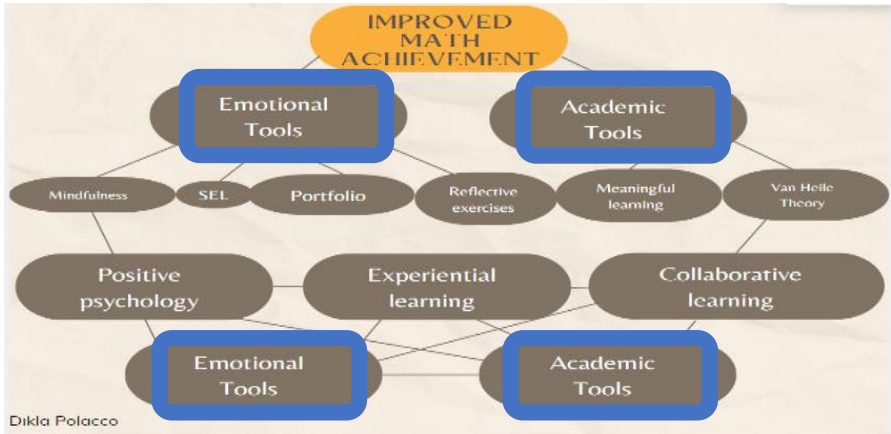


Figure 1: From the literature review to the development of an intervention plan

1.9 Methodology

The study, conducted in 2024 in an Israeli elementary school where the researcher teaches mathematics to grades 5-6, was designed to evaluate an intervention program

designed to improve students' mathematics achievement, strengthen self-efficacy, and reduce math anxiety.

The study consisted of four phases: (1) developing a survey for teachers to understand existing tools for dealing with learning barriers. (2) a pilot study to test and improve the intervention program. (3) The main study, which assessed the impact of the program through pre- and post-tests. (4) a qualitative study that included interviews and portfolio analysis to explore students' experiences and feelings, and a teacher's interview that served as a Case Study of teachers' experiences of the intervention program.

Following the Ryan and Barnard method, thematic analysis was used to analyze qualitative data. This structure allowed the study to combine statistical evaluation with rich personal narratives, ensuring a comprehensive understanding of the effects of the intervention on both academic achievement and emotional balance. The review of the research process, which contains four phases, created precision of the research objectives, questions, and hypotheses. The hypotheses were formulated to test the expected outcomes based on the theoretical underpinnings of the intervention. The alignment between the research process and the research questions and hypotheses created a response to the identified knowledge gaps and provided strong evidence to support its conclusions.

Table 2: Methodology

Phase	Research Aims	Research Questions	Hypotheses	Research Tools	Participants
Phase 1 Teacher Survey	To investigate teachers' perceptions, knowledge, and experience regarding math anxiety.	- Have teachers met students with math anxiety? - What symptoms and causes do they identify? - Are there differences based on teaching experience, grade level, or special training?	Teachers' knowledge of math anxiety is limited. - Tools are based on experience. - Knowledge is acquired mainly through teaching practice.	Teacher survey (developed by the researcher)	160 mathematics teachers
Phase 2 Pilot Study	To validate the intervention program using real-life contexts in	- What is the effect of the program on math anxiety, test anxiety, self-efficacy, and	Achievement will increase. - Self-efficacy will improve. - Math anxiety will decrease.	Pre- and post-tests -Semi-structured interviews, in-depth	22 students (pilot group) 7 student

	math instruction.	geometry achievement? - What activities should be updated in the intervention program?		interviews	
Phase 3	To examine the intervention's impact on academic performance, self-efficacy, and math anxiety.	- What is the effect on math anxiety, test anxiety, self-efficacy, and geometry achievement? - Are there gender-based differences?	Achievement will increase. - Self-efficacy will improve. - Math anxiety will decrease. - Girls will show more emotional difficulty despite similar abilities.	Pre- and post-tests Statistical analysis (t-tests, ANOVA)	146 students (5 th –6 th grade) 2 teachers teaching the program
Phase 4	To disclose students' and teachers' perceptions of the program and its personal and academic impact.	What are students' opinions on the effectiveness and enjoyment of the intervention How ?program does the intervention program influence students' learning outcomes, as evidenced in their portfolios What is ?portfolios the effect of the intervention program on students in teachers' perceptions What ?perceptions is the effect of the intervention program on ?teachers	Semi-structured interviews Student portfolios Thematic analysis	20 students (5 th –6 th grade) 2 teachers teaching the program	Phase 4 Qualitative Study

Chapter 2. Phase 1 - Teachers' Knowledge and Experience with Math Anxiety⁸

2.1 Introduction and Methodology

The first phase of the study focused on exploring teachers' perceptions of mathematics anxiety, including its recognition, symptoms, causes, and strategies for support. This phase aimed to answer six key research questions: whether teachers have encountered students with math anxiety; which symptoms they recognize; their beliefs about likely causes; and whether differences exist based on teaching experience, grade level, or specialized training in mathematics.

A mixed-methods approach was employed using a 40-item teacher questionnaire, including 35 items on the topic and five demographic items (Cronbach's $\alpha = 0.795$), distributed online through a national WhatsApp teacher group (983 members). A total of 160 mathematics teachers across Israel completed the survey, with the majority being active classroom teachers (96.9%), holding teaching qualifications (82.5%), and having over five years of experience (83.1%). Participants taught primarily grades 7–12 (59.4%) and grades 1–6 (37.5%), with a small proportion teaching both levels (3.1%).

Data collection and analysis provided insights into the prevalence, perceived causes, and manifestations of math anxiety as observed by teachers, and highlighted the impact of professional experience and training on teachers' recognition and management of student anxiety. The findings informed the design of subsequent phases of the intervention, particularly regarding teacher support strategies and the integration of emotional support tools in mathematics instruction.

2.2 Results and Discussion

The survey results revealed that the majority of teachers reported high self-perceived familiarity with math anxiety, with 86.9% indicating upper-level familiarity ($M = 3.93$, $SD = 0.78$). While teachers with mathematics qualifications or longer teaching experience reported slightly higher familiarity, differences were not statistically

⁸ The findings presented in this chapter were published in a peer-reviewed article co-authored by the doctoral student: Polacco, D., Zsoldos-Marchiş, I., and Dekel, R. (2023). Perspectives of teachers on the signs and causes of mathematics anxiety. *Acta Didactica Napocensia*, 16(2), 129–143.

significant, and no differences emerged between elementary and secondary educators. These findings suggest a widespread general awareness of math anxiety among teachers, independent of background characteristics.

Teachers commonly observed math anxiety in their students, manifested through physical symptoms (e.g., sweating, shaking), task avoidance, and premature disengagement. Interestingly, although teachers viewed math anxiety as prevalent school-wide, they reported fewer cases in their own classrooms, suggesting possible underrecognition (Calhoun, 2021). Secondary teachers more frequently noted both physical and behavioral signs, consistent with research indicating heightened anxiety in older students, particularly during the transition to secondary education (Erdem, 2017). Teachers' self-perceived familiarity positively correlated with symptom recognition, highlighting the importance of awareness for effective observation.

Regarding specific signs, teachers most frequently identified stress, frustration, and negative self-talk, while difficulties with attention and concentration were less often recognized. This aligns with literature indicating that math anxiety disrupts working memory and attentional control (Maloney & Beilock, 2012; Suárez-Pellicioni, 2016), though such symptoms may be underestimated by teachers. Elementary teachers reported noticing these signs more often, potentially reflecting closer daily interaction with students despite evidence that anxiety increases in later grades (Erdem, 2017).

Teachers attributed math anxiety primarily to parental influences, including parents' own math anxiety and attitudes toward mathematics, followed by evaluation methods and teacher attitudes to mistakes. In contrast, teachers' own anxiety and instructional methods were considered less influential, despite evidence of teachers' critical role in shaping students' emotional responses to mathematics (Foong, 1987; Hembree, 1990). Elementary teachers rated teacher anxiety as more significant than secondary teachers, consistent with research showing higher math anxiety among elementary educators (Chen, 2022). When asked to prioritize causes, teachers emphasized students' low self-efficacy (Hembree, 1990; Ma, 1999) and negative teacher attitudes toward mistakes, with parental anxiety less central, indicating a potential gap between general beliefs and classroom realities.

2.3 Conclusions

Teachers reported a generally high familiarity with math anxiety, with slightly higher levels among those with mathematics-teaching qualifications, more than five years of experience, or teaching in grades 7–12, though differences were not statistically significant. Despite this, teachers acknowledged the presence of students with math anxiety in their classrooms. Notably, secondary teachers observed significantly more cases of anxiety, particularly physical symptoms, compared to elementary teachers, while the most frequently reported signs overall were stress, frustration, and negative self-talk.

Regarding causes, teachers primarily attributed math anxiety to parental factors, such as parents' own anxiety and their attitudes toward their children's abilities. This reflects a lack of acknowledgment of teachers' own influence, despite evidence that parental anxiety strongly affects children's anxiety (Ashkenazi, 2019). The findings point to a need for greater professional reflection, accountability, and awareness among educators.

The results underscore the importance of addressing math anxiety systematically within teacher training and professional development. Equipping teachers with strategies to identify, prevent, and respond to math anxiety is essential across all grade levels. Failure to do so risks exacerbating existing gaps in achievement and emotional well-being. Based on these insights, an intervention plan was developed to support both teachers and students by fostering confidence, reducing anxiety, and improving mathematics learning outcomes.

Chapter 3. Phase 2 - Development and Pilot Testing of the Geometry Intervention Program

The teacher survey provided insights into how teachers perceive math anxiety and address it, which informed the design of the intervention program. The program aims to enhance self-efficacy, reduce math anxiety, and improve achievement by integrating mathematical instruction with everyday contexts and emotional support.

Grounded in Realistic Mathematics Education (RME), the program connects abstract concepts with real-life experiences to promote deeper understanding and engagement (Freudenthal, 1971; Juandi et al., 2022; Listiawati et al., 2023). By emphasizing relevance to daily life, the program fosters both academic progress and personal growth, underscoring the necessity of addressing emotional dimensions for academic success.

Through emotional support strategies and a supportive learning environment, students are encouraged to build confidence, reduce anxiety, and develop holistically. This integration of academic and emotional tools is intended to strengthen mathematical performance while contributing to broader personal development.

3.1 Developing the Geometry Intervention Program

3.1.1 Rationale of the Intervention Program

The geometry intervention program adopts a comprehensive approach integrating emotional support with academic learning. Grounded in principles of clarity, structure, and practicality, the program provides detailed lesson plans, user-friendly instructional materials, and clear tasks for both students and teachers, enhancing teachers' confidence and ensuring consistent implementation (Asli & Zsoldos-Marchis, 2023a, 2023b; Carless, 2004).

The program incorporates breathing exercises, reflective writing, and geometry tasks linked to students' real-world experiences, fostering self-efficacy, reducing math anxiety, and promoting engagement. Student portfolios document both academic and personal growth, enabling reflection and ownership of learning.

Aligned with the Israeli curriculum and international benchmarks (Luyten, 2017; Mullis et al., 2021; OECD, 2021), the program addresses both cognitive and emotional

dimensions, aiming to improve mathematical understanding, enhance self-efficacy, reduce anxiety, and increase achievement among fifth and sixth graders.

3.1.2 Goals of the Intervention Program

The program introduces students to emotional support tools in geometry lessons, helping them overcome negative beliefs about themselves and mathematics, evaluate their progress, and foster motivation for future success (Mikołajewska, 2021). It enhances achievement through structured activities, goal setting, and incremental tasks that build mastery and prepare students for assessments (Mikołajewska, 2021; OECD, 2012, 2019). Math anxiety is reduced by incorporating learning games, knowledge retrieval, mental development exercises, and mindfulness activities, creating a supportive and enjoyable learning environment (Zsoldos-Marchis, 2020). Self-efficacy is strengthened via reflective practices, empowering feedback, and personal responsibility strategies, enabling students to recognize their capability to manage academic tasks (Seligman, 2009; Bandura, 1977). Collectively, the program equips fifth- and sixth-grade students with cognitive and emotional tools to improve mathematical achievement and overcome academic and personal.

3.1.3 Participants

The intervention targeted 5th- and 6th-grade students (ages 10–12) in an Israeli elementary school, with 97 participants in total: 22 in the pilot phase (subchapter 3.2) and 75 in the main study (Chapter 4).

3.1.4 The Theories on Which the Program is Based

The intervention program is grounded in developmental theories that promote both academic and personal growth. Drawing on positive psychology and pedagogy (Seligman, 2009), it integrates positive feedback, mindfulness, and guided imagery to reduce math anxiety and remove learning barriers (Ergas et al., 2018; Mitsea et al., 2022; Weare, 2020). Social Emotional Learning (SEL) principles foster self-awareness, goal setting, and emotional regulation alongside mathematical skills (Allbright et al., 2019; McCormick et al., 2021).

Meaningful learning theory (Ausubel, 1968, 1980; Hewett, 1963; Muamanah, 2020) underpins the program's design, linking new knowledge to prior understanding and

promoting reflective practices to consolidate learning (Flavell, 1979; Hurtubise & Roman, 2014). Experiential learning (Kolb, 1984; Uyen et al., 2022) engages students in hands-on, context-relevant tasks, complemented by collaborative learning approaches (Vygotsky, 1978; Laal & Ghodsi, 2012; Maharani et al., 2020; Sathiya Priya & Shilaja, 2016) that enhance peer interaction, personal empowerment, and the reduction of math anxiety (Huang, 2021; Qomaria, 2021).

Geometric instruction is structured according to the Van Hiele model (Geldof & Van Hiele, 1984), emphasizing visual aids, hands-on experiences, and collaborative problem-solving to support spatial reasoning and geometric understanding (Alex & Mammen, 2018; Korthagen & Lagerwerf, 1995). Multiple intelligences theory (Gardner, 1987; Prasetyawan & Gunawan, 2020) informs the use of diverse activities, including artistic expression and interactive games, addressing individual learning preferences while reinforcing cognitive and emotional development (Dias et al., 2021; White & McCoy, 2019). Reflective documentation and assessments further strengthen student achievement and self-efficacy (Carr et al., 2021; Laakso et al., 2022).

3.1.5 Activities of the Intervention Program

The program incorporated a variety of activities to support emotional regulation, self-efficacy, and academic achievement. Breathing exercises and guided imagery, based on mindfulness and positive psychology, promoted emotional balance and prepared students for success. Students received feedback aimed at reinforcing learning and recognizing effort (Alic et al., 2022). Positive language and self-talk practices encouraged students to replace negative thoughts with empowering statements, supported by reflective writing and teacher feedback, fostering resilience and reducing math anxiety (Ergas et al., 2018; Mitsea et al., 2022; Weare, 2020).

Reflective writing exercises enhanced metacognitive awareness, allowing students to monitor their learning processes and track progress (Flavell, 1979a, 1979b), while achievement tests measured both academic and personal growth (Long et al., 2022; Pecorari & Sutherland-Smith, 2021). Geometric tasks were contextualized in everyday situations, linking abstract concepts to students' real-world experiences (Haigh, 2016; Nova & Putra, 2022). Learning games, creative projects, and interactive activities increased motivation, engagement, and conceptual understanding (Dias et al., 2021; White & McCoy, 2019; Zsoldos-Marchis & Hari, 2020; Zsoldos-Marchis & Juhász, 2020).

All tasks and reflections were compiled in student portfolios, allowing learners to document and evaluate their progress, consistent with practices observed in successful international programs such as the Singapore method (Boyd & Ash, 2018; Lindorff et al., 2019; Naranjo et al., 2020).

3.1.6 Geometry lesson plans for the Intervention Program

Both the experimental and control groups received two geometry lessons per week, aligned with the Chief Scientist's guidelines and the Israeli Ministry of Education curriculum, covering topics such as parallel and perpendicular lines, angles, properties of prisms and quadrilaterals, diagonals, classification of triangles, and calculations of area and perimeter. In the experimental group, each lesson incorporated the specially designed intervention program, including breathing exercises, mathematical activities, reflective writing, and feedback (See Appendix 7 in the thesis). The intervention was delivered over 15 lessons, after which instruction resumed following the standard geometry curriculum.

Table 3: Summary of intervention plan activities

Elements	Lesson No. 1	Lesson No. 2	Lesson No. 3	Lesson No. 4	Lesson No. 5
Mathematical Topic	Parallel Lines	Angle Detection	Area Calculations	Features of the squares	Diagonal in a square
Main Purpose	Knowing the strengths, the students will identify their strengths and understand how important and correct it is to develop them.	Guided Imagery – Techniques for Emotional Regulation and Control of Negative Thoughts +Use talking presentations.	Mindfulness- The students will be exposed to the experience of calculating areas in their surroundings.	Empowerment Sentences The students will acquire tools for coping with the academic or emotional difficulty that arises in the lesson.	The students will be exposed to educational goals and create personal and academic goals.
Using Tools	Strengths Questionnaire A page containing all the topics of the journey – my progress page.	Techniques for Emotional Regulation and Control of Negative Thoughts, with the Help of Speaking Presentations in Each Lesson	Deep Breathing Technique and Concentration and Control of Breathing and Not Thought	Empowerment Phrases for Later Success – Using Mobile Recording	S.M.A.R.T. - My Mathematical Goals- What are academic successes? What do I need to do to succeed? What strengths will help me build a goal?
Activity	Distributing the progress track sheet and a strengths questionnaire. Using colors for the path of progress in each lesson.	Guided Imagery Practice	Initial breathing practice and variation in each lesson	Memorization of sentences, empowerment, and variety, reflective writing in each lesson	Writing Personal and Academic Goals

Elements	Lesson No. 6	Lesson No. 7	Lesson No. 8	Lesson No. 9	Lesson No. 10
Mathematical Topic	Parallel sides and lines	Angle Calculations	Sorting Triangles	Features of the squares	Summary of the properties of the squares
Main Purpose	Identifying sides, lines, and basic concepts – students will delve into the definitions using written transmission into their simple and understandable language.	The students' angles used their bodies to identify and develop and improve ranges of motion.	Sorting triangles according to angles and sides The students will delve deeper and identify triangles in the various transformations.	The characteristics of the squares – the students will be visually familiar with the different squares and the use of their features in everyday life.	From features to squares Students used geometric knowledge to describe everyday objects in a variety of situations and contexts.
Using Tools	Visual – Experiential Learning	Tangible Visual – Experiential Learning	Virtual Lesson with a Bot	Movement and Sound Collaborative Learning	Building a test by the students
Activity	Identifying Concepts, Visual Applications, and The Relationship between Art and Mathematics	Online Games, the Connection between Sporting Activity and Mathematics	Online activity by a bot – collaborative learning with friends without a teacher.	Using movement and music for the quadruple properties	Creating a test by the students with the answer sheets they created. Preparing a test by students to relieve anxiety

Elements	Lesson no. 11	Lesson No. 12	Lesson no. 13	Lesson no. 14	Lesson no. 15
Mathematical Topic	Measuring Length	Square area and circumference	Features of the prism	Areas	Final Test
Main Purpose	Measurements of the length of the students will construct the meaning of the measurements and their use.	The area and scope of the students will be concretely familiar with the measurements and their use in daily life.	The characteristics of the prism – the students will develop critical thinking about the characteristics of the various prism bodies.	- Square Area Reminder and Finding Surface Area of the Body. The students will be arrogant in planning according to measurements.	The students will apply their confidence in themselves and their abilities when taking an assessment test, and they will also justify the use of tools that promote their learning to their peers. Test – reflective writing on the summary of the process. Summary of the Journey of Success – A summary of an educational and personal journey. Dealing with tests, and how to maintain the successes later on. Comments, clarifications, and successes.
Using Tools	tangible, shoe measurement, height and more.	Visual Planning with an app	Prism app and presentation	Visual App	
Activity	Measurements in daily life, continuing to practice breathing, and checking the improvement of emotional practice.	Continuing Reflective Writing – Testing Improving Self-Abilities for Reflective Writing	3D Creation – Experiential and Experiential Learning	Creating a room with real data, experiential learning	

3.1.7 Uniqueness

The intervention program is distinguished by its innovative integration of emotional support and cognitive strategies in geometry lessons, targeting 5th- and 6th-grade students (10–12 years old). Geometry was selected due to its unique cognitive demands, including spatial reasoning and abstract thinking (Juandi et al., 2022). The program addresses math anxiety by providing tools and strategies that align with students' learning preferences, incorporating games, movement, music, visual and verbal aids, and mindfulness exercises, creating a supportive and engaging environment (Foley et al., 2017; Ayuso et al., 2021; Zsoldos-Marchis, 2020).

Lessons are designed to be meaningful and relevant to students' daily experiences, fostering deeper engagement, self-efficacy, and positive attitudes toward mathematics (Ausubel, 1968, 1980; Erikson, 1982). Reflective practices, including daily self-assessment and portfolio documentation, promote metacognition and growth mindset (Boyd & Ash, 2018; Flavell, 1979a; Lindorff et al., 2019; Naranjo et al., 2020). Integrating emotional support with academic instruction enables students to overcome negative beliefs, develop resilience, and improve achievement in geometry, addressing a gap identified in international studies on mathematics performance (Mullis et al., 2021; OECD, 2023; White et al., 2019).

The program complements the standard curriculum while providing teachers with detailed lesson plans and practical tools, enhancing their professional development and confidence in teaching mathematics (Asli & Zsoldos-Marchis, 2023b). By combining cognitive, emotional, and reflective components, the intervention promotes long-term improvements in mathematical understanding, emotional regulation, and personal growth, laying the foundation for broader implementation and sustained student success.

3.2 Pilot Testing of the Intervention Program⁹

3.2.1 Introduction

An experimental pilot study with 22 students examined the feasibility and effectiveness of the initial intervention program in enhancing geometry achievement, reducing math anxiety, and improving self-efficacy. Findings from this phase informed the development of the final program, which integrated emotional support tools into geometry instruction to promote both academic performance and emotional regulation (Polacco, 2024).

3.2.2 Methodology

The study, conducted in 2023, aimed to evaluate the feasibility and effectiveness of a geometry intervention program integrating emotional support to improve students' mathematics anxiety, self-efficacy, and achievement, while refining program activities for future implementation. The research addressed five questions: the impact of the program on students' math anxiety, test anxiety, self-efficacy, geometry achievement, and necessary adjustments to program activities.

Participants included 22 female sixth-grade students (aged 11–12) from a single class at "Shaphir" Elementary School, Israel. A mixed-methods approach was employed, combining quantitative assessments with qualitative interviews. Quantitative instruments included standardized geometry and arithmetic tests (RAMA, Israeli Ministry of Education), the General Self-Efficacy Scale (Schwarzer & Jerusalem, 2014), Academic Self-Efficacy Scale (Schechter & Jerusalem, 1995), adapted geometry-specific self-efficacy items, the Abbreviated Math Anxiety Scale (AMAS; Hopko, 2003) translated via back-translation, and the State-Trait Anxiety Inventory (STAI; Spielberger et al., 1970). Qualitative data were collected through semi-structured interviews to explore students' perceptions of the program's impact (See Appendices 1–5 in the thesis).

The pilot procedure involved pre- and post-intervention assessments to establish baseline and follow-up measures of academic achievement and emotional responses. The intervention integrated geometry tasks with emotional support activities, including

⁹ The findings presented in this subchapter were published in a peer-reviewed article authored by the doctoral student: Polacco, D. (2024). Development and pilot testing of an intervention program for teaching geometry with emotional support. *PedActa*, 14(2), 1–10.

breathing exercises, reflective writing, guided imagery, feedback, and positive self-talk, fostering both academic skills and personal development. Data analysis employed descriptive and inferential statistics, with t-tests and Pearson correlations evaluating changes across geometry achievement, self-efficacy, and anxiety measures. Reliability and validity of the scales were confirmed through Cronbach's alpha and inter-scale correlations. Qualitative interview data were thematically analyzed to identify perceived strengths and areas for refinement.

Findings from the pilot informed revisions to the intervention, enhancing lesson clarity, structure, and effectiveness. This methodology enabled a rigorous evaluation of the program's impact on both academic performance and emotional development, establishing its feasibility and guiding the subsequent main study.

3.2.3 Results

The pilot study evaluated the impact of the geometry intervention program on students' math-related outcomes and informed refinements for the main study. Quantitative analysis revealed a significant reduction in geometry-specific math anxiety, with pre- to post-intervention scores decreasing from $M = 2.95$, $SD = 1.09$ to $M = 2.39$, $SD = 1.05$ ($t(21) = 2.35$, $p = .0286$). Test anxiety showed a trend toward reduction, though it did not reach conventional significance (pretest $M = 3.20$, $SD = 0.33$; posttest $M = 2.60$, $SD = 0.99$; $t(15) = 2.10$, $p = .0531$). No significant change was observed in general or geometry-specific self-efficacy (pretest $M = 3.36$, $SD = 0.99$; posttest $M = 3.31$, $SD = 0.87$; $t(15) = 0.23$, $p = .8212$). Achievement outcomes demonstrated significant improvement: geometry test scores increased from $M = 45.75$, $SD = 23.75$ to $M = 68.18$, $SD = 22.23$ ($t(21) = 5.10$, $p = .001$), and calculus scores improved from $M = 64.84$, $SD = 27.23$ to $M = 79.69$, $SD = 19.89$ ($t(21) = 3.16$, $p = .001$).

Qualitative data from semi-structured interviews with students provided insights into the program's perceived impact and guided program adjustments. Thematic analysis identified four main themes: academic performance, self-efficacy and goal-setting, attitudes toward mathematics, and program components. Students reported improved understanding of geometry concepts, effective application of principles, and enhanced stress management through breathing exercises. Increased confidence, goal-setting ability, and enjoyment of mathematics emerged, particularly due to interactive and experiential learning elements. Breathing exercises, games, and structured lessons were highlighted as

key contributors to engagement and emotional regulation, reinforcing academic and personal growth.

Based on the pilot findings, the program was refined to strengthen self-efficacy and academic performance. Adjustments included more targeted and structured activities, diversified breathing and reflective writing exercises, detailed geometric worksheets, and lesson renaming to emphasize geometric concepts. Multimedia enhancements were integrated into lesson presentations, including learning games, video-guided breathing exercises, and timed tasks. Teacher feedback and student self-evaluation were incorporated to reinforce self-efficacy. These refinements ensured that the intervention was more responsive to diverse student needs and optimized for both cognitive and emotional development in the main study.

3.2.4 Discussion and Conclusions

The pilot study played a crucial role in evaluating and refining the geometry intervention program for 5th- and 6th-grade students, confirming that addressing both emotional and academic factors is essential for overcoming barriers to success in mathematics. The study was grounded in the premise that students' engagement with mathematical challenges depends on the perceived balance between effort and expected success (Choe et al., 2019). By integrating tools for emotional support and academic development, the program aimed to make mathematics more accessible and rewarding, fostering positive attitudes toward learning.

Quantitative results indicated a significant reduction in geometry-specific and situational (test) anxiety, demonstrating the effectiveness of built-in stress management and confidence-building strategies. However, self-efficacy did not show a significant change, highlighting the need for targeted activities to enhance students' confidence and resilience in mathematics tasks. Achievement outcomes showed a notable increase in geometry performance, confirming the precision and impact of the intervention. These findings support the overall program approach while suggesting that refinements focusing on self-efficacy would strengthen its effectiveness.

Qualitative insights from student interviews emphasized improved understanding of geometric concepts, enhanced application of principles, increased goal-setting abilities, and greater enjoyment of mathematics through interactive and experiential learning. Key

program elements, such as breathing exercises, games, and structured lessons, were particularly valued for promoting focus, engagement, and emotional regulation.

Based on these findings, the intervention program was refined for the main study. Adjustments included reorganizing worksheets, integrating emotional and academic exercises into each task, embedding timed presentation links to promote focus and organization, and expanding reflective writing activities with both self-assessment and teacher feedback. These modifications aimed to strengthen students' self-efficacy, reinforce learning, and optimize both academic and emotional growth. The pilot study thus provided a strong foundation for implementing a more focused and effective intervention in the main research phase.

Chapter 4. Phase 3 - Testing the Impact of the Geometry Intervention Program on Students' Achievement, Math-Anxiety, and Self-Efficacy

4.1 Introduction

In Phase 2 (Chapter 3), a Geometry Intervention Program was developed with the aim of enhancing students' self-efficacy, reducing math anxiety in geometry classes, and fostering a more effective and supportive learning environment to promote higher mathematics achievement. An experimental study was conducted to evaluate the impact of this intervention on students' mathematics achievement, self-efficacy, and math-related anxiety. The study involved three experimental classes and two control classes, with the participation of two teachers in implementing the program.

4.2 Methodology

The study was conducted in 2023 in an elementary school in Israel, involving students in grades 5 and 6. The research employed a quantitative methodology to examine the effects of a Geometry Intervention Program designed around everyday situations on students' mathematics achievement, self-efficacy, and math anxiety. The primary research aim was to evaluate the impact of this program on students' academic performance and emotional development in geometry, guided by the following research questions: (1) To what extent does the Geometry Intervention Program improve students' achievement in geometry? (2) To what extent does it enhance students' self-efficacy? and (3) To what extent does it reduce students' mathematics anxiety.

The study included 124 students, with 75 students assigned to the experimental group and 49 to the control group. The experimental program was implemented by two teachers, including the researcher, across three heterogeneous experimental classes with comparable characteristics. The intervention consisted of 15 lessons delivered over two weekly mathematics sessions, focusing on structured activities that integrated both academic content and emotional support strategies. Both experimental and control groups completed pre- and post-tests in geometry and calculation, alongside validated scales measuring geometric anxiety, test anxiety, self-efficacy, and geometry-specific self-efficacy.

Standardized assessments from RAMA, the Israeli Ministry of Education's testing organization, were used to evaluate geometry and calculation achievement. Self-efficacy was measured with the validated scale developed by Schwarzer and Jerusalem (2014), while math anxiety was assessed using the Abbreviated Math Anxiety Scale (AMAS; Hopko et al., 2003) with an adaptation for geometry-specific contexts. The State and Trait Anxiety Inventory (STAI; Spielberger, 1970) was administered to distinguish situational test anxiety from stable trait anxiety, which would not be expected to change through the intervention. Demographic data, including family size and geographic location, were also collected.

Data were analyzed using descriptive and inferential statistics. Paired-sample t-tests and Pearson correlation coefficients examined differences between pre- and post-intervention measures across academic achievement, self-efficacy, and anxiety levels. Cronbach's alpha verified the reliability of the scales, while correlations among anxiety measures and their relationships with self-efficacy supported the validity of the instruments. Additionally, qualitative data from student interviews were thematically analyzed to identify key insights, capturing participants' perceptions of the program's effectiveness and highlighting areas for improvement. This comprehensive approach allowed for an evaluation of both cognitive and emotional outcomes, providing evidence for the effectiveness of the Geometry Intervention Program in supporting academic performance and emotional development.

4.3 Results

This subchapter presents the detailed results of the main study, which were obtained through quantitative analyses of achievement tests and self-report scales. Means and standard deviations were calculated for all measures, and paired t-tests and mixed-design ANOVAs were conducted to examine differences across time and between groups.

Analysis of geometry performance revealed that both experimental and control groups improved from pre- to post-test. In the program group, the mean geometry score increased from 43.03 (SD = 19.23) to 67.52 (SD = 21.69), $t(74) = 8.27$, $p < .001$, whereas the control group showed a smaller increase from 42.94 (SD = 15.71) to 51.35 (SD = 22.33), $t(47) = 2.78$, $p = .008$. A mixed-design ANOVA indicated a significant main effect of Time, $F(1,121) = 55.31$, $p < .001$, and a significant Time $\times$ Group interaction, $F(1,121)$

= 13.20, $p < .001$, confirming that the program group improved significantly more than the control group, with a larger effect size (Cohen's $d = 0.95$ vs. 0.40). Similarly, in calculation performance, the program group showed significant improvement ($M_{pre} = 58.60$, $SD = 23.34$; $M_{post} = 80.93$, $SD = 18.65$; $t(74) = 7.57$, $p < .001$), while the control group did not demonstrate a significant change, $t(48) = 0.45$, $p = .653$. Mixed-design ANOVA revealed a significant Time $\times$ Group interaction, $F(1,122) = 24.13$, $p < .001$.

The results for self-efficacy indicated stability across the intervention period. No significant changes were observed in general self-efficacy ($F(1,122) = 0.20$, $p = .215$) or geometric self-efficacy ($F(1,122) = 0.73$, $p > .05$), and no significant Time $\times$ Group interactions emerged, suggesting that the program did not impact these measures within the study timeframe.

Regarding anxiety measures, test anxiety showed a significant Time $\times$ Group interaction, $F(1,122) = 5.93$, $p < .05$, with a decrease in the program group ($t(74) = 1.97$, $p = 0.03$), whereas no significant change was observed in the control group. Geometry-related math anxiety also demonstrated a significant Time $\times$ Group interaction, $F(1,122) = 3.54$, $p < .05$, with the program group showing a decrease from $M_{pre} = 2.71$ to $M_{post} = 2.55$, $t(74) = 1.67$, $p = 0.049$, while the control group showed no change.

Gender comparisons were conducted using independent t-tests. Prior to the program, boys scored significantly higher in calculus ($M = 61.09$ vs. 50.94 , $t = 2.44$, $p = .016$) and geometry self-efficacy ($M = 3.66$ vs. 3.02 , $t = 3.16$, $p = .002$), while no significant differences were found in geometry achievement, test anxiety, geometry anxiety, or general self-efficacy. Separate mixed-design ANOVAs by gender revealed that for boys, the program group exhibited significantly greater gains in geometry ($F(1,44) = 9.89$, $p < .001$) and calculus performance ($F(1,44) = 15.47$, $p < .001$) compared to controls. For girls, a significant improvement was found in calculus performance ($F(1,44) = 5.93$, $p < .05$), but not in geometry, indicating that the program had a stronger effect on male students' geometry achievement. No significant Group $\times$ Time interactions were observed for either general or geometric self-efficacy in boys or girls. Test anxiety decreased slightly for boys in the program group ($F(1,44) = 3.20$, $p < .05$), whereas no significant changes were observed for girls. Geometry anxiety remained largely unchanged for both genders.

Overall, these results indicate that the Geometry Intervention Program effectively improved students' academic achievement in geometry and calculus and reduced test and geometry-related anxiety, particularly for boys. However, self-efficacy measures did not

show significant changes, suggesting the need for additional program components focused specifically on enhancing students' confidence in mathematical tasks.

4.4 Discussion and Conclusions

This study examined the effects of a geometry intervention program specifically developed for this research on the math achievement, self-efficacy, and math anxiety of 5th-6th grade students. The findings indicated significant improvements in academic performance, demonstrating the program's effectiveness in enhancing achievements in geometry and calculation competencies.

Academic Achievement. The hypothesis that the program would improve students' academic performance was confirmed. Significant gains were observed in geometry test scores among the experimental group, reflecting enhanced understanding and application of geometric concepts. These findings are consistent with previous research highlighting the benefits of integrating emotional support tools in mathematics instruction (Ergaz, 2018). For example, the Singapore Method, which incorporates reflective writing and collaborative learning strategies, has been linked to high mathematics performance (OECD, 2018). Notably, improvements were also observed in calculation performance, suggesting that the program's strategies foster broader academic growth beyond the targeted content area.

Self-Efficacy. The hypothesis that self-efficacy would improve was not confirmed, as no significant change was observed in either general or geometric self-efficacy. This suggests that changes in self-efficacy may require longer exposure to intervention strategies for students to internalize and recognize their abilities. Literature indicates that students of this age are influenced by social, cultural, and stereotypical factors in assessing their own abilities (Macmull & Ashkenazi, 2019; Pellizzoni et al., 2022). Future longitudinal studies are recommended to examine self-efficacy development over time.

Math Anxiety. The program effectively reduced situational math and test anxiety, confirming the hypothesis that anxiety would decrease following the intervention. The program's multifaceted approach—including mindfulness techniques, breathing exercises, game-based learning, reflective writing, and skill-building tasks—created a supportive learning environment that promoted academic success. However, trait anxiety, which reflects stable personal tendencies toward worry (Bruns et al., 2020), was not affected, as

expected. This distinction highlights the importance of tailored interventions that address situational rather than stable forms of anxiety (Li et al., 2023; Saviola et al., 2020).

Gender Differences. Boys demonstrated significantly higher achievement in calculation tests and higher geometric self-efficacy than girls. These findings align with existing literature showing that math anxiety is negatively correlated with female students' performance (Hembree, 1990; Wu et al., 2020). Despite these differences, both boys and girls in the program group showed substantial improvements in geometry and calculation skills, indicating the broad effectiveness of the intervention.

Educational Implications. The study underscores the importance of integrating emotional support tools within the mathematics curriculum. Combining pedagogical strategies with anxiety management and self-confidence tools can significantly enhance student achievement and emotional resilience. It is recommended that these strategies be implemented in all mathematics classes and incorporated into teacher training programs to maximize their impact. Although immediate improvements in self-efficacy were not observed, continuous exposure to these strategies may foster gradual growth in students' confidence and belief in their mathematical abilities. Long-term studies are suggested to evaluate these effects.

Ultimately, the findings highlight the value of emotional tools in mathematics education. The geometry intervention program not only improved academic achievement and reduced anxiety but also provides a model for integrating emotional and cognitive support in teaching. Complementary qualitative research further enriched the study by capturing students' and teachers' experiences, perceptions, and personal growth, contributing to a comprehensive understanding of the program's effectiveness.

Chapter 5. Phase 4 - Qualitative Research on the Geometry Intervention Program Efficacy

In line with Creswell's (2012) emphasis on the value of incorporating qualitative analysis, this study adopted a mixed methods approach to complement quantitative analysis with qualitative insights. While the quantitative phase measured students' achievement, math anxiety, and sense of self-efficacy, the qualitative research examined students' and teachers' experiences and perceptions of the intervention program. This phase, conducted in 2023 in an Israeli elementary school with grades 5 and 6, provided a deeper understanding of how the program was experienced in practice, enriching the overall assessment of its effectiveness.

5.1. Effect of the Intervention Program Based on Students' Self-Reports and Portfolios¹⁰

5.1.1 Methodology

The qualitative phase explored the impact of the geometry intervention program through student interviews and portfolio analysis. Twenty students (grades 5–6) participated in semi-structured interviews, and ten portfolios were analyzed. Interviews and portfolios revealed significant improvements in academic performance, self-efficacy, goal-setting, and attitudes toward mathematics. Students reported greater engagement, enjoyment of lessons, and effective use of program components, including breathing exercises, reflective writing, creative tasks, and interactive games. Portfolios documented enhanced reflective skills, emotional regulation, and progressive achievement in geometry tasks. Gender differences highlighted the need for personalized approaches, with girls expressing privacy concerns regarding writing tasks. Overall, the program fostered emotional resilience and academic growth, reduced math anxiety, and promoted motivation and confidence. Findings emphasize the importance of integrating emotional tools into mathematics education and suggest potential scalability to other classrooms and schools for broader impact.

¹⁰ The research presented in this subchapter was published in the following paper: Polacco, D., and Zsoldos-Marchis, I. (2025). Evaluating the effectiveness of a geometry intervention program through student insights. *Education 21*, (30), 100–111. <https://doi.org/10.24193/ed21.2025.30.08>

5.2 Case Study with the Teachers Participating in the Intervention Program¹¹

This case study examined the impact of a mathematics intervention program on fifth- and sixth-grade students, focusing on both academic outcomes and emotional development, as perceived by their teachers. Conducted in 2023 at an Israeli elementary school, the study employed qualitative methods, including semi-structured interviews with two mathematics teachers who implemented the program. The interviews explored both the program's effects on students and teachers' personal and professional experiences, with analysis guided by thematic and categorical approaches (Creswell, 2018).

Teachers reported notable improvements in students' mathematical abilities, particularly in geometry, as well as increased engagement, motivation, and academic performance. Mindfulness and breathing exercises were highlighted as effective strategies for reducing math anxiety and fostering students' self-efficacy, which, in turn, facilitated better focus and emotional readiness to tackle challenging tasks. Both teachers observed that these principles were applicable across subjects and contributed to broader life skills, including stress management and cognitive flexibility. Recommendations for improvement included shorter, 30-minute lessons and more interactive, hands-on activities to sustain attention and engagement.

Regarding teachers' professional development, participation in the program enhanced confidence, pedagogical insight, and openness to integrating emotional and experiential strategies. Teachers valued the structured, all-in-one lesson presentations, which simplified lesson management and enabled consistent implementation of the program's tools. Despite initial hesitation in adopting novel methods, both teachers reported personal and professional growth, continuing to incorporate emotional tools, reflective writing, and game-based activities into their teaching practices.

The findings underscore the importance of integrating cognitive and emotional support in mathematics instruction. Emotional strategies complemented traditional teaching methods, reducing anxiety, increasing self-efficacy, and promoting holistic student development. Moreover, the program facilitated lasting changes in teaching practices, demonstrating the potential for sustainable professional development. These

¹¹ The results from this subchapter were published in the following paper: Polacco, D. (2025). Teachers' opinion about the effectiveness of a geometry intervention program integrating emotional support. *Acta Didactica Napocensia*, 18(1), 114–129. <https://doi.org/10.24193/adn.18.1.10>

results align with social-emotional learning theories and prior research emphasizing the connection between emotional support, engagement, and academic achievement (Foley et al., 2017; Ayuso et al., 2021; Hembree, 1990; Ergas et al., 2018; Zsoldos-Marchis, 2020).

In conclusion, this case study provides evidence that integrating emotional, reflective, and experiential tools into mathematics education can significantly enhance both student outcomes and teacher professional growth. The program's holistic approach illustrates the value of addressing cognitive and affective needs simultaneously, fostering inclusive, engaging, and effective learning environments in geometry education.

Chapter 6. Summary

The present study introduced an intervention program integrating emotional support tools within geometry instruction to promote both mathematical achievement and personal growth. By targeting challenges such as math anxiety and low self-efficacy, the program aimed to provide meaningful and relevant learning experiences that support students' academic success and emotional well-being. To capture the program's full impact, the research encompassed the entire process—from developing a theoretical framework and designing the intervention, to implementation and the collection and analysis of quantitative and qualitative data. This comprehensive approach allowed for an in-depth understanding of the program's structure, methodology, and outcomes, highlighting its effectiveness in fostering holistic student development.

6.1 Summary of the Methodology

Table 2 summarizes the methodology of the study: phases of the study with research aims, participants, research tools, and data analysis.

6.2 Ethics of the Research

The current study adhered to ethical guidelines, as outlined by the chief ethicist of the Israeli Ministry of Education (2018). Research approval appears in see Appendix 6 in the thesis. Before beginning the research, all the necessary documents were submitted, and letters were sent both to the parents of the research participants and the teachers involved in the research team.

The parents of the participants were required to provide consent by signing a form confirming their child's participation in the study. This form detailed the scope of the research, including participation in in-depth interviews and examination of student files. Parents were given the option to opt out of the qualitative part of the study, which included personal interviews and analysis of the students' portfolios.

The submission to the ethics committee was accompanied by a confirmation from the supervisor at the University of Cluj regarding the approval of the study (Creswell, 2012), as well as a confirmation from the statistician supporting the study.

This research adhered to ethical principles such as informed consent and full disclosure of the nature of the research and any foreseeable risks to the participants (Creswell, 2012; Pecorari, Sutherl & Smith, 2021). As such, the findings were analyzed and disseminated ethically and confidentially to protect individual privacy, especially when the participants were elementary school students. All personal information, including names, photos, and other identifying information, was kept confidential and not reported to anyone outside the research group. Also, any material written by the students during the program, such as portfolios, was treated confidentially and was not shared with external parties.

This approach ensured the privacy of the students and fostered an environment where they felt very comfortable sharing their thoughts and feelings during the program and at its conclusion in the in-depth personal interviews (Satakar & Shaw, 2019; Shamim & Qureshi, 2013). Participants were assured that there were no right or wrong answers, and their responses would not be judged. Instead, the focus was on listening to their thoughts and opinions about the experience and facilitating discussions about potential ways to change (Buchanan & Warwick, 2021; Pecorari & Sutherland-Smith, 2021; Sperling, 2021). The teaching staff took steps to mitigate the effect of any social desirability bias.

6.3 General Discussion Conclusion

This study focused on improving geometry education for fifth and sixth grade students (ages 10–12) by integrating emotional development tools into the learning process. It addressed math anxiety, self-efficacy, and emotional regulation alongside academic instruction. The study examined how the intervention program affected students' performance and achievement, while providing them with tools to overcome barriers affecting their success in math at this critical stage of development (Erikson, 1982; West et al., 2020; White & McCoy, 2019).

The intervention revealed a variety of emotional support tools, such as breathing exercises (Zuo & Wang, 2023) and reflective writing (Long et al., 2022; Samavi, 2022; Smith, 2018), etc., designed to reduce math anxiety and build emotional resilience. The results showed significant improvements in students' Geometry and Calculus test scores after the intervention, highlighting the effectiveness of the program in improving academic performance.

This study highlights the importance of using emotional tools in mathematics education, tailored to the specific needs of each country and each school, especially in the wake of the COVID-19 pandemic. These findings are consistent with existing literature that emphasizes the need for emotional empowerment in response to the increased challenges brought about by the pandemic (Benner et al., 2024; Contini et al., 2022; Levi-Belz et al., 2024)

By reducing math anxiety and supporting emotional and academic development among fifth and sixth graders, the intervention was shown to be compatible with existing educational frameworks. Furthermore, the study makes a significant contribution to understanding the factors that influence mathematics achievement, and addresses a notable gap in research related to math anxiety and self-efficacy among younger students (West et al., 2020; White et al., 2019). This highlights the global relevance of these issues, especially during times of educational disruption, such as the COVID-19 pandemic and regional conflicts, such as the October 7, 2023, Israel-Israel War, which have exacerbated students' anxiety and posed additional challenges (Levi-Belz et al., 2024; Sagi & Gilat, 2024).

The study also suggests that the emotional development tools & strategies presented may yield positive outcomes in other academic subjects beyond geometry instruction, as this study also demonstrated improvements in calculus tests.

These findings are consistent with previous research by Foley et al. (2017) and Ayuso et al. (2021), which highlights the significant role of emotional interventions in reducing anxiety and improving academic achievement. By equipping students with a diverse set of tools for emotional and personal development, the program fostered a pattern of consistent achievement, provided students with a stable emotional foundation, and motivated them to strive for continued success (Botha et al., 2019; Mikołajewska, 2021).

Furthermore, the study shows that students benefited not only academically but also in their ability to cope with everyday emotional challenges. The findings further emphasize the importance of addressing emotional aspects in mathematics instruction. Incorporating tasks from students' real-world contexts into the intervention contributed to improved performance, supporting previous findings that mathematics projects related to students' interests improve positive attitudes and mathematical achievement (London, 2022). Similarly, a study conducted among high school students in Israel found that teaching applied mathematics through real-world contexts positively affects mathematical performance and achievement (Asli & Zoldos-Marchis, 2023a).

In addition, the simplicity of the program structure facilitated implementation for teachers, strengthened their sense of confidence, and enhanced their teaching skills. As described in the literature, simple and well-structured programs contribute to teacher training and increased teacher confidence in teaching (Asli & Zsoldos-Marchis, 2023b). This study indicates that the intervention program significantly improves both academic achievement and enhances students' personal and emotional development, while remaining practical, accessible, and easy for educators to implement.

6.4 Validity, Reliability, Triangulation, and Generalization

This study applied **methodological triangulation**, combining both qualitative and quantitative methods to ensure greater validity and reliability of the findings. Its integration of multiple research tools provided a more comprehensive understanding of the research problem and verified the consistency of the results across different data sources. Through utilizing this triangulation, the study enhanced the credibility and depth of the findings, as well as ensured that the insights gained were well-supported by various forms of data.

The mixed methods approach used in this study, incorporating both qualitative and quantitative data, allowed for a more holistic exploration of the research questions (Aspers & Corte, 2019; Creswell & David Creswell, 2018). This combination of methodologies not only enriched the understanding of the program's impact but also supported the generalization of the findings and their implications for broader educational contexts (Barker & Pistrang, 2021; J. W. Creswell & David Creswell, 2018). The **quantitative analysis** which involved tests and questionnaires was supplemented by qualitative data, such as in-depth interviews and portfolio analysis, offering a robust view of the intervention's effects on academic achievement, math anxiety, and self-efficacy.

Quantitative Data: The analysis of the data collected through quantitative questionnaires provided key insights into the program's effects on math achievement and anxiety levels. The consistency of the results across various tools further validated the findings. For instance, the closed questionnaires on calculus and geometry (See Appendix 2 and Appendix 3 in the thesis) showed measurable improvements in student performance, while the math anxiety questionnaires reflected reductions in anxiety.

Qualitative Data: The qualitative findings, obtained through in-depth interviews and portfolio analysis, complemented and reinforced the quantitative results. In the

interviews, students expressed personal growth in both mathematical skills and self-efficacy. These qualitative insights highlighted the emotional and cognitive dimensions of learning that were not fully captured by the quantitative data alone. The portfolio analysis, which examined students' reflections and progress, further substantiated the positive impacts of the intervention program on their academic and emotional development.

Through cross-validating findings from the quantitative and qualitative analyses, the study demonstrated strong **internal reliability**. For all quantitative scales, the internal consistency was measured using Cronbach's Alpha, ensuring that each item and factor within the questionnaires met the necessary reliability standards (see Chapter 3 for details). The triangulation process ensured that the data from different sources, tests, questionnaires, interviews, and portfolios, aligned and provided a well-rounded perspective on the outcomes of the intervention.

The use of validated research tools, a geometry and calculus questionnaire developed by RAMA, a modified math anxiety questionnaire (Hopko, 2003; Spielberger et al., 1983), and a self-efficacy questionnaire drawn from the literature Schwarzer and Jerusalem (1995, 2014) further bolstered the study's **validity**. These tools were carefully selected and adapted to ensure that the data collected were both reliable and appropriate for the study's context (See Appendices 1, 2, and 3 for full details in the thesis).

Findings from Phase 4 (Qualitative Analysis, see Chapter 5) reinforced the **quantitative findings** from Phase 3 (Chapter 4). Both the in-depth interviews and the closed questionnaires revealed improvements in student performance and a significant reduction in math anxiety. The qualitative data provided additional insights into the students' experience, emotions, and personal development that emerged from participating in the intervention program. Many students expressed positive feelings about their progress in geometry, which corresponded with their improved performance on geometry-related tasks.

In particular, the **qualitative interviews** shed light on the emotional and cognitive transformations students underwent during the program. They reported feeling more confident in their abilities and a stronger sense of self-efficacy, both personally and academically. This improvement in self-efficacy was particularly evident in the interviews, where students clearly articulated their enhanced belief in their abilities to tackle mathematical tasks. While the quantitative questionnaires did not show a statistically significant improvement in self-efficacy, the qualitative data results strongly suggest a meaningful positive shift in the students' perceptions of their own capabilities. Through

triangulation in this study, the researcher found accuracy between the findings and confirmed the research hypotheses through the data collected, which were supported by the theoretical foundation (Creswell, 2012).

6.5 Contribution of the Research to Knowledge

This research significantly contributes to the existing literature by incorporating real-life situations into the teaching of mathematics to create motivation and interest, which has the potential to alleviate mathematical anxiety and build on students' cognitive abilities. The study introduces students and teachers to a variety of tools that combine emotional and mathematical approaches to learning, recognizing that addressing emotional needs is essential for successful learning (Carroll et al., 2020; Loreman et al., 2017). Disseminating the research findings and presenting these tools will help students who have mathematical abilities but face barriers and anxieties that hinder their mathematical performance and achievement. Math skills are essential throughout life, but many students choose to internalize their struggles, avoiding confrontation and missing opportunities to overcome their difficulties. However, life regularly requires us to face these challenges (Cohen et al., 2021; Commodari and La Rosa, 2021). Integrating everyday situations into math studies can benefit students at any stage of life, even beyond school. The program can lead to significant learning and long-term retention of these tools (Carroll and Isaacs, 2020). The integration of these tools is critical to improving mathematical achievement, not only in our country but throughout the world.

During the COVID-19 pandemic, the global population faced unprecedented challenges, including lockdowns that led students to face difficulties and anxieties on their own, without close assistance. In the years 2020-2021, the levels of anxiety about mathematics increased, which further increased the difficulties and created greater anxiety among the students. Therefore, the integration of these tools in mathematics classes is essential now more than ever (Mendoza et al., 2021).

This study contributes to the literature in reference to important factors that affect mathematical achievement in Israel and around the world. The effect of math anxiety and low self-efficacy on achievement has not been sufficiently studied, especially among 5th-6th grade students (Nicoloff, 2019; Živković et al., 2023). This study shows an improvement in students' achievement in math and geometry as a result of providing an emotional response to students.

Mathematics grades in general and geometry in particular are an important and disturbing issue in themselves, according to PISA, TIMSS, and RAMA reports. The achievement is very low in relation to the results of the calculus tests. This study seeks to provide an answer to improving geometry achievement already in elementary school in grades 5-6.

This study examined and found the effect of tools designed to deal with anxiety and self-efficacy in mathematics on student achievement in the 5th-6th grades. Research on this topic, in elementary schools, is essential and necessary, since most research on this topic focuses on high school students (Commodari & La Rosa, 2021; Forsblom et al., 2022; Živković et al., 2022). The literature and research indicate that the 5th-6th grades are a crucial stage in the development of mathematical thinking, where students move from concrete to abstract learning (Blazer, 2011; Commodari & La Rosa, 2021; White & McCoy, 2019). This study recognizes the importance for providing tools for students of these ages.

In subsequent years, math anxiety and low self-efficacy may deepen (West et al., 2020; White & McCoy, 2019). This research may help to stop or eradicate the phenomenon and lead to positive change both now and in the future. The need for intervention at this age further supported by Erikson's (1982) theory of the "industry versus inferiority" stage, which occurs between ages 6 and 11, a critical period for establishing self-efficacy.

According to Erikson, this is an ideal stage to offer tools to establish self-efficacy. After these ages, students' goal is to form a personal identity. If we offer students the right response to the previous stages, students will have a sense of autonomy, self-confidence, and belief in their ability to successfully cope with challenges.

This study highlights the importance of exposing students to tools that increase self-efficacy at this stage. The study provided appropriate tools and skills for cultivating self-efficacy (Erikson, 1982; Cherry, 2022). Publishing these tools in the literature can help improve the self-image of the students and their sense of their abilities in mathematics. Without support at this stage, students may develop feelings of inferiority and incompetence, which will lead to low self-efficacy and consequently to lower mathematical achievement.

This research also contributes by integrating emotional and academic tools into the existing mathematics teaching without the need to change current teaching methods. The integration of the intervention program is expected to lead to an improvement in

mathematical achievement (Gunaseelan & Pazhanivelu, 2016; Karsenty, 2021; Kazmagambet et al., 2020).

This study reinforces previous studies that have shown that social-emotional learning programs can effectively develop a positive and empowering self-concept for students with low self-efficacy or math anxiety (Beilock & Maloney, 2015; Sapazhanov et al., 2020). The purpose of the research is to reduce or eliminate the emotional symptoms in math classes, thereby improving mathematical knowledge and achievement. According to the articles and professional literature, this study contributes to the understanding and treatment of math anxiety and its effect on current and future students (Luttenberger et al., 2018).

Math anxiety is receiving increasing attention in current research, and this study's findings contribute to helping teachers and students overcome mathematical barriers in daily tasks and math classes (Dowker et al., 2016). This study makes a significant contribution to the existing literature on geometric anxiety. Although math anxiety has been widely documented, this study specifically examines and investigates its presence in the context of geometry classes. Through characterizing and addressing geometry-related anxiety, the study provides new insights into how students experience and cope with this specific form of anxiety. The research underscores the importance of identifying geometric anxiety and implementing effective strategies to manage and reduce it in the classroom (Huang, 2021; Wahyuni et al., 2024). This recognition of geometric anxiety as distinct from general math anxiety is a crucial step forward in supporting students' emotional and academic success. This study, which enables academic and emotional development for students in mathematics teaching without the need to replace and change the existing teaching, allows the integration of the program in every school and every country.

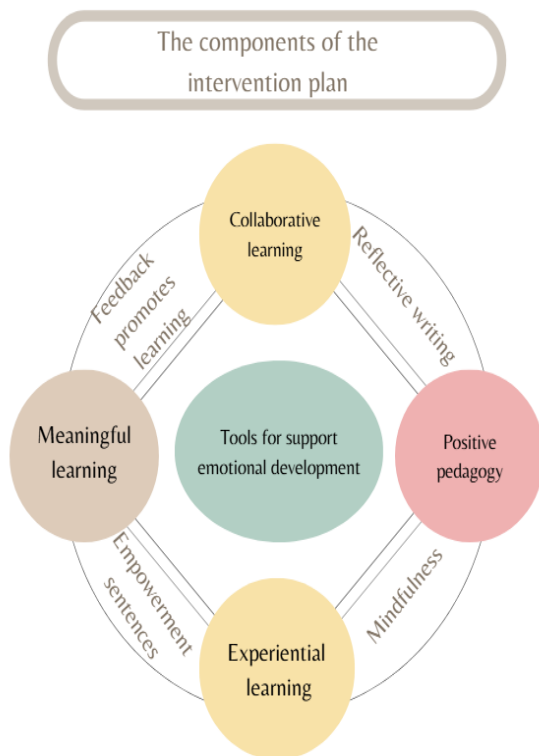


Figure 2: The components of the intervention plan

6.6 Research Limitations

Sample size and generalization: Because the sample size of the study was limited to fifth and sixth grade students from a limited geographic area, this could affect the generalizability of the findings to a wider population. Future studies should include a larger and more diverse sample to improve the external validity of the results. A total of 146 students participated in this study, including the pilot group, with 30% of them identified as having low self-efficacy based on the research questionnaires. A more comprehensive study that includes a larger population can yield more significant insights, especially regarding students with low self-efficacy in the 5th and 6th grades.

Duration of the intervention: The intervention program was relatively short, including 15 lessons that took place over about two months, with two lessons a week. Long-term studies are needed to determine the lasting effects of the intervention on self-efficacy.

Self-reported data: Much of the data was collected through self-reported questionnaires and interviews, which may be subject to biases such as social desirability and recall bias. As noted in the literature, students at these ages may not be mature enough to accurately reflect their abilities and self-efficacy. Future research should incorporate objective measures of emotional and academic outcomes to validate self-reported data.

Geometry specificity: The intervention program focused on geometry education. Although significant improvements were observed in geometry achievement, which also had a positive effect on calculus test scores, the findings may not be directly applicable to other areas of thought. Future research should investigate the effectiveness of similar interventions across different domains and subjects.

External factors: The study was conducted following the COVID-19 pandemic and during regional conflicts, which may have affected students' emotional resilience and academic performance. Future studies should examine the impact of the program in other countries where relationships are more stable and peaceful to moderate these effects.

Referring to the limitations of the research, the field can progress in creating interventions in other countries and in different areas of opinion, and creating an improvement in the academic performance and emotional well-being of the students.

6.7 Future Research

Future research should investigate other factors that may influence student self-efficacy, such as parental involvement and teacher-student relationships. Understanding these factors can help design more comprehensive intervention programs.

In addition, the current study identifies the need for future research to test the tools and intervention strategies of this study and their impact on diverse student populations, including those with learning disabilities and dyscalculia.

Future research could explore the impact of this intervention program across additional academic subjects, such as geography, language, or other areas within mathematics, including verbal problem-solving. Investigating its effectiveness in these contexts would offer valuable insights into the program's broader applicability and potential to enhance both academic performance and emotional well-being in diverse learning domains.

Additional future research is needed to evaluate the long-term effects of the current intervention program on students' math anxiety, self-efficacy, and academic achievement. This will help determine the durability of the benefits of the intervention over time. Future research is needed that will examine the differences between geometric anxiety and math anxiety and deepen the issue of geometric anxiety among elementary school students.

Further research should examine the effect of monitoring teacher groups on implementation in the delivery of the intervention program, and examine how teachers use

the current intervention program and emphasize the convenience and simplicity of the current intervention program, or provide best practices for implementation.

Future studies are important to the current research, as they involve a combination of emotional and academic developmental tools across different and other subjects. With the understanding that the current research provides an anchor and resilience for emotional development, future research will confirm that these tools on a different frontal topic will improve student achievement. This approach can help create a more holistic educational experience that supports students' overall well-being and academic success.

In the meantime, the use of the tools and strategies in the intervention program developed in this research could promote mathematics education in other countries, as well as be applied in different teaching areas, to foster improvement in students' academic performance and emotional development.

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